

# Temporal Interpretation of Modals

## Modals for the Present and for the Past

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This paper provides a uniform analysis of the temporal interpretation of epistemic and metaphysical modals referring to the present, the past, or the future. It argues for a decompositional analysis of modals referring to the past, attributes the ambiguity of such modals to scopal ambiguity, and claims that a generalization relating the temporal reference of modals with the kind of modality they express is a consequence of the structure of possibilities and a felicity condition governing the association of modals with a modal base.

### 1 Introduction

This paper shows that non-root modals make a uniform contribution to temporal interpretation.<sup>1</sup> The seeming diversity of the temporal reference of modals is attributable to the interaction of their semantics with the semantics of the expressions they combine with.

Modal auxiliaries in English are used to express possibility or necessity, from the perspective of the time of utterance, about a state of affairs temporally located in the present, future or past. Modals such as *may*, *must*, *might*, *should*, *ought to*, sometimes referred to as ‘present

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<sup>1</sup>The traditional dichotomy is between root and epistemic modals. Since, however, the class of so-called epistemic modals includes modals expressing metaphysical as well as epistemic modality, the more neutral term ‘non-root’ is a more appropriate name for the class. The class of root modals includes deontic, dynamic and quantificational modals. For detailed discussion of the different uses of modals and of the distinction between root and non-root modals see, e.g., Palmer (1986), Jackendoff (1972), Brennan (1993).

tense modals,' express that it is possible or necessary, as far as the knowledge of an agent (e.g., the speaker) at the present moment is concerned, or as far as the state of the world at the present moment is concerned, that a certain state of affairs obtains at the present or will obtain in the future. I will refer to them as 'modals for the present.' In short, we can say that modals for the present take the perspective of the present, possibly with a future orientation. Modals such as *may have*, *must have*, *might have*, *should have*, *ought to have*, often referred to as 'past tense modals,' express that it is possible or necessary at the present moment that a certain state of affairs obtained in the past. I will refer to them as 'modals for the past.' Modals for the past take the perspective of the present with a past orientation.

Adverbial modification shows that modals for the past shift the time of evaluation of the sentence in their scope backward from the time of utterance, and that modals for the present sometimes shift the time of evaluation forward from the time of utterance, and sometimes do not. As seen in [1] and [2], modals for the present are only compatible with frame adverbials referring to the present or the future, and modals for the past are only compatible with frame adverbials referring to the past.<sup>2</sup>

- [1] a. He must/ought to/should/may/might get sick tomorrow/??now/\*yesterday.  
 b. He must/ought to/should/may/might be getting sick now/\*yesterday.  
 c. He must/ought to/should/may/might be sick now/tomorrow/\*yesterday.
- [2] a. He must/ought to/should/may/might have gotten sick yesterday/\*tomorrow.  
 b. He must/ought to/should/may/might have been sick yesterday/\*tomorrow.

These generalizations raise the question whether modals contribute to temporal interpretation directly, or whether their observed effect on temporal interpretation comes about through implicit tense. I will argue that modals contribute to temporal interpretation directly.

Supposing that modals are temporal as well as modal operators, one position would be that modals for the present and modals for the past express the same kind of modality but differ in their temporal meaning.

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<sup>2</sup>For purposes of this paper I ignore the future perfect reading of modals for the past, as in *He may have arrived by next week*.

This is, in effect, the position of a theory like Hornstein's (1990), where modals for the present and modals for the past are associated with distinct Reichenbachian temporal structures. It would also be the position of a theory that distinguished between forward-shifting modals, non-shifting modals and backward-shifting modals, giving each a distinct interpretation. Backward-shifting and forward-shifting modals would quantify over worlds and, like Priorian tense operators, they would existentially quantify over times as well. The semantics of each type would be along the lines of [3], [4], [5], respectively, where  $MB$  designates the modal base a modal depends on for its interpretation.  $MB$  here is taken to be a contextually determined function from world-time pairs to sets of worlds.

[3] Forward-shifting modals:

$\text{MIGHT}_{MB}^1 \phi$  is true at  $\langle w, t \rangle$  iff there exist  $w', t'$  such that  $w' \in MB(w, t)$ ,  $t \prec t'$  and  $\phi$  is true at  $\langle w', t' \rangle$ .

[4] Non-shifting modals:

$\text{MIGHT}_{MB}^2 \phi$  is true at  $\langle w, t \rangle$  iff there is  $w' \in MB(w, t)$  such that  $\phi$  is true at  $\langle w', t \rangle$ .

[5] Backward-shifting modals:

$\text{MIGHT-HAVE}_{MB}^1 \phi$  is true at  $\langle w, t \rangle$  iff there exist  $w', t'$  such that  $w' \in MB(w, t)$ ,  $t' \prec t$  and  $\phi$  is true at  $\langle w', t' \rangle$ .

Enç (1996) makes such a proposal for modals for the present, distinguishing between forward-shifting and non-shifting modals.

I argue instead for a decompositional analysis of modals for the past (section 3.1) and propose a unitary semantics for the modals in all three cases (section 3.2). Building on this proposal, I then show how the temporal interpretation of the modal determines whether the modal expresses epistemic or metaphysical modality (section 4).

## 2 The Ambiguity of Modals for the Past

With a modal for the present as in [6a], the possibility is unambiguously from the perspective of the present about the future and the modality can be either epistemic or metaphysical. Epistemic modality has to do with knowledge or information of agents. Metaphysical modality has to do with how the world may turn out, or might have turned out, to be. A modal of the past as in [6b], on the other hand, can have two temporal readings, one associated with epistemic modality, the other with metaphysical modality. I will refer to them as the *epistemic reading*

and the *counterfactual reading*. The two readings can be distinguished by surrounding context, as in [7].

- [6] a. He may/might win the game.  
 b. He might have won the game.
- [7] a. He may/might have (already) won the game (# but he didn't).  
 b. At that point he might (still) have won the game but he didn't in the end.

In the epistemic reading the possibility is from the perspective of the present about the past; its truth conditions are captured by [5]. The modality is epistemic: [7a] is used to communicate that we may now be located in a world whose past includes an event of his winning the game. The possibility is in view of the epistemic state of the speaker: his having won the game is consistent with the information available to the speaker. The issue of whether he won or not is actually settled, but the speaker does not, or presumes not to, know which way it was settled.

The counterfactual reading involves a future possibility in the past and the modality is metaphysical. [7b] is used to communicate that we are now located in a world whose past included the (unactualized) possibility of his winning the game. The possibility is about how the world might have turned out to be: at some point in the past the world was such that it could evolve into a world in which he won the game. At the relevant point in the past, the issue of whether he won or not had not been settled and the world could have developed either way. Certainly, [7b] is not just about epistemic uncertainty at that past point (though of course since the outcome had not materialized one couldn't know it either). Nor is it about epistemic uncertainty at the present (where what happened is in fact known).

That the counterfactual reading involves a future possibility in the past has been argued for persuasively by Mondadori (1978):

Contrary to what is generally claimed and believed and expected, “might have” is not a past (perfect) tense of “might”. It is the dual of the future perfect “will have”. Just as the latter is a past in the future, so the former is a future in the past—the future of a past. Just as the future perfect is (temporally) indexed to an event which is past to a given future time, so “might have” is indexed to an event which is future to a given past time. (p. 223)

A Priorian analysis of modals, as outlined in section 1, that incorporates Mondadori's claim would give *might have* on the counterfactual reading the semantics in [8].

- [8] Backward-then-forward-shifting modals:  
 MIGHT-HAVE<sub>MB</sub><sup>2</sup>  $\phi$  is true at  $\langle w, t \rangle$  iff there exist  $w', t', t''$  such that  $t' \prec t$ ,  $w' \in MB(w, t')$ ,  $t' \prec t''$  and  $\phi$  is true at  $\langle w', t'' \rangle$ .

The discussion above implies that modals are grouped together in one way according to their temporal orientation and in a different way according to their temporal perspective. With respect to their temporal orientation, modals for the present as in [6a] and modals for the past on the counterfactual reading, as in [7b], are alike, both having a future orientation. Modals for the past on the epistemic reading, by contrast, have a past orientation, as in [7a]. With respect to their temporal perspective, on the other hand, it is modals for the present and modals for the past on the epistemic reading that are alike, both having a present perspective. Modals for the past on the counterfactual reading differ from them in having a past perspective. The classification of modals with respect to these two parameters is summarized in the table in [9]. Note that there are no modals with a past perspective and a past orientation.

[9]	Future Orientation	Past Orientation
Present Perspective	modals for the present	modals for the past (epistemic reading)
Past Perspective	modals for the past (counterfactual reading)	

Why do modal expressions referring to the past, like *might have*, have a wider range of readings than the corresponding expressions referring to the present? Karttunen (1972) and Groenendijk & Stokhof (1975) claim, in effect, that such modals are lexically ambiguous and do not connect the ambiguity to their temporal interpretation. I will argue that the ambiguity is scopal, a result of the decompositional analysis of modals for the past, and that the availability of the epistemic or the metaphysical interpretation is tied to the underlying structure of possibilities.

### 3 Temporal Perspective and Orientation

#### 3.1 Tense with Modals

Do modals occur in the scope of tense, and do they combine with tensed or untensed sentences? These two questions are often conflated, but they are actually distinct.<sup>3</sup> I will argue that modals combine with untensed sentences and that they may occur in the scope of tense.

The question whether modals occur in the scope of tense is about how modals get their temporal perspective fixed. It is often observed that modal auxiliaries in unembedded clauses can only be interpreted as having the perspective of the time of utterance. For instance, Groenendijk & Stokhof (1975:70) note: “Modal expressions in the possibility meaning,<sup>4</sup> like *may* in *Makarios may be dead now*, cannot occur within the scope of a tense operator, they always occur in the present tense. Whatever is said to be possible with a sentence containing *may* is said to be possible on the basis of the information available to the speaker at the moment he utters the sentence. *Makarios may be dead tomorrow* must be paraphrased as *It may (now) be the case that Makarios will be dead tomorrow* or *Maybe/perhaps Makarios will be dead tomorrow*, not as *\*Tomorrow it may be the case that Makarios will be dead.*”

Abusch (1997:23), who concentrates on modals for the present, argues further that modals “are semantically tenseless and directly pick up the local evaluation time as a modal perspective, without mediation of a tense.” Abusch’s claim implies that there is no tense taking scope over a modal in the logical representation of sentences with modals. The main motivation for this claim is the interpretation of modals in intensional contexts.

If we allow for zero tenses, as in von Stechow (1995), we can assume that modals are in the scope of present tense in extensional contexts and in the scope of zero tense in intensional contexts. This is what I will assume in this paper and will refer to this tense as ‘outer tense.’ Therefore, the logical form of [6a] is as in [10], where the present tense operator fixes the temporal perspective of the modal to be the time of utterance.

[10] PRES(MIGHT(he win the game))

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<sup>3</sup>Settling for the presence of tense in one case does not force one to settle for the presence of tense in the other. For instance, Groenendijk & Stokhof (1975) argue that the scoping TENSE(MODAL  $\phi$ ) is impossible in their interpretation setup, while MODAL(TENSE  $\phi$ ) is a semantically acceptable scoping.

<sup>4</sup>Groenendijk & Stokhof use the term ‘modals in the possibility meaning’ to refer to non-root modals.

In a decompositional analysis of modals for the past, like the one I will propose, the perspective of a modal for the past in extensional contexts would still be the time of utterance when the modal is given scope over the perfect. Hence, it is not surprising that modals for the past have a present perspective in one of their readings, as in [7a]. On the other hand, when the perfect intervenes between the modal and outer tense, the perspective of the modal will not be the time of utterance but some time in the past, as set by the perfect. Hence, the past perspective reading, as in [7b]. One important issue to address is how these two scopal options are each coupled with one particular choice of modal base for the modal: epistemic when the modal takes scope over the perfect, metaphysical when the perfect takes scope over the modal. I address this issue in section 4. In this section I focus on the temporal aspects of the meaning of the modals.

The question whether modals combine with tensed or untensed sentences is about how the temporal parameter for the evaluation of the sentence in their scope gets fixed. Morphologically, there is obviously no tense. But what about semantic tense? One view, an early example of which is McCawley (1971) and a recent one Steedman (1997),<sup>5</sup> is that modals compose with tensed sentences. Present and future tenses are assumed to have no overt morphosyntactic manifestation in non-finite contexts, while past tense shows up as a perfect. I will refer to a tense in the scope of a modal as ‘inner tense.’ Ignoring outer tense, [11a] would thus be ambiguous and have the logical representations in [12a] and [12b], and [11b] would have the logical representation in [12c]. PRES, FUT and PAST are interpreted as deictic tenses, making reference to the time of utterance.

- [11] a. He may be sick.  
 b. He may have been sick.

- [12] a. MAY(PRES(he be sick))  
 b. MAY(FUT(he be sick))  
 c. MAY(PAST(he be sick))

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<sup>5</sup>Steedman, for instance writes: “modals and conditionals are essentially predications about entire Reichenbachian tensed propositions. In a, below, the modal is predicated about a present proposition, where S=R. Example b is predicated of a past tensed proposition.

a. She may be weary.  
 b. Einstein may have visited Philadelphia.  
 (Being infinitival, this past shows up as a perfect.)” (p. 26)

The patterns of adverbial modification seen in [1] and [2] are explained in this approach in terms of the compatibility of the meaning of the adverbs with the meaning of the implicit tense of the sentence the adverbs are part of.

The view that I will defend here is that there is no tense in the scope of the modal.<sup>6</sup> The forward-shifting or the backward-shifting effect seen in [1] and [2] is attributable to the contributions the modal and the perfect make to the temporal interpretation of the sentences they combine with in the way spelled out in section 3.2. On this view then, [11a] is unambiguous and has the logical representation in [13a], and [11b] has the logical representation in [13b] (ignoring outer tense).

- [13] a. MAY(he be sick)  
 b. MAY(PERF(he be sick))

Since on its standard interpretation<sup>7</sup> the perfect itself has a backshifting effect, there is no need to interpret the perfect auxiliary as a past tense in order to get the desired interpretation. Now, if there is no need to posit a past tense operator for modals of the past, it would also be desirable to account for the non-shifting and the forward-shifting of modals of the present by some means other than positing implicit tense operators, for doing so would unify modals for the present and modals for the past.

The fact that we do not need to posit implicit tense operators to get the right interpretation is a conceptual advantage of [13] over [12]. [13] is also to be preferred over [12] on empirical grounds. One empirical argument is that in certain cases the perfect auxiliary must be interpreted as a perfect, not as a past tense. A second empirical argument is that if there were tense in the scope of the modal, we would get a different interpretation in certain cases than is in fact attested.

The evidence that the perfect auxiliary is semantically a perfect comes from adverbials, such as *already* and *yet*, with a sortal restriction against eventive predicates. These adverbials are compatible with modals for the past even when the basic verbal predicate is eventive. Moreover, when the basic verbal predicate is eventive, they are compatible only with modals of the past. The sortal restriction of *already* and *yet* against eventive predicates is exemplified in [14] and the contrast between present and past modals in [15].<sup>8</sup>

<sup>6</sup>This is also the position of Crouch (1993) and of Enç (1996) for modals of the present.

<sup>7</sup>This is the interpretation manifested in the so-called existential reading of the perfect.

<sup>8</sup>Recall that I am concentrating here on non-root modals so consideration of root



- [14] a. He (?\**already*) returned.  
 b. He did not write us (?\**yet*).  
 c. He has *already* returned.  
 d. He has not written us *yet*.
- [15] a. He must/should/might/may have *already* returned.  
 b. He must/should/might/may not have written us *yet*.  
 c. He must/should/might/may (\**already*) return.  
 d. He must/should/might/may not write us (\**yet*).

The contrast between [15a,b] and [15c,d] remains unaccounted for under an analysis that gives modals for the past only a past tense complement, as in [16a], for in that case *already* would have to combine with an eventive predicate.

The acceptability of [15a] and [15b] implies that *already* and *yet* have the perfect in their scope, as in [16b] or [16c], which in turn implies that auxiliary complexes composed of a modal plus *have* involve the perfect semantically as well as morphosyntactically.

- [16] a. MODAL(PAST(ALREADY(he return)))  
 b. MODAL(ALREADY(PERF(he return)))  
 c. MODAL(PRES(ALREADY(PERF(he return))))

As analyzed in section 3.2, the perfect is a modifier on eventuality predicates resulting in a predicate over times, thus satisfying the sortal restrictions of *already* and *yet*.

The evidence in [15] indicates that *already* and *yet* need to scopally intervene between the modal and the perfect thus supporting the decompositional analysis of the modal–perfect auxiliary complex into two operators. However, it does not rule out the possibility of a present tense complement, as in [16c], or an ambiguity for modals of the past such as that between [16a] and [16c]. Embedded modals, discussed next, show that there is no tense in the scope of a modal and that, therefore, the temporal orientation of the modal is determined by its own temporal semantics and the semantics of the perfect.

The first part of the argument that there is no tense in the scope of the modal is a variant of the argument by Abusch (1997) and von Stechow (1995) about the behavior of tenses in the scope of strong

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modals falls outside the scope of this paper. On a deontic construal of the modals in [15d], for instance, *yet* is acceptable.

intensional contexts. These authors show that there can be no deictic tense in strong intensional contexts. Then it follows that if a modal appears in the scope of an intensional predicate like *believe*, its inner tense would have to be a zero tense, not PRES, FUT, or PAST. But then what accounts for the forward shifting effect seen in [17a] (absent in [17c]) or the backward shifting effect in [17b] (absent in [17d])?

- [17] a. Mary believed that John may get sick.  
 b. Mary believed that John may have been sick.  
 c. Mary believed that John got sick.  
 d. Mary believed that John was sick.

If the shifting effect seen in extensional contexts were due to the inner tense the modal composes with, there would be no shifting effect in intensional contexts, where the inner tense is uniformly a zero tense. Therefore, we can conclude that the forward shifting effect is due to the modal and the backward shifting effect due exclusively to the perfect.

The second part of the argument that there is no tense in the scope of the modals has to do with the counterfactual reading of modals for the past, which has a past perspective. If we attempted a decompositional analysis for the past perspective reading of *might have*, we would encounter a problem similar to the one seen with intensional predicates. An initial attempt at decomposing the modal auxiliary would be as in [18].

[18] PRES(PERF(MIGHT(FUT(he win))))

But this would not do: the future should be a future in the past, not a future from the time of utterance (recall the deictic interpretation we are assuming for all non-zero tense operators). More generally, the previous case and this one show that the dependence on the time of utterance is in effect only when the perspective of the modal is the time of utterance, not otherwise. Therefore, the temporal localization of the sentence the modal scopes over must be attributed to the modal itself rather than to an implicit inner tense.

What is the temporal contribution of modals, then? Do they shift the time of evaluation forward, as examples like [1a] indicate, or do they not, as examples like [1b] or [1c] with the adverbial *now* indicate? The divergent behavior seen in these examples has led Enç (1996) to propose that there are shifting and non-shifting modals, depending on the kind of modality they express: some epistemic modals, like *must*, are non-shifting, while other epistemic modals, like *may*, are shifting. However,

cases like [1c] indicate that this is not the correct generalization, for the variants with *tomorrow* and *now* point in opposite directions.

Moreover, if *may* uniformly shifted the time of evaluation forward and *must* did not, then *must have* and *may have* on the epistemic reading would be predicted to differ in whether they required the element in their scope to be located to the past of the utterance time or to the past of some future time. But this is not the case. Therefore, the temporal contribution of the modal does not depend on the kind of modality it expresses.

The correct generalization is that modals for the present have a future orientation optionally with stative predicates and obligatorily with eventive predicates. The presence of the progressive results in a stative predicate hence the pattern of adverbial modification in [1b]. This generalization is captured in the analysis I propose in the next section by the different temporal relations involved when eventive and stative properties are instantiated.

To sum up this section, modals can appear in the scope of present tense in extensional contexts and in the scope of zero tense in intensional contexts. When the outer tense is present tense, the perspective of the modal is the time of utterance. The orientation of the modal, that is the time of evaluation of the element in its scope, is set by the modal itself, not by an embedded tense, and is shifted backwards when the perfect is present. Whether modals for the present have a future orientation depends on the type of eventuality the sentence in their scope denotes.

### 3.2 The Semantics

In this section I spell out the semantics of modals and the perfect and show how the temporal properties of modals for the present and of modals for the past can be derived. For my basic setup, I assume an ontology of sorted eventualities and temporal intervals. There are two sorts of eventualities, events and states, and, correspondingly, eventive and stative predicates. Verbal predicates take an eventuality argument<sup>9</sup> and basic untensed sentences (sentence radicals) denote properties of eventualities. I will assume an extensional language in which the intensional parameters, time and worlds, are explicitly represented.

Tense operators map properties of eventualities, or of times, to propositions and instantiate these properties in time. By instantiating

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<sup>9</sup>It is irrelevant for my purposes whether verbal predicates take the eventuality argument as their sole argument or as an additional argument so I will not decide between a Davidsonian and a neo-Davidsonian approach.

properties of eventualities in time, they locate eventualities relative to a temporal interval, corresponding roughly to a reference time. As argued by Kamp & Rohrer (1983), Partee (1984), Kamp & Reyle (1993), among others, the temporal relation for locating eventualities relative to the reference time depends on the type of eventuality: it is temporal inclusion for events and temporal overlap for states.

For perspicuity, let us specify the translation of temporal operators, like tense, the perfect and modals, in terms of the AT relation. The definition of the AT relation, as given in [19], depends on the type of its third argument.  $\tau$  is a function yielding the temporal trace of an eventuality in a given world. The term ‘eventive’ is a shorthand for ‘property of events,’ ‘stative’ a shorthand for ‘property of states’ and ‘temporal’ a shorthand for ‘property of times.’

$$[19] \quad \text{AT}(t, w, P) = \begin{cases} \exists e[P(w)(e) \ \& \ \tau(e, w) \subseteq t] & \text{if } P \text{ is eventive} \\ \exists e[P(w)(e) \ \& \ \tau(e, w) \circ t] & \text{if } P \text{ is stative} \\ P(w)(t) & \text{if } P \text{ is temporal} \end{cases}$$

$\text{AT}(t, w, P)$  means that property  $P$  is instantiated in world  $w$  at time  $t$ . How a property is instantiated in a world at a given time depends on whether it is a property of times, of events, or of states. If  $P$  is property of times, then  $P$  is instantiated in  $w$  at  $t$  iff  $P$  holds of  $t$  in  $w$ . If  $P$  is a property of eventualities, then  $P$  is instantiated in  $w$  at  $t$  iff there is an eventuality  $e$  such that  $P$  holds of  $e$  in  $w$  and the temporal trace of  $e$  in  $w$  bears a certain temporal relation with  $t$ . That relation is temporal inclusion ( $\subseteq$ ) if  $P$  is a property of events and temporal overlap ( $\circ$ ) if  $P$  is a property of states.

In a given context, present tense instantiates a property to the time of utterance, *now*, which I take to be an interval, albeit a short one. The translation of the present tense operator is given in [20].<sup>10</sup>

$$[20] \quad \text{PRES: } \lambda P \lambda w [\text{AT}(\text{now}, w, P)]$$

The perfect maps properties of eventualities or properties of times to properties of times, and shifts the time of evaluation of the element in its scope to an interval before the relevant reference interval, as seen in [21].

$$[21] \quad \text{PERF: } \lambda P \lambda w \lambda t \exists t' [t' \prec t \ \& \ \text{AT}(t', w, P)]$$

When the perfect is directly under the scope of present tense, the relevant reference interval is *now*. If the perfect is directly under the scope of a modal, the reference interval depends on the modal.

<sup>10</sup>[20] specifies the content of present tense relative to a fixed context.

Modals are of the same type as the perfect. They map properties of eventualities or properties of times to properties of times, but they do not shift the time of evaluation. Rather, they expand the time of evaluation forward. Abusch (1998) proposes this kind of temporal semantics for the future auxiliary *will* in order to account for the behavior of present and past tense in future contexts. As shown here, it should be generalized to all non-root modals for independent reasons. Modals also differ from the perfect in instantiating  $P$  in different possible worlds.

[22] and [23] give the translation of possibility and necessity modals that do not involve graded modality.<sup>11</sup> As in section 1,  $MB$  is a function, fixed by the context of use, from world-time pairs to sets of worlds.<sup>12</sup> If  $MB$  is the epistemic state of a particular agent,  $MB(w, t)$  consists of the set of worlds compatible with what that agent knows in  $w$  at  $t$ . If  $MB$  is a metaphysical modal base,  $MB(w, t)$  consists of the metaphysical alternatives of  $w$  at  $t$ .<sup>13</sup>  $[t, \_)$  designates an interval with  $t$  as an initial subinterval and extending to the end of time.

[22] MAY/MIGHT<sub>MB</sub>:  $\lambda P \lambda w \lambda t \exists w' [w' \in MB(w, t) \ \& \ AT([t, \_), w', P)]$

[23] WOLL<sub>MB</sub>:<sup>14</sup>  $\lambda P \lambda w \lambda t \forall w' [w' \in MB(w, t) \rightarrow AT([t, \_), w', P)]$

Almost all non-root necessity modals in English express graded modality. One example of a necessity modal that does not involve graded modality is the future auxiliary *will* if analyzed as a modal expressing metaphysical necessity.

Assuming that modals expand the local time of evaluation into the future rather than shifting the time of evaluation to some future time is crucial in accounting for (i) the fact that in the absence of any future-oriented temporal adverbials, or other contextual clues, modals for the present with stative predicates imply that the temporal trace of the described state includes the time of utterance, (ii) the fact that the past orientation on the scoping MODAL over PERF is from the perspective of the time of utterance, not some future time.

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<sup>11</sup>The semantics of modals expressing graded modality needs to make reference to an ordering between possible worlds, in addition to an accessibility relation between possible worlds (determining the modal base), but is the same as far as the temporal aspect of modals is concerned. For the role of the ordering source see Kratzer (1981).

<sup>12</sup>Like [20], [22] and [23] specify the content of a modal relative to a fixed context.

<sup>13</sup>The nature of the metaphysical alternatives of a world  $w$  at time  $t$  is discussed in section 4.1.

<sup>14</sup>Following by now well-established practice (see, e.g., Abusch (1997)), I take *woll* to be the untensed modal, *will* being the morphosyntactic manifestation of PRES applied to WOLL.

Adverbials like *already*, *yet*, and *still* are predicate modifiers with a trivial truth-conditional content. They map properties of states or properties of times onto themselves, as seen in [24].

$$[24] \text{ ALREADY/YET/STILL: } \begin{cases} \lambda P \lambda w \lambda e [P(w)(e)] & \text{if } P \text{ is stative} \\ \lambda P \lambda w \lambda t [P(w)(t)] & \text{if } P \text{ is temporal} \\ \text{undefined} & \text{otherwise} \end{cases}$$

I am assuming that these adverbials can, in principle, scope either under or over other predicate modifiers, like a modal or the perfect.<sup>15</sup> Not all scopings, however, result in an acceptable interpretation. In order for a given scoping to result in an acceptable interpretation the sortal restrictions of the adverb must be satisfied, as discussed in section 3.1, and its (other) presuppositions must be satisfied as well, as discussed later in this section and in section 4.

Let us now see how the semantics of present tense, the modals and the perfect interact to give us the temporal properties of the modals discussed earlier. Present perspective about the present or the future comes about when the modal combines with a stative predicate.

- [25] a. He might be here.  
 b. he be here:  $\lambda w \lambda e$  [he be here]( $w$ )( $e$ )  
 c. MIGHT<sub>MB</sub>(he be here):  $\lambda w \lambda t \exists w' [w' \in MB(w, t) \ \& \ \exists e$  [[he be here]( $w'$ )( $e$ )  $\& \ \tau(e, w') \circ [t, \_)]$   
 d. PRES(MIGHT<sub>MB</sub>(he be here):  $\lambda w \exists w' [w' \in MB(w, now) \ \& \ \exists e$  [[he be here]( $w'$ )( $e$ )  $\& \ \tau(e, w') \circ [now, \_)]$

Temporal overlap of the state of his being here with the interval [*now*,  $\_$ ) can be satisfied if his being here started at some point in the past of the time of utterance and extends at least through the time of utterance. The required temporal overlap can also be satisfied if his being here is fully included in [*now*,  $\_$ ). In that case his being here occurs in the future of the time of utterance. As discussed below, adverbials like *today*, *yesterday* or *next year* restrict the relevant reference interval to a subinterval of [*now*,  $\_$ ) and are acceptable only if that subinterval is not the null interval.

Present perspective with a future orientation comes about when the modal combines with an eventive predicate.

<sup>15</sup>In section 3.1 we saw cases where the adverbial scopally intervenes between the modal and the perfect.

- [26] a. He might run.  
 b. he run:  $\lambda w \lambda e$  [he run]( $w$ )( $e$ )  
 c. MIGHT<sub>MB</sub>(he run):  $\lambda w \lambda t \exists w' [w' \in MB(w, t) \ \& \ \exists e$  [[he run]( $w'$ )( $e$ ) &  $\tau(e, w') \subseteq [t, \_]$ ]]  
 d. PRES(MIGHT<sub>MB</sub>(he run)):  $\lambda w \exists w' [w' \in MB(w, now) \ \& \ \exists e$  [[he run]( $w'$ )( $e$ ) &  $\tau(e, w') \subseteq [now, \_]$ ]]

Since the event of his running must be included in the interval [*now*,  $\_$ ) it can start, at the earliest, during the time of utterance and would, therefore, be completed some time after the time of utterance.

Present perspective with a past orientation, associated with the epistemic reading of modals for the past, comes about when the modal takes scope over the perfect.

- [27] a. He may have won.  
 b. he win:  $\lambda w \lambda e$  [he win]( $w$ )( $e$ )  
 c. PERF(he win):  $\lambda w \lambda t \exists t' [t' \prec t \ \& \ \exists e$  [[he win]( $w$ )( $e$ ) &  $\tau(e, w) \subseteq t'$ ]]  
 d. MAY<sub>MB</sub>(PERF(he win)):  $\lambda w \lambda t \exists w' [w' \in MB(w, t) \ \& \ \exists t' [t' \prec [t, \_]$  &  $\exists e$  [[he win]( $w'$ )( $e$ ) &  $\tau(e, w') \subseteq t'$ ]]]  
 e. PRES(MAY<sub>MB</sub>(PERF(he win))):  $\lambda w \exists w' [w' \in MB(w, now) \ \& \ \exists t' [t' \prec [now, \_]$  &  $\exists e$  [[he win]( $w'$ )( $e$ ) &  $\tau(e, w') \subseteq t'$ ]]]

The event of his winning must be included within an interval that temporally precedes the interval [*now*,  $\_$ ), hence his winning precedes the time of utterance.

The patterns of adverbial modification seen in [1] and [2] are easily accounted for in this analysis. I follow Abusch (1998) in assuming an intersective semantics for frame adverbials. Frame adverbials map properties of eventualities to properties of times. Therefore, they must combine with sentence radicals before any other operators do. The translation of a representative frame adverbial is given in [28].

- [28] YESTERDAY:  

$$\begin{cases} \text{undefined} & \text{if } P \text{ is temporal} \\ \lambda P \lambda w \lambda t [\text{AT}(t \cap \text{yesterday}, w, P)] & \text{otherwise} \end{cases}$$

*Yesterday* can occur with modals for the past but not with modals for the present, a contrast exemplified in [29].

- [29] a. He may have won yesterday.  
 b. \*He may win yesterday.

The semantics of [29a] is given in [30] and [31]. The semantics of [29b] is given in [30] and [32].

- [30] a. he win:  $\lambda w \lambda e$  [he win]( $w$ )( $e$ )  
 b. YESTERDAY(he win):  $\lambda w \lambda t \exists e$  [[he win]( $w$ )( $e$ ) &  $\tau(e, w) \subseteq t \cap \text{yesterday}$ ]
- [31] a. PERF(YESTERDAY(he win)):  $\lambda w \lambda t \exists t'$  [ $t' \prec t$  &  $\exists e$  [[he win]( $w$ )( $e$ ) &  $\tau(e, w) \subseteq t' \cap \text{yesterday}$ ]]  
 b. MAY<sub>MB</sub>(PERF(YESTERDAY(he win))):  
 $\lambda w \lambda t \exists w' \exists t'$  [ $w' \in MB(w, t)$  &  $t' \prec [t, \_)$  &  $\exists e$  [[he win]( $w'$ )( $e$ ) &  $\tau(e, w') \subseteq t' \cap \text{yesterday}$ ]]  
 c. PRES(MAY<sub>MB</sub>(PERF(YESTERDAY(he win)))):  
 $\lambda w \exists w' \exists t'$  [ $w' \in MB(w, \text{now})$  &  $t' \prec [\text{now}, \_)$  &  $\exists e$  [[he win]( $w'$ )( $e$ ) &  $\tau(e, w') \subseteq t' \cap \text{yesterday}$ ]]
- [32] a. MAY<sub>MB</sub>(YESTERDAY(he win)):  $\lambda w \lambda t \exists w'$  [ $w' \in MB(w, t)$  &  $\exists e$  [[he win]( $w'$ )( $e$ ) &  $\tau(e, w') \subseteq [t, \_) \cap \text{yesterday}$ ]]  
 b. PRES(MAY<sub>MB</sub>(YESTERDAY(he win))):  
 $\lambda w \exists w'$  [ $w' \in MB(w, \text{now})$  &  $\exists e$  [[he win]( $w'$ )( $e$ ) &  $\tau(e, w') \subseteq [\text{now}, \_) \cap \text{yesterday}$ ]]

In both cases the possibility is from the perspective of the time of utterance. In the case of [29a] his winning must be located within the maximal interval that precedes  $[\text{now}, \_)$  and is within the time interval *yesterday*. That interval is the time interval *yesterday*. In the case of [29b], however, his winning must be located within  $[\text{now}, \_) \cap \text{yesterday}$ . That interval is the null interval, hence, [29b] can never be true and is, therefore, deviant.

If the modal is in an intensional context,<sup>16</sup> like the predicate *believe* in [17], its perspective will be the time determined by the intensional context—in [17] the internal *now* of Mary, let's call it  $t_0$ . The modal expands the reference time to  $[t_0, \_)$  and if it combines with an eventive predicate, as in [17a], the property denoted by the sentence radical would be instantiated within  $[t_0, \_)$ . Hence the forward-shifting effect in [17a]. If the perfect is in the scope of the modal, as in [17b], the property denoted by the sentence radical would be instantiated within, or overlapping, an interval preceding  $[t_0, \_)$ . Hence the backward-shifting effect in [17b].

<sup>16</sup>In this paper I focus on modals in extensional contexts so my discussion of modals in intensional contexts will be at an informal level.



Finally, past perspective with a future orientation, associated with the counterfactual reading of modals for the past, comes about when the perfect takes scope over the modal. This is possible only for modals that are in the so-called subjunctive form in English, such as *might*, *would*, *should*, *ought to*.

- [33] a. He might have won.  
 b. PRES(PERF(MIGHT<sub>MB</sub>(he win))):  $\lambda w \exists w' \exists t' [t' \prec \text{now} \ \& \ w' \in MB(w, t') \ \& \ \exists e \text{ [[he win]}(w')(e) \ \& \ \tau(e, w') \subseteq [t', \_]]]$

As far as the meaning of *might have* on the scoping PERF > MIGHT goes, there is no restriction that the relevant state of affairs obtain before the time of utterance. As seen in [33b], the reference time set by the modal is an interval starting at some past time and extending to the end of time. Hence, the pattern of adverbial modification for the counterfactual reading is predicted to be different from the pattern of adverbial modification for the epistemic reading, as is indeed the case. Compare, for instance, [34], where the modal can take scope under the perfect, with [35], where the modal can only take scope over the perfect.

- [34] a. He might have been available yesterday/next month.  
 b. It might have been raining yesterday/now.  
 [35] a. He must have been available yesterday/\*next month.  
 b. It must have been raining yesterday/\*now.

By decomposing modals of the past into a modal and a perfect operator, with the scoping MODAL > PERF possible for all modals and the scoping PERF > MODAL for some, we are able to unify the meaning of modal auxiliaries, occurring with or without the perfect, and we are able to account for the (non-)shifts of the temporal argument of the modal base *MB* and of the temporal parameter at which the element in the scope of the modal must be evaluated without any additional stipulations.

Just as *already* and *yet* provide evidence for the decompositional analysis of the modal–perfect auxiliary complex on the epistemic reading, as discussed in section 3.1, *still* provides evidence for the decompositional analysis of the modal–perfect auxiliary complex on the counterfactual reading. Like *already* and *yet*, *still* selects against eventive predicates, but because of different presuppositions it can appear with possibility modals of the present, as seen in [36a]. The reading of [36a] that is of interest here is one where *still* is given a temporal, rather than a concessive, interpretation.

- [36] a. He might still win.  
 b. PRES(STILL(MIGHT(he win)))
- [37] a. At that point he might still have won.  
 b. PRES(PERF(STILL(MIGHT(he win))))

Given both the selectional restrictions of *still* and the meaning of [36a]—the possibility of his winning still exists—the logical form of [36a] must be as in [36b], with the adverbial taking scope over the modal. Similarly, with modals of the past on the counterfactual reading, as in [37a], *still* must take scope over the modal and under the perfect, as shown in [37b].

My analysis of the counterfactual reading relies on scope reversal of the perfect and the modal. English syntax fixes the linear order of the modal and perfect auxiliaries, but languages, like German, whose syntax allows the order to vary exhibit the two scopal options overtly. In German the linear order between the perfect auxiliary and the modal in the syntax mirrors semantic scope. [38a] has only the epistemic reading, while [38c] has only the counterfactual reading.

- [38] a. Er könnte (schon) gewonnen haben.  
 he could already won have  
 ‘He might have (already) won.’
- b. \*Er hätte schon gewinnen können.  
 he had already won could  
 ‘He might have already won.’
- c. Er hätte (noch) gewinnen können.  
 he had still won could  
 ‘He might (still) have won.’
- d. \*Er könnte noch gewonnen haben.  
 he could still won have  
 ‘He might still have won.’

Because of its presuppositions, the adverbial *schon* requires the scoping MODAL > ALREADY > PERF. The syntax allows for this scoping in [38a] but not in [38b]. Similarly, the adverbial *noch* requires the scoping PERF > STILL > MODAL. The syntax allows for this scoping in [38c] but not in [38d].

These are the scopings that produce an acceptable interpretation for the (scopally ambiguous) English equivalents of [38a] and [38c]. The decompositional analysis of modals for the past allows us to determine

the scope options between the modal, the adverbials and the perfect in pairwise fashion. It is well-known that the scoping ALREADY > PERF is possible, while the scoping STILL > PERF is not, independently of the presence of a modal. Consider, for instance, the contrast between [39a] and [39b], where the adverbials cannot combine directly with the sentence radical, which denotes a property of events.

- [39] a. He has already won.  
b. \*He has still won.

ALREADY and STILL also differ with respect to their relative scope with a modal. STILL can take scope over a possibility modal while ALREADY cannot. Consider, for instance, the contrast between [40a] and [40b].

- [40] a. He may still win.  
b. \*He may already win.

I discuss the reason for this difference between ALREADY and STILL in section 4.1.

### 3.3 Conclusion

I have argued that modals for the past must be given a decompositional analysis and have shown that the modal auxiliary in modals for the present and in modals for the past has the same meaning. The temporal perspective of a modal is fixed by the operator whose scope it is directly under: if the operator is PRES (as it is in extensional contexts), the perspective is that of the time of utterance; if the operator is PERF, itself under the scope of PRES, the perspective is some time to the past of the time of utterance. Modals uniformly expand the time of evaluation forward. If modals have PERF in their immediate scope, they exhibit a backward-shifting reading due to the effect of PERF. If they do not have PERF in their immediate scope, they exhibit a forward-shifting or a non-shifted reading depending on the type of eventuality the sentence radical they combine with denotes and on the frame adverbials modifying the sentence radical.

## 4 The Modal Base

### 4.1 Metaphysical modality and historical necessity

The meaning I have given to the modals is general enough to account for their apparently distinct temporal properties in different environments.

Moreover, it allows modals to be construed with either an epistemic or a metaphysical modal base without regard for the scopal configuration they appear in.<sup>17</sup> But then, why is it that in cases like [7a], where the modal scopes over the perfect, the modality is epistemic and in cases like [7b], where the perfect scopes over the modal, the modality is metaphysical and gives rise to a counterfactual implication?

This correlation between the relative scope of the modal and the kind of modality it expresses is, in fact, part of a more general phenomenon involving the interpretation of non-root modals, for the present and for the past alike. The generalization, to be refined later,<sup>18</sup> is that non-root modals have exclusively an epistemic reading when the property they apply to is instantiated at a time coinciding with, or in the past of, the temporal perspective of the modal; they allow for a metaphysical reading when the property they apply to is instantiated at a time in the future of the temporal perspective of the modal. This is the case for both necessity and possibility modals. In the remainder of the paper I will restrict the discussion to possibility modals.

I will argue that the generalization relating the temporal reference of the modals to the kind of modality they express is a consequence of the structure of possibilities and a felicity condition governing the association of modals with a modal base. It is important to note that the need to account for this generalization is not an artefact of my particular analysis of the temporal interpretation of modals. It arises for any theory that does not simply stipulate the modality that can be expressed by a modal as part of its meaning but instead abstracts it out as a contextually fixed parameter and tries to relate in a systematic way the temporal and the modal dimension of the meaning of modals. A Priorian analysis along the lines of [3], [4], [5] and [8], for instance, would also need to be coupled with an account for what the modal base can be in each case (metaphysical or epistemic for [3], epistemic for [4] and [5], metaphysical for [8]).

In the discussion below I first characterize more precisely the cases where the metaphysical reading is unavailable and then argue that the missing metaphysical reading for possibility modals is due to a felicity

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<sup>17</sup>This is relevant specifically for those modals, like *might*, *may*, or *will*, which can express both epistemic and metaphysical modality. I am not claiming that all non-root modals are construed with either an epistemic or a metaphysical modal base. As is well-known, there are modals that select particular kinds of modal bases as part of their meaning (Kratzer 1981). *Must*, for instance, can be construed with an epistemic modal base but not with a metaphysical modal base.

<sup>18</sup>The refinement reflects the fact that non-root modals can have exclusively an epistemic reading even when the property they apply to is instantiated at a time in the future of the temporal perspective of the modal.

condition that in effect ensures the distinctness of modal assertions from non-modal assertions.

First let us see that modals for the present are also subject to the same restriction regarding the modal base they can associate with as modals for the past. Consider the interpretation of the modals for the present in [41].

- [41] a. He may/might have the flu (now).  
 b. He may/might get the flu.

In [41a] the presence of a stative predicate makes reference to the present possible. On the reading where reference is to the present, the modals have only an epistemic reading: his having the flu is compatible with what the speaker takes the actual world to be now. The issue itself of his having the flu is settled by the course of events in the actual world though it may not be known which way it is settled. He either has the flu now or does not, and nothing that happens from now on can change whatever is in fact the case.

In [41b] there is an eventive predicate, hence only reference to the future is possible. The modal can have a metaphysical as well as an epistemic reading. The metaphysical reading has to do with what the actual world may turn out to be in the future given that at present there are any number of live options as to how it will evolve. The issue need not be settled by the course of events up to the present in the actual world since his contracting the flu depends on any number of circumstances (including chance events and human actions) that may or may not come about in what will turn out to be the actual world.

If an issue has not been settled by the course of events up to a given time, then the future is open with respect to that issue and, consequently, it cannot be known at that time which way it will be settled. Moreover, if an issue is taken by an agent not to be settled, then metaphysical live options are also epistemic alternatives. As a result, the epistemic reading and the metaphysical reading of possibility modals can be easily confounded. They are clearly distinguished in the case where an issue is *presupposed* to be settled because in that case the metaphysical reading is not available.

The decisive factor in excluding a metaphysical reading for possibility modals is whether an issue is presupposed to be settled or not. As we will see later, when the property a modal applies to is instantiated at a time coinciding with, or in the past of, the temporal perspective of the modal, settledness is always presupposed. As a case in point consider [41a] and [7a], which exclude the metaphysical reading without the need for any specific assumptions about the context in which they

occur. However, when the property a modal applies to is instantiated at a time in the future of the temporal perspective of the modal, settledness is presupposed only if the context contains specific information to this effect.

For an example where extra information makes clear whether a particular issue has been settled or not and the corresponding effect on the modality expressed by possibility modals consider [42b] and [42c] in the context of [42a].

- [42] a. He will meet with one senior administrator.  
 b. It hasn't been decided yet who he will meet with. He may see the dean. He may see the provost.  
 c. It has been decided who he will meet with but I don't know who it is. He may see the dean. He may see the provost.

In both [42b] and [42c] temporal reference is to the future. In [42b] the issue of which senior administrator will attend the meeting is asserted to not have been settled and, like [41b], the modals get a metaphysical interpretation. A future, for instance, in which the dean attends the meeting is at present a live option. In [42c] the issue is asserted to have been settled so, after the first sentence of [42c] is uttered, it is presupposed that it is settled. Like [41a], the modals have an epistemic reading.

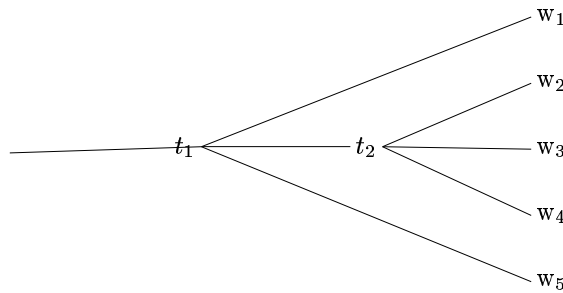
The concept of an issue being settled at a given time corresponds to the notion of *historical necessity*, as discussed by Kamp (1979) and Thomason (1984), who traces it back to Aristotle.<sup>19</sup> A sentence is historically necessary at time  $t$  if it is true at  $t$  regardless of what the future is like. Historical necessity relies on a structure of possibilities such that at any given time the past and the present are settled whereas the future is open.

The underlying structure of possibilities must be based on a fixed past and indeterministic future and can thus be characterized as 'forward branching.' I follow Thomason's (1984) world-time model, assuming  $T \times W$  frames. The basic idea of the world-time model is to have worlds be complete histories through time and have multiple copies of those worlds with an identical past and a distinct future. In forward branching  $T \times W$  frames, the set of times is a linear structure and there is a 3-place relation on  $T \times W \times W$ ,  $\simeq$ , such that (i) for all  $t$ ,  $\simeq_t$  is an equivalence relation, and (ii) for any  $w, w' \in W$  and  $t, t' \in T$ , if  $w_1 \simeq_t w_2$  and  $t' \prec t$ , then  $w_1 \simeq_{t'} w_2$ .

<sup>19</sup>Related is also Lewis' (1979) discussion on the asymmetry of counterfactual dependence.

According to condition (i), for any given time each world belongs into an equivalence class of worlds, those worlds with an identical past up to and including that time and possibly diverging futures. In the toy model graphically depicted in [43], all five worlds are identical up to  $t_1$  but only three of them remain identical up to the later point  $t_2$ .

[43]



$$\begin{aligned} w_1 \simeq_{t_1} w_2 \simeq_{t_1} w_3 \simeq_{t_1} w_4 \simeq_{t_1} w_5 \\ w_2 \simeq_{t_2} w_3 \simeq_{t_2} w_4 \end{aligned}$$

All five worlds are historical alternatives of one another through  $t_1$ . Worlds  $w_2$ ,  $w_3$  and  $w_4$  are historical alternatives of one another through  $t_2$ . After  $t_1$ ,  $w_1$  and  $w_5$  have no historical alternatives other than themselves, that is, after  $t_1$  the future is completely deterministic for  $w_1$  and  $w_5$ . The same is true for  $w_2$ ,  $w_3$  and  $w_4$  after  $t_2$ .

Condition (ii) is a monotonicity condition governing  $\simeq$ . A consequence of this condition is that as time advances the set of metaphysical alternatives to any given world decreases and, therefore, at any given time fewer things remain possible than were possible before that time. A sentence like *he may win this game* can be true at all times before the outcome of the game but ceases to be true once he loses.

The fact that certain states of affairs are live options for the future at some time but cease to be live options for the future at a later time, rather than the other way around, is the reason why *still* can take scope over a possibility modal while *already* cannot. Recall our discussion of [36], [37], [38] and [40], where the required scoping for an acceptable interpretation was claimed to be MODAL > ALREADY and STILL > MODAL because of the presuppositions of *already* and *still*.

Following Löbner (1989), we can say that both *already* and *still* presuppose the existence of a prior state and the possibility of a state transition but with the reverse polarity: a transition from a negative phase to a positive phase for *already* and a transition from a positive phase to a negative phase for *still*. So *still* is used to convey that a

preexisting state persists at the reference time, while *already* is used to convey that the relevant phase transition has taken place by the reference time. On the scoping STILL > MAY, [40a] presupposes that the possibility of his winning has been a live option and that eventually it may cease to be and asserts that at the time of utterance his winning persists as a live option for the future. This presupposition is consistent with possibilities decreasing over time. On the scoping ALREADY > MAY, [40b] presupposes that the possibility of his winning has not been a live option and that eventually it may be and asserts that at the time of utterance his winning has become a live option. This presupposition is not consistent with possibilities decreasing over time, hence the unacceptability of *already* with *may* and an eventive predicate. With a stative predicate, *already* can take scope within the modal without violation of its selectional restrictions.

Historical necessity involves quantification over worlds that are historical alternatives of a given world at a given time. The metaphysical alternatives of a world change with time: for any given time they are its historical alternatives at that time. For modals expressing metaphysical modality then, the modal base consists of historical alternatives:  $MB(w, t) = \{w' \mid w \simeq_t w'\}$ .  $w$  and its historical alternatives through  $t$  determine the same set of facts up to  $t$  and may differ only in what is future to  $t$ . For modals expressing epistemic modality the modal base is an epistemic state. Epistemic states are unions of sets of equivalence classes of worlds with respect to a given time.

The correlation between the modality expressed by a modal and its relative scope with the perfect was seen to be a special case of a generalization making reference to the time the property the modal applies to is instantiated. That, in turn, was seen to be a special case of a generalization making reference to a presupposition of settledness. We can now reformulate this last generalization as follows: a non-root possibility modal has exclusively an epistemic reading when the instantiation of the property it applies to is presupposed to be historically necessary if true. Presupposition in this sense is a property of epistemic states capturing what is (presumed to be) common knowledge among the participants in a conversation, that is, a property of common grounds.

Let us take common grounds to consist of unions of equivalence classes of worlds determined by  $\simeq_{t_0}$ , with  $t_0$  the time of utterance. In order for a common ground  $cg$  to satisfy settledness with respect to the instantiation of property  $P$ , where  $P$  is a property of times or of eventualities, the condition in [44] has to hold.

[44] Settledness for  $P$ :



For any  $w' \in cg$  and any  $w''$  such that  $w' \simeq_{t_0} w''$ :  
 $AT([t_0, \_], w', P)$  iff  $AT([t_0, \_], w'', P)$ .

Within each equivalence class the issue of the instantiation of  $P$  has to be resolved uniformly but different equivalence classes may resolve it differently. One can presuppose that an issue has been settled without knowing which way it is settled. Now for each such equivalence class the past up to the time of utterance is settled. Therefore, when  $P$  is to be instantiated at  $t_0$  or in the past of  $t_0$ , settledness is satisfied by *any* common ground. As a result, for cases like [41a] and [7a], even if out of context, the metaphysical reading can be excluded. On the other hand, when  $P$  is to be instantiated in the future of  $t_0$ , a common ground would satisfy settledness only if it contains specific information to this effect. As a result, the default or out of context reading for the modal in cases like [41b] is metaphysical since in that case the common ground cannot be assumed to satisfy settledness.

Suppose now that the modal in [41a] were to be construed with a metaphysical modal base. Then [41a] and *he has the flu (now)* would be truth conditionally equivalent. More generally, relative to a common ground satisfying settledness, an assertion with a possibility modal construed with a metaphysical modal base becomes equivalent to a non-modal assertion. The fact that [41a] can never be used to mean that he has the flu now implies that a context whose common ground satisfies settledness for the property the modal applies to never fixes the modal base of the modal to be metaphysical. Note that one cannot explain the absence of the metaphysical reading for the modal on purely pragmatic grounds, by appealing to the maxim of quantity, since the proposition that would be expressed by [41a] on the metaphysical construal of the modal base would be exactly as informative as the proposition expressed by *he has the flu (now)*.

I would like to suggest it is in order to avoid the equivalence between modal and non-modal assertions that a context can associate a possibility modal applying to property  $P$  with a metaphysical modal base only if the common ground of that context does not satisfy settledness for  $P$ . A context  $c$ , with common ground  $cg$ , can assign to a possibility modal MODAL, with temporal perspective  $t$  and applying to property  $P$ , a modal base  $MB$  only if  $cg$  and  $MB$  satisfy the condition in [45].

[45] Diversity Condition:

There is  $w \in cg$  and  $w', w'' \in MB(w, t)$  such that:  
 $AT([t, \_], w', P)$  and  $\neg AT([t, \_], w'', P)$ .

If the common ground satisfies settledness for  $P$  and the temporal perspective of the modal is the time of utterance, then a metaphysical

modal base cannot satisfy diversity. Consequently, a metaphysical reading is excluded, in any context, when the modal takes scope over the perfect, as in [7a], or when the modal combines with a stative predicate instantiated at a time including the time of utterance, as in [41a]. It is also excluded when the modal combines with an eventive predicate and the common ground contains sufficient information to satisfy settledness, as in [42c]. Hence, in these cases the modal can only be construed with an epistemic modal base.

The diversity condition in [45], constraining the assignment of a modal base to a modal by a context, is similar in spirit to felicity conditions, or other pragmatic conditions, for modal assertions proposed in other works.<sup>20</sup> One crucial difference is that other conditions are limited in requiring epistemic uncertainty, not metaphysical indeterminism for the relevant cases as well.<sup>21</sup>

#### 4.2 Perspective from the past: the counterfactual reading

To express how the world might have been now, when a given issue is already settled, you have to go back to the point where the options about what would happen were still open. This was already Mondadori's (1978) insight about the meaning of *might have*:

the truth conditions for a given “might have” statement are provided by the past truth of the corresponding “might” statement *plus* the passing of time. (p. 224)

It also implies that the temporal aspect of the meaning of *might have* plays a role in the counterfactual reading as well. The counterfactual reading is different from the mere possibility for things being different than they are presumed to be by the participants in a conversation.<sup>22</sup> An account based on similarity between worlds would have to make reference to the past history of those worlds.

We can have the desired kind of interpretation by taking the semantics proposed in section 3.2 for *might have* on the scoping PERF > MIGHT and by having the modal base be  $\simeq_t$ , where  $t$  is the time as

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<sup>20</sup>Groenendijk & Stokhof (1975), for instance, propose that the modal assertion *may p* is correct iff neither  $p$  nor *not p* are contained in the conversational information (the set of propositions which the speaker takes to be true of the actual world).

<sup>21</sup>In a related paper (Condoravdi 2000), I discuss the consequences of condition [45] for epistemic modality. One consequence is that it can help account for why *He may have won but he didn't* or *He may be sick but he isn't* appear contradictory.

<sup>22</sup>This is, in effect, the semantics assigned to *might have* by Groenendijk & Stokhof (1975).

set by the perfect. The proposition expressed by [46a], for instance, is [46b].

- [46] a. He might have won the game.  
 b.  $\lambda w \exists w' \exists t' [t' \prec \text{now} \ \& \ w \simeq_{t'} w' \ \& \ \exists e [[\text{he win the game}](w')(e) \ \& \ \tau(e, w') \subseteq [t', \_]]]$

In order for the diversity condition to be satisfied for some  $t' \prec \text{now}$ , the common ground must be compatible with there being some past time at which the outcome of the game was open. In order for [46a] to be true in world  $w$  there must be some world identical to  $w$  at least until some past time in which he eventually wins the game.

On this analysis, the counterfactual reading of modals for the past and the forward shifting reading of modals for the present with a metaphysical modal base, despite their apparent differences, are semantically the same except for the different temporal perspective of the modal. Compare, for instance, [46b] with [47b], the proposition expressed by [47a].

- [47] a. He might win the game.  
 b.  $\lambda w \exists w' \exists t' [t' = \text{now} \ \& \ w \simeq_{t'} w' \ \& \ \exists e [[\text{he win the game}](w')(e) \ \& \ \tau(e, w') \subseteq [t', \_]]]$

Ultimately, the differences between the two kinds of modals should follow from the fact that in one case the temporal perspective is the time of utterance and in the other the temporal perspective is some time before the time of utterance.

Where does the counterfactual implication of [46a] come from then? The truth conditions stated above for [46a] are consistent with [46a] being true in world  $w$  by virtue of his winning in  $w$ .<sup>23</sup> Certainly, [46a] can be uttered in a context where it is presupposed that he lost. But it can also be uttered in a context where it is not presupposed that he lost and in that case it conveys that he in fact lost.

We have taken a common ground to be the union of equivalence classes of worlds determined by  $\simeq_{t_0}$ , with  $t_0$  the time of utterance. For any world  $w$  in the common ground, and any time  $t \prec t_0$ , the set of historical alternatives of  $w$  at  $t_0$ ,  $\{w' \mid w \simeq_{t_0} w'\}$ , is a subset of the set of historical alternatives of  $w$  at  $t$ ,  $\{w' \mid w \simeq_t w'\}$ , given the monotonicity of  $\simeq$ . These sets constitute the domain of quantification for the modal in evaluating the truth of [47a] and [46a] in  $w$ . If it is already presupposed that he lost the game, then that he won can be

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<sup>23</sup>Similarly for [47a].

verified only by worlds in  $\{w' \mid w \simeq_t w'\}$  that are outside the common ground. Such worlds would exist as long as  $\{w' \mid w \simeq_{t_0} w'\}$  is a proper subset of  $\{w' \mid w \simeq_t w'\}$ , which we can assume is generally the case.

More generally, a world in  $\{w' \mid w \simeq_t w'\}$  but not in  $\{w' \mid w \simeq_{t_0} w'\}$  is outside of the common ground.<sup>24</sup> The domain of quantification for the modal in [46a] is not only wider than the domain of quantification for the modal in [47a], it is also partly outside the common ground. By using an expression that widens the domain of quantification for the modal so that it is partly outside the common ground, the speaker indicates that the relevant state of affairs could not be verified in the common ground. In recovering the speaker's intention, the hearer can reason as follows: why would the speaker use an expression that requires backtracking in order to enlarge the domain of quantification, unless the speaker cannot take it for granted that the relevant state of affairs is verified in a domain that is a subset of the common ground? Therefore, the speaker must intend to communicate that this past possibility was an unactualized one.

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<sup>24</sup>This rests on the assumption that if a past historical alternative to some world compatible with what we take the actual world to be is not a historical alternative to that world at the time of utterance, then it is also not compatible with what we take the actual world to be.

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