MODALITY, WORLDS, ESSENCE, AND MODAL KNOWLEDGE

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A theory of what it is for a proposition to be metaphysical necessary should satisfy a number of desiderata. Among other things, it should account for the characteristic connections between metaphysical modality and various other philosophically important notions, and it should explain how it is possible for us to possess the modal knowledge we have. I will describe the links between modal concepts and three other concepts (possible worlds, counterfactuals, and essence) in section 1. It is tempting to try to exploit the connections between modality and these other notions to give an illuminating account of necessity. However, existing attempts to do so face significant limitations. I will draw on previous work (Kment 2014) to propose a theory of modality that can shed light on the conceptual connections (section 2). Finally, after discussing some preliminaries in section 3, I will argue (section 4) that the account outlined in section 2 also yields an attractive explanation of how modal knowledge is possible.

1. Necessity, Possible Worlds, Essence, and Counterfactuals

Let us begin by considering the connections that exist between metaphysical necessity and three other notions that are often invoked to clarify the nature of modality.

Possible worlds. This connection is expressed by the following familiar biconditionals:

(1) (a) A proposition is metaphysically necessary iff it is true (not only as things actually are but) at all possible worlds.

(b) A proposition is metaphysically possible iff it is true at some possible world.

These biconditionals are widely applied in philosophy. They can be useful when we try to decide modal questions. For example, when we are wondering whether a certain scenario *S* is possible, it is often helpful to reformulate the question in terms of possible worlds: is there some possible world where *S* obtains?

David Lewis famously used the two biconditionals in (1) in his analysis of modality. On his view, possible worlds are (to simplify somewhat) spatio-temporally extended objects like the universe we inhabit, existing in mutual spatio-temporal isolation.[1] This account defines possible worlds in non-modal terms, thereby making it possible to give a reductive analysis of necessity

[1] Lewis (1986e, chapter 1).

as truth at all possible worlds.[2] The approach has not gained a wide following, however. Not only is it hard to believe in the plurality of universes postulated by Lewis, but many philosophers find it implausible that Lewisian worlds form the subject matter of modal claims even on the assumption that they exist.[3]

The best-known alternative to Lewis-style realism identifies possible situations with entities whose existence seems easier to accept than that of Lewisian worlds, such as stories or other representations that could have correctly and exhaustively described reality, maximal states of affairs that could have obtained, or maximally strong properties the universe could have had.[4] On all of these views, the property of being a possible world is itself seemingly modal, and (1) therefore does not look like a promising starting point for an illuminating theory of the nature of modality. These views seem entail that (1), far from being an informative account of what necessity is, merely articulates a fairly trivial connection between two modal properties. But that leaves us without a satisfying explanation of why possible worlds have played such a central role in so many philosophical accounts of modality.

Counterfactuals. Necessity is connected to counterfactuals in important ways.

(a) *Necessary truths are counterfactually robust*. One characteristic feature of the necessary truths can be described, as a first shot, as follows:

(2) If a proposition is necessary, then it would have held no matter what (else had been the case).

Let us say that the proposition that P counterfactually implies the proposition that Q iff, had it been that P, it would have been that Q. Then (2) can be restated as follows ("p" and "q" are propositional variables):

(3) $\forall q\,(\Box q \rightarrow \forall p\,(p \mathrel{\Box\!\!\rightarrow} q))$
A necessary truth is counterfactually implied by every proposition.

It is controversial whether this principle is true, however. Some philosophers have defended it (Williamson 2007, 171–5; 2017; 2018; 2020; also see Lewis 1973a; Stalnaker 1968, 1996). Others, including myself, have rejected the claim that every necessary truth is counterfactually implied by every impossible proposition, including its own negation (see Nolan 1997; Vander Laan 2004; Kment 2006b; 2014; Brogaard and Salerno 2007a; 2007b; 2013; Lange 2009, section 2.7; Berto, French, Priest, and Ripley 2018). For example, it is necessary that whales are mammals. And yet, to many philosophers, it seems false to say: if whales had not been

[2] Not everyone agrees that Lewis's account is truly reductive. See Lycan (1988), Shalkowski (1994), and Divers and Melia (2002). See Cameron (2012) for an overview of and contribution to this debate.

[3] See Lewis's discussion of the objection from actualism in Lewis (1986e, section 2.1).

[4] Examples of such views include the accounts in Plantinga (1974; 1976), Adams (1981), Stalnaker (1968; 1996), and Kment (2014, chapters 4–5), among many others.

mammals, then whales would have been mammals. This suggests that the quantifier in "no matter what else had been the case" in (2) should be understood as restricted to metaphysically possible scenarios. So interpreted, (2) can be spelled out as the following principle.

(4) $\forall q\,(\Box q \rightarrow \forall p\,(\Diamond p \rightarrow (p \mathrel{\Box\!\!\rightarrow} q)))$[5]
A necessary proposition is counterfactually implied by every possible proposition.

Given classical logic, the idea underlying (4) can be reformulated as the claim that the following inference rule is valid (i.e., truth-preserving under any interpretation of the schematic sentence letters "P" and "Q").

(5) $\Box Q, \Diamond P \vdash P \mathrel{\Box\!\!\rightarrow} Q$

(b) *Counterfactual implication transmits possibility*. We can capture an important connection between counterfactuals and possibility by saying that the following inference rule is valid.

(6) $\Diamond P, P \mathrel{\Box\!\!\rightarrow} Q \vdash \Diamond Q$

Assuming that $\Box$ and $\Diamond$ are duals, (6) can be derived from (5) with the help of (7).[6]

(7) $\Diamond P \vdash \neg((P \mathrel{\Box\!\!\rightarrow} Q) \,\&\, (P \mathrel{\Box\!\!\rightarrow} \neg Q))$

Since it is plausible that (7) is valid, it is natural to view the validity of (6) as a corollary of the validity of (5). (6) is commonly used to show that a proposition is metaphysically possible. For example, a philosopher might say the following to convince an interlocutor that gold could have failed to be yellow: "There could have been a metal with the same microstructure as gold in the actual world that was not yellow. If there had been such a metal, then (that metal would have been gold and so) gold would not have been yellow." This line of reasoning employs an instance of (6) (with **P** in (6) being instantiated with "There is a metal with the same microstructure as gold in the actual world that is not yellow" and **Q** with "Gold is not yellow").[7]

The truth-conditions of ordinary-language counterfactuals are commonly held to be context-dependent. I do not claim that (5) and (6) are valid for such counterfactuals and metaphysical modality in every context. Instead, I hold that they are valid in a specific class of contexts that characterizes most uses of counterfactuals in explanatory reasoning and practical deliberation (Kment 2014, section 2.7). $\mathbf{P} \mathrel{\Box\!\!\rightarrow} \mathbf{Q}$ in (5) and (6) is to be understood as having the truth-

[5] Some philosophers doubt even the qualified principle (Nolan 1997, Bernstein 2016, Vander Laan 2004). For defenses, see Jago 2014, Mares 1997. Also see Berto, French, Priest and Ripley 2018.

[6] Suppose that $\Diamond\mathbf{P}$ and $\mathbf{P} \mathrel{\Box\!\!\rightarrow} \mathbf{Q}$ hold and assume for *reductio* that $\Diamond\mathbf{Q}$ is false. Then $\Box\neg\mathbf{Q}$ is true. By (5), we can infer $\mathbf{P} \mathrel{\Box\!\!\rightarrow} \neg\mathbf{Q}$. Hence, $\mathbf{(P \mathrel{\Box\!\!\rightarrow} Q)\ \&\ (P \mathrel{\Box\!\!\rightarrow} \neg Q)}$ is true. But from $\Diamond\mathbf{P}$ we can infer $\neg\mathbf{((P \mathrel{\Box\!\!\rightarrow} Q)\ \&\ (P \mathrel{\Box\!\!\rightarrow} \neg Q))}$ by (7).

[7] For other accounts that place emphasis on counterfactuals in thought experiments that are intended to establish modal conclusions, see Jackson 1998; 2010; Chalmers 2002; Williamson 2007. Also see Lange 2009.

conditions that an ordinary-language counterfactual with the same antecedent and consequent would have in such contexts. A detailed account of these truth-conditions is given in Kment 2014, chapters 8−9.

(a)−(b) are not distinctive of metaphysical modality but are valid for a larger class of modal properties. Consider transmission of possibility across counterfactual implication. There seem to be readings of (6) in which "◊" expresses a form of possibility different from metaphysical possibility and which make (6) valid. Note that the following argument would fit perfectly naturally into an everyday conversation, and it appears to be valid:

(8) Team A could have won (the soccer tournament). For, they could have hired Jones as a trainer, and if they had done that, they would have won.

(8) is an application of (6) if "◊" in (6) is interpreted as expressing the same form of possibility as "could" in (8). Now, in most realistic scenarios in which (8) is uttered, "could" expresses a kind of possibility much stronger than metaphysical possibility. (Understood as a claim about metaphysical possibility, the conclusion of (8), i.e. the first sentence, is trivial.) Moreover, it is easy to imagine a long series of contexts c_1, c_2, … such that (i) "could" expresses a form of possibility stronger than metaphysical possibility in all of c_1, c_2, …, and (ii) "could" expresses a stronger form of possibility in c_{i+1} than in c_i (i.e., for "Team X could have won" to be true in c_{i+1}, Team X needs to be better than it has to be for the same sentence to be true in c_i), and (iii) (8) seems to be a valid argument in all of c_1, c_2, …. This seems to show that there is a whole range of possibility properties that are transmitted across counterfactual implication.

There are equally strong reasons to deny that counterfactual robustness is distinctive of metaphysical modality. *First*, many philosophers believe that there is a form of necessity (called "nomic," "physical," or "natural" necessity) that is weaker than metaphysical necessity, and which attaches to all propositions metaphysically necessitated by the natural laws. A high degree of counterfactual robustness, i.e. the power to support a wide range of counterfactuals, is usually thought to be the hallmark of this kind of necessity. *Secondly*, there are readings of (5) in which ◊ and □ express a form of modality different from both metaphysical and nomic modality and which make (5) valid. Suppose that we are watching the semi-finals of a sports tournament in which Team A loses after their goalkeeper commits an avoidable blunder. After the game I say:

(9) (i) Team A could have made it to the finals, though (ii) they could not have won the tournament.

Clearly, the occurrences of "could" in this utterance express a form of possibility stronger than metaphysical possibility. (Otherwise, (9)(i) would be trivial and (9)(ii) would be obviously false.) You would take (9) to commit me to:

(10) If Team A had made it to the finals, they would (still) not have won the tournament.

Thus, where ◊ represents the notion of possibility expressed by "could" in (9), it seems that ◊**P** and ¬◊**Q** entail **P** □→ ¬**Q**. The inference appears to be valid. Assuming that □ is the dual of ◊ and that ¬◊**Q** is therefore equivalent to □¬**Q**, it seems that ◊**P** and □¬**Q** entail **P** □→ ¬**Q**, and more generally, that ◊**P** and □**Q** entail **P** □→ **Q**. As before, we can imagine a series of contexts in which "could" in (9) expresses increasingly strong notions of possibility and the inference from (9) to (10) remains valid. (5) therefore seems to be valid for a broad range of forms of modality.

A central element of our conception of necessity seems to be the idea that the truth of a necessary proposition is *unconditional*, or *secure* in some non-epistemic sense, while that of a contingent proposition is contingent on what else is the case (and therefore not unconditional). The thesis that the necessary truths are particularly counterfactually robust seems to provide a good way of capturing this idea (Kment 2006b; 2014; Lange 2009). The foregoing reflections suggest that this connection to unconditionality or security is not distinctive of metaphysical modality but characteristic of a broader family of modal properties. A theory of modality should accommodate this finding.

Timothy Williamson and Marc Lange have offered accounts of necessity in terms of counterfactual robustness. Williamson (2005; 2007, chapter 5) holds that it is the hallmark of the metaphysical necessities that they are counterfactually implied by all propositions whatsoever—a feature captured by rule (3). (Also see McFetridge 1990; Hill 2006.) In particular, metaphysical necessities are the only propositions that are counterfactually implied even by their own negations. This account can accommodate the centrality of counterfactual robustness to the notion of necessity. However, as mentioned above, it is highly controversial whether (3) holds for metaphysical necessity. The debate about this question is ongoing and I will not be able to join it here. Suffice it to say that those of us who have not been convinced of the truth of (3) have good reasons for exploring alternatives to Williamson's account.

Lange's theory (1999; 2000; 2005; 2009) focuses on logical and natural necessity. On his account, the natural necessities are, in all contexts, counterfactually implied by all propositions consistent with them, and the same is true of the logical necessities. Moreover, the natural necessities and the logical necessities are the only deductively closed collections of truths of which this is true. This view avoids commitment to (3). (On Lange's account, (3) is false—see Lange (2009, section 2.7).) However, Lange focuses on a property that he takes to be exemplified only by the nomic and logical necessities. Consequently, his account does not illuminate the aforementioned broader family of modal concepts characterized by counterfactual robustness and the transmission of possibility across counterfactual implication (i.e., the family that includes the modal properties expressed by "could" in typical utterances of (8) and (9)).

Essence. Metaphysical necessity is often believed to be intimately connected to essence. The essential truths about *a* articulate part of what it is to be *a*, or part of what makes something *a*. For example, it is an essential truth about gold that it is a metal, since being a metal is part of what it *is* to be gold, or part of what *makes* a substance gold. By contrast, it is merely an

accidental truth about gold that it fills the cavities and adorns the necks of the rich, since that is not part of what makes a stuff gold. It used to be common to define essentialist notions in modal terms. For example, Kripke (1981) thought that a property was essential to an entity iff the entity could not have existed without having the property. However, Kit Fine (1994) argued that such modal definitions are unpromising. It is arguably necessary that, if an object exists, then its singleton set exists as well. Hence, Socrates could not have existed without being a member of {Socrates}. And yet, being a member of {Socrates} is not part of what it is to be Socrates, or of what makes something Socrates. (By contrast, it may very well be part of what it is for something to be {Socrates} to have Socrates as a member.) Fine argues in detail—convincingly in my view—that there is no modal condition that is both necessary and sufficient for it to be essential to *a* that P.

Nevertheless, many philosophers who are friendly towards a hyperintensional notion of essence accept that there are two important connections between essence and necessity. *First*, while the truth of (11) is not sufficient for the truth of (12), the converse does hold: if it is essential to *a* that *P*, then it is necessary that (if *a* exists, then) P.

(11) It is necessary that (if *a* exists, then) P.

(12) It is essential to *a* that P.

Secondly, it seems that modal facts are often *explained* by facts about essence. If the question is raised *why* water could not have (existed but) failed to have the chemical structure H_2O, it seems natural to reply: because that is part of what it is to be water.

Is it possible to use the notion of essence to give an account of what it is for a proposition to be necessary? We may try out a view along the following lines (see Fine 1994; also see Lowe 2006; 2007; 2012; Hale 2013, chapter 11; Teitel 2019; Ditter 2020):

(13) For a proposition to be necessary is for it to be true in virtue of the essences of things.

Further work would be required to turn this into a full-fledged account of necessity—in particular, one would need to explain the phrase "in virtue of." But irrespective of how these details are worked out, there are reasons to doubt that any theory like (13) can give us a correct and complete account of what it is for a proposition to be metaphysically necessary . Such an account should not merely yield the right extension in all possible worlds, but should tell us what *makes* a proposition necessary. As we saw before, it seems plausible that what makes a proposition necessary has something to do with the fact that it is especially unconditional and secure in some metaphysical sense. (13) does not capture this thought (or at least it does not do so unless it is supplemented with an account according to which the essential truths themselves enjoy a special kind of unconditionality and security). (See Kment 2014, section 7.4.) Moreover, (13) sheds no light on the aforementioned broader family of modal concepts, since it is true only of metaphysical necessity and it is unclear how to generalize it.

2. A Theory of Necessity

I will outline an account of what necessity is (which is developed in detail in Kment 2014) that seems particularly well-suited to explain the data surveyed in the preceding section. Let me begin by describing some of the basic elements of the view.

Impossible Worlds. Following Daniel Nolan (1997; 2013) and others, I will employ a theoretical framework that allows for impossible worlds as well as possible ones. One way to bring out the motivation for this approach is to consider counterpossibles, i.e. counterfactual conditionals with metaphysically impossible antecedents. On the standard account of counterfactuals (Stalnaker 1968; Lewis 1973a; 1986),

Q $\square\!\!\rightarrow$ P iff P at the worlds closest to actuality where Q.

On the assumption that all worlds are metaphysically possible, this account entails that all counterpossibles are vacuously true (since there are no antecedent-worlds), irrespective of the contents of their antecedents and consequents. But to many philosophers that seems very implausible. We already encountered one apparent counterexample above: the counterfactual "If whales had not been mammals, they would still have been mammals" sounds false, despite the fact that its antecedent is metaphysically impossible. In many other cases, the fact that the antecedent of a counterfactual is metaphysically impossible does not seem to settle the truth-value of the conditional. It is metaphysically impossible for me to be the son of Hillary and Bill Clinton. But that leaves it an open question in what ways I would be different if I were their son. Similarly, it is metaphysically impossible for there to be no numbers, but that does not seem to answer the question whether physical events would have unfolded differently if numbers had not existed. Since this problem arises from disallowing worlds where impossible propositions are true, the obvious remedy—suggested and developed by a number of philosophers (Routley 1989, Mares 1997; Nolan 1997; Zalta 1997; Vander Laan 2004; Kment 2006b; 2014, chapters 2–5, 7–8, in particular chapter 4)—is to lift this restriction. Instead of appealing to possible worlds, we can formulate the account in terms of worlds more generally, including both possible and impossible worlds. Worlds are simply ways for reality to be, and they include both ways reality could have been and ways reality could not have been.[8]

I think of worlds as collections of structured Russellian propositions (which are constructed from the individuals, properties, etc. that they are about). I argue in Kment 2014, chapter 4 that we can introduce non-modal notions of logical entailment and logical consistency for Russellian propositions, to be explained in terms of the logical structures of these propositions. To count as a world, a collection of propositions *w* needs to answer every question, in the sense that either *P* or the negation of *P* is logically entailed by *w* for every Russellian proposition *P*. Hence:

[8] For more on impossible worlds, see Nolan 1997; 2013. See Stalnaker 1996 for some arguments against impossible worlds.

(14) *w* is a world iff *w* is a collection of propositions and, for every proposition *P*, either *P* or *P*'s negation is true at *w*.

Moreover:

(15) *P* is true at *w* iff *P* is a proposition that is logically entailed (in the non-modal sense) by the propositions in *w*.

Unlike the notion of a possible world, the concept of a world is non-modal.

Gradability of modal properties.[9] Although it is often assumed that necessity and possibility are all-or-nothing matters, I think that there is some linguistic evidence to the contrary. Just as we can say that such-and-such could have been the case, we can say that this could more easily have been the case than that. On the face of it, that sounds like a comparison of degrees of possibility. I propose that we take this appearance at face value: possibility and necessity come in degrees (see also Lewis 1973b). Proposition *P* has a higher degree of possibility than proposition *Q* just in case *P* could more easily have been true than *Q*. Similarly, a true proposition *P* has a higher degree of necessity than another true proposition *Q* just in case *Q* could more easily have been false than *P*. To get a better handle on claims about how easily something could have been the case, it is useful to consider how we ordinarily support such a claim. When talking about a soccer game, we may say: "The game ended in a draw, but our team could easily have won. If the goalkeeper had stood two inches further to the right a minute before the end, the other team would not have scored their goal." In less favorable circumstances, we may say instead: "Our team couldn't easily have won. They would have beaten their opponents only if Mary had been on the team, Katie had been sober, Bob had known the rules, and so forth." How easily our team could have won depends on how great a departure from actuality is required for them to win. If they win in some situations that are only minimally different from the way things in fact are, then we can say that they could easily have won, or that their winning had a high degree of possibility. We can say the opposite if all situations where they win depart very significantly from actuality. Similarly, for any true proposition *P*, how easily *P* could have failed to be true depends on how great a departure from actuality is required for *P* not to be true. The greater the departure required, the higher *P*'s degree of necessity.

Talk about degrees of possibility is ubiquitous in ordinary life, but the locutions we use are not always overtly modal. Often (but not invariably) we employ idioms that involve metaphors of proximity, fragility, or security. You are running to catch the train, but the doors close on you before you can jump in, causing you to sigh in frustration "I nearly made it." Your utterance expresses the thought that you could easily have caught the train: a minimal departure from actuality—the doors closing half a second later—is all that was necessary. We say that something was a *close* call, that an event *almost* happened, or that somebody came *within a hair's breadth of* disaster, to communicate that various situations could easily have obtained. The

[9] See also Lewis 1973b; Kratzer 1991; 2012; Lange 1999.

peace between two nations during some period in history can be called *fragile* or *secure* depending on how easily their tensions could have escalated into war.

The theoretical framework of (possible and impossible) worlds can be used to sharpen the account of modality just sketched. Let us say that:

(16) *w* is actualized iff *w* is a world that entails all and only the true propositions.

There is exactly one actualized world ("the actual world" or "actuality")—a world that provides a wholly accurate and complete description of reality. Other worlds depart from actuality to varying degrees. The degree of possibility of a proposition P is determined by how close the closest P-worlds are to actuality: the closer these worlds, the more easily P could have been true. I will say that:

(17) S is a sphere iff S is a class of worlds and every world in S is closer to the world that is actualized than any world not in S.[10]

The ordering of unactualized worlds by their closeness to actuality generates a system of nested spheres. For each sphere there is a grade of necessity that attaches to just those propositions that are true at every world in that sphere, as well as a grade of possibility attaching to all propositions that are true at some world in the sphere. The larger the sphere, the greater the associated grade of necessity. One sphere (described in more detail below) is associated with metaphysical modality: a world counts as metaphysically possible just in case it is in that sphere and a proposition is metaphysically necessary just in case it is true at every world in that sphere.[11]

I call the relations of comparative possibility and necessity and modal properties defined in terms of them (such as metaphysical necessity) *ontic modal properties*/*relations*, to distinguish them from various other kinds of modal properties, like those of epistemic or deontic modality. The words "could" and "must" involve quantification over worlds. In most contexts, the quantification is restricted to worlds that meet specific conditions, and it is well known that the restrictions vary greatly between contexts (Kratzer 1991, 2012). "Could" expresses a grade of

[10] Note that the description "the world that is actualized" is a non-rigid designator. Roughly speaking, when (17) is evaluated at a possible world *w*, the phrase picks out *w*. (For complications, see Kment 2014, sections 4.7−4.8.) So understood, (17) is true at every possible world. The same observation applies to principle (18) below.

[11] The graded form of modality I described is similar to what Kratzer (1991, sections. 3.3, 5) calls "circumstantial modality," which she defines in terms of a closeness ordering. However, there is an important difference in the order of explanation and a closely related further difference between the non-reductive character of her account and the reductive nature of my own. I start with a non-modal concept of a world and a notion of comparative closeness between worlds that is defined non-modally, and I use them to give a non-modal definition of a graded notion of possibility. The graded notion in turn is used to define metaphysical possibility (as well as other specific grades of possibility, such as nomic possibility): the metaphysically possible propositions are those that have at least a certain degree of possibility, i.e. those that are true at some world within a certain distance from actuality. By contrast, Kratzer starts with an unanalyzed modal notion of a possible world, and then defines the closeness ordering and the graded notion of possibility in terms of it. Her view is non-reductive.

ontic possibility in a given context just in case the quantification over worlds is restricted to the worlds that are within a certain sphere around actuality and there are no other restrictions on these quantifiers.

To complete the analysis of modality we need an account of the rules that determine the ordering of worlds by their closeness to actuality. Such an account is developed in detail in Kment 2014, chapters 8–9. On this occasion, I will confine myself to sketching its most relevant parts.

The weightiest criterion of closeness to actuality is logical consistency, followed by similarity to actuality with regard to the laws.[12] Not all similarities regarding the laws carry the same weight, however. We need to distinguish between natural laws and what I call "metaphysical laws" (Kment 2014, chapter 6). The metaphysical laws include a range of metaphysical principles, such as essential truths and certain ontological principles, that play a distinctive explanatory role (which will be described in section 3). Let us say that a world *matches actuality with respect to the metaphysical laws* just in case it has the same metaphysical laws as actuality and it perfectly conforms to these laws. Match with respect to the metaphysical laws has greater weight in determining the closeness ordering than conformity to the natural laws of actuality. Match in matters of particular fact is also relevant to the closeness ordering but carries less weight than law-related similarities. On this account, the logically consistent worlds are closer to actuality than any other worlds—they form a sphere around actuality. The consistent worlds that match actuality with respect to the metaphysical laws form a second sphere inside the first one, and the consistent worlds that match actuality with respect to the metaphysical laws and also conform to the actual natural laws form a third sphere inside the second. There are many other spheres as well—some larger than the three mentioned, some intermediate between them, and some smaller than the three. Each sphere corresponds to a grade of necessity that attaches to just those propositions that are true at every world in that sphere. Metaphysical necessity is the grade corresponding to the sphere of consistent worlds that match actuality with respect to the metaphysical laws. Hence:

(18) P is metaphysically possible (necessary) iff P is a proposition that is true at some (all) worlds in the sphere of consistent worlds that match the world that is actualized with respect to the metaphysical laws.

This account can easily explain the connections of modality to the other notions that were discussed in section 1. Let us consider them in turn.

Possible Worlds. The theory I sketched explains why it seems illuminating to explain possibility and necessity of individual propositions in terms of possible worlds. Such an explanation highlights an important aspect of ontic modality, namely that it is by its very nature

[12] See, e.g., Lewis 1986; Bennett 1984; 2001; 2003, among many others.

holistic: a proposition's degree of ontic possibility is determined by how great a departure from the complete way things are is required for P to be true, i.e. by how much we need to change in *all of reality* to allow P to be true. The apparatus of worlds allows us to state this idea in less metaphorical terms. We start with a true and complete description of reality and then consider the changes we need to make to it to turn it into a complete description of reality that entails P. The true description we start from is the actual world. A complete description of reality that entails P is a P-world. P-worlds can be ordered by how great a change to the actual world is required to obtain them from the actual world. The smaller the changes that are required to obtain a P-world, the greater P's degree of possibility.

Counterfactuals. As we saw in section 1, there is evidence for thinking that metaphysical necessity belongs to a broader family of modal properties that have two characteristic connections to counterfactuals: they conform to the principle that necessary propositions are counterfactually robust (which is encapsulated in the inference rule (5)) and to the principle that possibility is transmitted across counterfactual implication (enshrined in principle (6)). The account outlined in this section captures this idea. It entails that there is a scale of different grades of necessity that correspond to spheres of different sizes around the actual world and that metaphysical necessity is one of these grades. Moreover, rules (5) and (6) are valid for all of these grades of modality. Let S be any sphere around actuality, and let necessity_S and possibility_S be (respectively) the grade of necessity and of possibility corresponding to S. Now, suppose that P is possible_S and Q is necessary_S. Then, P is true at some worlds in S and Q is true at all of these worlds. Moreover, since S is a sphere, the P-worlds in S are closer to actuality than any P-worlds outside of S. Therefore, Q holds at all of the closest P-worlds, so that $\mathbf{P} \boxright \mathbf{Q}$ is true. This shows that (5) is valid for possibility_S and necessity_S. Next, suppose that P is possible_S and that $\mathbf{P} \boxright \mathbf{Q}$ is true. Then P is true at some worlds in S. Given that S is a sphere, the P-worlds in S include the closest P-worlds. Moreover, since $\mathbf{P} \boxright \mathbf{Q}$ is true, Q holds at the closest P-worlds. It follows that Q holds at some worlds in S and is therefore be possible_S. So, (6) is valid for possibility_S.

Essence. As discussed in section 1, friends of essence often hold that there appear to be two important connections between metaphysical necessity and essence: (i) essential truths are metaphysically necessary, and (ii) for any essential truth E, the fact that E is metaphysically necessary is explained by the fact that E is an essential truth. The account I proposed explains both of these facts. It immediately entails (i). Moreover, if E is an essential truth, then that explains the fact that E holds at every world in the sphere of worlds that match actuality with respect to the metaphysical laws, which it turns explains the fact that P is metaphysically necessary.

In the remainder of this paper I will argue that the theory outlined in this section also allows us to explain how it is possible for us to gain the modal knowledge we seem to have. This will require an account of how we can acquire knowledge about the metaphysical laws. Before

offering such an account, some preliminary discussion of the notion of a metaphysical law and of its role in explanation will be required.

3. Metaphysical Laws, Grounding, and Causal Explanation

Since I take the notion of a metaphysical law to be defined by its theoretical role in a specific conception of grounding, I will start by briefly sketching this conception (for a more detailed statement of the account, see Kment 2014, chapter 6; 2015).

Grounding is the form of explanation described in statements like the following:

> What makes 28 a perfect number is the fact that it is a positive integer equal to the sum of its proper positive divisors.
>
> This particle is a hydrogen atom because (in virtue of the fact that) it is composed of one proton and one electron in such-and-such configuration.

Grounding relationships connect metaphysically non-fundamental facts to the more fundamental facts that give rise to them.[13] I think that the metaphysical laws play a role in grounding very similar to that of the natural laws in deterministic causation. Metaphysically more fundamental facts typically give rise to less fundamental ones in accordance with the metaphysical laws, just as in a deterministic universe earlier events bring about later ones in accordance with the laws of nature. The metaphysical laws are, as it were, the covering laws of such grounding relationships.[14]

The metaphysical laws include the essential truths, which relate to the question of what it takes to be a certain entity or to have a certain property.[15] For example, the essential truths about a non-fundamental property *F* lay down necessary and sufficient conditions for having *F* that are formulated in terms of more fundamental entities. An essential truth that lays down such conditions can be called a "real definition" of *F*.[16] When *F*'s real definition lays down that meeting condition *c* is necessary and sufficient for having *F*, we can express this by saying that to have *F* is to meet condition *c*, or that *F*-ness is the property of meeting condition *c*. To illustrate, the following might be a real definition of the property of being a hydrogen atom:

(19) *x* is a hydrogen atom iff *x* is composed of one proton and one electron that stand to each other in the H configuration.

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[13] For recent discussions of grounding and metaphysical explanation, see Schaffer 2009; 2016; Rosen 2010; Jenkins 2011; Bennett 2011; 2017; Koslicki 2012; Audi 2012a; 2012b; and Fine 2012a; 2012b. For some skeptical voices, see Hofweber 2009; Sider 2011, chapter 8; Daly 2012; and Wilson 2014.

[14] Versions of the covering-law conception of grounding and metaphysical explanation are proposed and defended in Kment 2014, chapter 6; 2015; Wilsch 2015a; 2015b; Glazier 2016; Rosen 2017; Schaffer 2017.

[15] See Fine 1994; 1995.

[16] For a slightly different conception of real definition, see Rosen 2015; 2017.

The claim that (19) is a real definition of the property of being a hydrogen atom can be stated more briefly by saying that (what it is) to be a hydrogen atom is to be composed of one proton and one electron that stand in the H configuration, or that hydrogen-atom-hood is the property of being so composed (Kment 2014, section 6.1.2).[17]

We have already encountered a number of real definitions in section 2, for I think that (14), (15), (16), (17), and (18) are real definitions of worldhood, truth-at, actualization, spherehood, and metaphysical necessity, respectively. For P to be metaphysically necessary is for P to be a proposition that is true at every world in the sphere of consistent worlds that match the world that is actualized with respect to the metaphysical laws. For *w* to be a world is for *w* to be a collection of propositions such that, for every proposition P, either P or P's negation is true at *w*. And so forth.

If the real definition of *F* lays down that condition *c* is necessary and sufficient for having *F*, then facts about which entities have *F* are at least partly grounded in facts about which entities satisfy *c*. For example, (20) and (21) are grounded in (22) and (23), respectively.

(20) Hydra is a hydrogen atom.

(21) You are not a hydrogen atom.

(22) Hydra is composed of one proton and one electron that stand in the H configuration.

(23) You are not composed of one proton and one electron that stand in the H configuration.

(19) functions as a covering law for both instances of grounding. The fact that (19) is essential to the property of being a hydrogen atom explains the fact that (22) grounds (20) and the fact that (23) grounds (21). Similarly, the fact that the proposition that 2+2=4 is metaphysically necessary is grounded in the fact that this proposition is true at all worlds in the sphere of consistent worlds that match the world that is actualized with respect to the metaphysical laws. The fact that the proposition that 2+2=5 is not metaphysically necessary is grounded in the fact that this proposition is not true at all worlds in that sphere. These grounding relationships are explained by the fact that (18) is essential to metaphysical necessity.

(It is a crucial assumption of this account that (20) and (22) state different facts—after all, the fact stated by (22) is supposed to explain the fact stated by (20) and this is not meant to be a case of self-explanation! I think that this assumption is independently plausible. (20) and (22) are not even about the same entities. (20) ascribes to Hydra the property of being a hydrogen atom, and this property is not mentioned, nor ascribed to anything, in (22). On the other hand, (22) says that Hydra stands in the composition relation to two other objects that are configured in a certain way and instantiate the properties of protonhood and electronhood, respectively. (20) does not say any of this—it says nothing about composition, protonhood, electronhood, or the H configuration. *Mutatis mutandis*, the same observations are true of (21) and (23).)

[17] For other accounts of idioms like "To be *F* is to be *G*," see Rayo 2013; Dorr 2016.

In addition to real definitions that lay down necessary and sufficient conditions for having a certain non-fundamental property, there may be others that lay down necessary and sufficient conditions for being a certain non-fundamental entity (specified in terms of more fundamental entities). For example, where "*N*" is a directly referential name for the singleton of the number 2, the following might be a real definition of this set: *x* is *N* iff *x* is the set whose sole member is 2.[18] We can express this by saying that to be *N* is to be the set that has 2 as its sole member. Many facts about *N* are grounded in facts that are not about *N* but are instead partly about the more fundamental entities in terms of which *N* is defined (2, membership, sethood, etc.). For instance, the fact that *N* figures in many philosophical examples is grounded in the fact that the set whose sole member is 2 figures in many such examples. The real definition of *N* stated above covers this instance of grounding.

The metaphysical laws may include principles other than essential truths as well, for example certain ontological laws. These are principles that tell us that under certain conditions there exists something of a certain kind. Laws of mereological composition are one example. They might include principles to the effect that whenever there are things meeting a certain condition *c*, there is something composed of exactly these things. Another example is principles of plenitude for properties, like the one stated by schema (24).

(24) There is a unique property of individuals F such that for an individual *x* to have F is for it to be the case that A(*x*),

or in other words, there is such a thing as the property of being an individual *x* such that A(*x*). Like essential truths, ontological laws are instantiated in certain cases of grounding. For example, the fact that (i) there is an object composed of the *a*s might be grounded in the fact that (ii) the *a*s exist and meet condition *c*. The law of mereological composition is the covering law for this instance of grounding, and the fact that it is a law explains the fact that (ii) grounds (i).

Grounding and causal explanation are closely intertwined (Kment 2014 section 1.2.1; 2015, section 1.1; Schaffer 2016). In many cases, *X* causally explains *Z* by causally explaining some other fact *Y* that in turn grounds *Z*. Let me run through a couple of examples. (a) The fact that you rubbed your hands together causally explains the fact that they are hotter than they were previously. It does so by causally explaining the fact that the kinetic energy of your hands' surface molecules increased, which in turn grounds the fact that your hands are hotter than before. The laws that connect the rubbing fact to the increase in temperature include various natural laws that are instantiated in the process by which the rubbing raises the kinetic energy. But they also include the real definition of being-hotter-than: *x* is hotter at *t* than *y* is at *t** iff the mean kinetic energy of *x*'s molecules at *t* is higher than that of *y*'s molecules at *t**. (b) The fact that you mixed certain ingredients in the right proportions and baked the resulting batter at a

[18] A real definition of an individual is a singular proposition about that individual, and stating such a real definition requires a directly referential name. The most common expressions for {2}, such as "the singleton of two" and "{2}," are not obviously directly referential, which is why I needed to introduce the term "*N*".

specific temperature for a suitable amount of time causally explains the fact that there is a Bundt cake on the kitchen counter. The facts about your actions are connected to the later existence of a Bundt cake by specific laws of nature (for example those instantiated in the various processes that happen during the baking of the cake) and certain metaphysical laws, including the real definition of being a Bundt cake: something is a Bundt cake iff it is made by such-and-such a process from such-and-such ingredients, combined in such-and-such proportions. (c) Suppose, for the sake of illustration, that the physical facts ground the mental facts by giving rise to them in accordance with the laws of metaphysics. You take a sip of coffee, which brings it about that such-and-such part of your brain is in a certain state, which (possibly in combination with certain background facts) grounds the fact that you have a specific taste sensation. The fact that you sipped your coffee causally explains the fact that you have the sensation via an explanatory chain that features both links of causal explanation (for example between the sipping fact and the facts about your brain state) and grounding links (for instance between brain-state facts and sensation facts). Moreover, the laws involved include both natural laws (such as those instantiated by the relevant brain processes) and metaphysical laws (including those in accordance with which the facts about your brain state ground the occurrence of the sensation).

These examples illustrate how both natural and metaphysical laws can be instantiated in the chain of explanatory relationships that connect a fact *f* to the facts that causally explain *f*. Elsewhere, I have argued (Kment 2014 sections 1.2.1, 6.4; 2015, section 1.1) that that is a pervasive phenomenon. Only a small set of properties and relations—the "physically fundamental" ones—are mentioned in the (fundamental) natural laws. If a fact *f* involves physically non-fundamental properties or relations and *f* is causally explained by other facts, then both natural and metaphysical laws figure as covering laws in the chain of explanatory connections that lead from *f*'s causal explainers to *f*. The natural laws alone do not suffice to forge the required connections.

4. Modal Knowledge

4.1 Knowledge of Modal Facts and Knowledge about the Metaphysical Law

One test for a metaphysical account of modality is whether it enables us to explain how it is possible for us to have the modal knowledge we do. In the remainder of this paper, I will aim to show that the account outlined in section 2 passes this test.

Note that the account entails the following principle:

(25) For every proposition P, P is metaphysically necessary (possible) iff the metaphysical laws and the truths about which propositions are metaphysical laws jointly logically entail (are jointly logically consistent with) P.

Moreover, given basic logical competence, modal knowledge can be gained from

(i) knowledge that (25) is true, and

(ii) knowledge about the metaphysical laws.

For example, if you know that that (25) holds and that *There are flying pigs* is logically consistent with all metaphysical laws and truths about which propositions are metaphysical laws, you can conclude that there could have been flying pigs. Similarly, suppose you know that (25) is true and that it is essential to gold that something is gold iff it is the element with atomic number 79. You can then conclude that it is necessary that, if gold exists, then gold is the element with atomic number 79. We can therefore explain the possibility of modal knowledge consistently with the account of section 2 if we can explain the possibility of the two kinds of knowledge specified in (i) and (ii). Moreover, since (25) can be known on the basis of knowledge of such real definitions as (14)–(18), an explanation of how knowledge about the metaphysical laws is possible also yields an explanation of how we can know that (25) is true.

The remaining task, therefore, is to explain how we can gain knowledge about the metaphysical laws. Let us turn to this question next.

4.2 Knowledge of the Metaphysical Laws

I will discuss two methods by which we may be able to gain knowledge about the metaphysical laws.[19] I do not claim that they are the only ones.

The *first* method proceeds by inference to the best explanation (IBE). As discussed in section 3, metaphysical laws figure as covering laws in the causal and grounding explanations of non-fundamental facts. We can apply our standards of theory evaluation to find the best account of how various non-fundamental facts are grounded, or the best account of what causally explains these facts (an account of their grounds will be part of a complete account of what causally explains them, as discussed in section 3). When made fully explicit in the right way, the complete version of such an account will involve certain assumptions about the metaphysical laws that cover the grounding relationships involved, and the abductive inference that establishes the account will support these assumptions about the metaphysical laws as well. For example, according to the best account of what grounds facts about temperature, these facts are grounded in facts about molecular kinetic energy. What makes it so that the sun is hotter than the earth, for instance, is that the sun's mean molecular kinetic energy is higher than the earth's. This account requires the assumption that there is a certain metaphysical covering law that is instantiated in the instance of grounding described. The relevant law is the real definition of being-hotter-than stated above. When we support our theory of what grounds facts about temperature by an

[19] Both methods are discussed in somewhat more detail in Kment 2021. For other discussions of (the possibility of) knowledge of essences. see Lowe 2012; Hale 2013, chapter 11; Tahko 2018; Mallozzi 2021.

inference to the best explanation, we support the hypothesis about the real definition of being-hotter-than at the same time.

The theory of what grounds facts about temperature is also part of a fully explicit version of the best account of how facts about temperature are *causally explained*. Suppose that you have just rubbed your hands and that they are now hotter than they were before. According to the best account of what causally explains the fact that your hands heated up, the fact that you rubbed your hands led to an increase in the mean kinetic energy of the molecules that make up your hands, and the fact that their kinetic energy increased grounds the fact that your hands are hotter than before. This account requires the aforementioned hypothesis about what the real definition of being-hotter-than is, and the abductive inference that establishes the account also confirms the hypothesis.

In the examples just considered, the grounding relationships require an essential truth as a covering law. In other cases, an ontological law plays this role. For example, on the best account of facts about macroscopic objects, they are grounded in facts about the arrangement of particles. The metaphysical laws covering these instances of grounding include certain laws of composition.

In some cases, the inference to the best explanation may start from truths that are known a priori and may not require recourse to sense experience. For example, mathematicians had a good grasp of the notion of the limit value of a function long before they knew a precise definition. Eventually, the Bolzano-Weierstrass definition gained widespread acceptance. Perhaps one way to rationalize that acceptance is to regard it as the result of an abductive inference. Mathematicians knew many facts of the form *The limit of f(x), as x approaches a, is y*. According to the best account of what grounds these facts, the fact that $\lim_{x \to a} f(x) = y$ is grounded in the fact that, for every real number $\varepsilon > 0$, there is a real number δ such that, for all $x \in (a-\delta, a+\delta)$, $|f(x)-y| < \varepsilon$. This account requires the assumption that the Bolzano-Weierstrass definition specifies the real definition of the relation of being-a-limit-of.

The conclusion of an abductive inference will often give us no more than a *partial* account of what explains the explanandum. It might be that all it tells us is that the factors that explain the explanandum are of such-and-such general kind. Picking a fruit from the apple tree in your garden, I notice that it is covered with ugly splotches and smells bad. I look at apples from other, nearby trees and the same is true of them. Given this and similar evidence (and a modest amount of background knowledge), I can conclude that the trees in your garden suffer from some disease. This is an inference to the best explanation—I conclude that the best account of what is responsible for the appearance of your apples involves the assumption that your trees are afflicted by disease. This conclusion falls far short of a complete account of what explains my data—I do not know *what* disease your trees have, or why that disease causes the symptoms I have observed. Similarly, an inference to the best explanation may establish some truths about the essence of *X* without giving us a complete account of its essence. Suppose that I am able to

recognize a Bundt cake by its look, taste, and smell, but I do not know what it *is* to be a Bundt cake. One day, I watch you make a dish that I recognize to be a Bundt cake. I know that the best account of what causally explains the presence of a Bundt cake on the kitchen counter appeals to specific assumptions about what it is to be a Bundt cake, and I can consequently support certain assumptions about the essence of Bundt-cake-hood abductively. But my evidence may not be sufficient to arrive at a complete account of what it is to a Bundt cake. Perhaps I have watched you from a distance and noticed that you mixed flour, milk, and eggs, and then added some other ingredients. But I couldn't quite tell what those additional ingredients were, nor do I know precisely in what proportions the ingredients were added to the batter or how a cake was made from the batter. In that case, all that I can conclude from my observations is that being a Bundt cake involves being made from ingredients that include flour, milk, and eggs. But that falls short of complete knowledge of the essence of Bundt-cake-hood.

The *second* way of gaining knowledge about the metaphysical laws relies on our conceptual or linguistic competence. It seems plausible that at least in some cases, competence with a concept or linguistic term *E* constitutively requires (at least implicit) knowledge of a specific condition that an entity needs to satisfy to be picked out or expressed by *E*. In some cases, this condition might be both necessary and sufficient for an entity to be the one picked out or expressed by *E*, while in other cases the condition might be merely necessary. Sometimes the condition might be that of having a certain (kind of) essence.

The notion of being a vixen might illustrate this. Full mastery of this concept arguably constitutively requires knowing (at least implicitly) that it picks out a given property F only if F's extension includes exactly the female foxes. Moreover, it arguably *also* constitutively requires knowing the stronger claim that the concept picks out a property F iff to have F *is* to be female and a fox, i.e., iff F is the property of being female and a fox. To see this, suppose that Fred knows that all and only female foxes are vixens. However, he is not sure whether being female and a fox is what makes something a vixen, or whether what makes something a vixen is the fact that it satisfies some other condition that merely happens, as a matter of accidental fact, to be met by all and only female foxes. (Perhaps he is wondering why it is the case that no non-foxes and no non-female foxes have ever been found to be vixens.) It seems plausible that Fred cannot be credited with a full grasp of the concept of being a vixen. Contrast this example with the case of the concept of water. A specific person's mastery of that concept might be partly constituted by the person's knowledge that the concept picks out *x* only if *x* is some stuff that plays a certain role *R* in our lives. However, it is *not* partly constituted by the speaker's knowledge that the concept picks out *x* only if (or if and only if) being a stuff that plays role *R* is (part of) what it is to be *x*. The speaker does not know the latter proposition, since that proposition is false. (Playing role *R* is not part of what it is to be water.)

Assume that the account of the possession conditions of the concept of being a vixen that I sketched in the preceding paragraph is correct. Then competence with the notion of being a vixen might put a speaker in a position to know the following:

(26) If the property of being a vixen exists, then being a vixen is the property of being female and a fox.

(27) If the property of being female and a fox exists, then it is the property of being a vixen.

Now suppose that the speaker also knows that femaleness and foxhood exist and that she knows, perhaps on the basis of inference to the best explanation, that (22) is true. Then she can infer that there is such a thing as the property of being female and a fox. Given her knowledge of (27), she can conclude that this property is the property of being a vixen, and hence that to be a vixen is to be a female fox.

Even when competence with a concept does not constitutively require knowing any proposition of the form *Concept C picks out F only if F's real definition is P*,[20] it might still require knowing (at least implicitly) some proposition of the form *C picks out F only if the essential truths about F meet such-and-such conditions*. For example, it might require knowing that a property *F* is picked out by C only if the following holds: it is essential to *F* that an entity *x* has *F* only if *x* meets condition *c*. (The proposition that *F* meets this condition does not entail that it is also essential to *F* that an entity *x* has *F if x* meets condition *c*; i.e., it does not entail that it is essential to *F* that *c* is *sufficient* for having F.) To take a concrete example, competence with the concept of propositional knowledge might require knowing (at least implicitly) that a relation *R* is picked out by this concept only if *R* meets the following condition: it is essential to *R* that *x* stands in *R* to a proposition *P* only if *P* is true and *x* believes *P*. (This constrains, but does not determine, which relation the concept picks out.) Someone who has mastered the concept of propositional knowledge might then be in a position to know that, if the relation of knowledge exists, then it is essential to knowledge that it relates a thinker to a proposition only if the proposition is true and the thinker believes the proposition. (While these conditions might be necessary for knowledge, they are not sufficient.)

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[20] See Putnam 1975 and Johnston and Leslie 2012 for arguments for the claim that competence with most expressions does not require knowledge of necessary and sufficient application conditions of the right kind.

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