

DEDUCING THE FUTURE AND DISTINGUISHING THE PAST:
TEMPORAL INTERPRETATION IN MODAL SENTENCES IN ENGLISH

by

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ABSTRACT OF THE DISSERTATION

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This dissertation concerns the semantic analysis of modals in English with the aim of accounting for variation in their temporal interpretation under different modal readings. A paradigm of modals is considered that undergo an alternation between epistemic, non-future readings and non-epistemic, future readings. Each distinct temporal interpretation is seen as due to interactions between a modal base and general interpretive principles. A *disparity principle* requires the content of the modal to hold only in some and not all worlds selected by the modal base. If the modal base is only associated with branching futures, the disparity principle results in future, or partially future readings. If the modal base is epistemic, the disparity principle by itself allows past, present, or future readings, but the supplemental *requirement to make first distinctions first* guarantees non-future readings. One of the key modals in the paradigm is *will* and arguments are given that this is truly a modal, and that its temporal interpretation is not due to tense marking. These arguments include temporal interpretations involving future readings with present overlap as well as a defense on conceptual grounds of treating the future as open and *will* as a universal quantifier over the implicit possibilities. One result is an account of the semantic difference between *will* and its past tense form *would* in terms of using the most up-to-date ordering source available. The

general motivation for disparity is ordering, and differences between modals with similar temporality are seen as due to differences in the ordering source. Entailment relations between future *will*, deontic *must*, and potential *can* are thereby captured. The relation between imperatives and deontic modals is examined in terms of the general approach offered here, and preliminary ideas are discussed for applying the treatment to the temporal interpretation of conditionals.

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Introduction

1.0 Overview

Modals sentences are about what is possible and what is necessary. Such sentences are true or false not according to facts that hold in the world of utterance. What counts are facts that hold in worlds closely related to the world of utterance – accessible worlds under a particular interpretation (and these worlds may include the world of utterance). Modal sentences are true or false at particular times in the world of utterance, and the facts holding in closely related worlds that make the sentence true or false also hold at particular times. It follows that at least two sets of times are involved in the interpretation of a modal sentence. There is the set containing the time at which the possibility or necessity holds in the world of utterance, and there is the set of times at which the other-worldly facts hold that make the sentence true or false.

In what follows, I first show that two sets of times are indeed involved in the interpretation of modal sentences, at least in a core subset of the set of modal sentences that I take to be most revealing. There is the time at which the necessity or possibility holds, and there are the times at which the facts hold in the accessible possible worlds which make the modal sentence true or false. Next I turn to the question of how these times get into the interpretation. I assume that the first time, the time at which the modality holds, is contributed by a tense head that selects for the modal in the syntax. For the second set of times, there are several possibilities. One such possibility is that a modal sentence is syntactically complex, containing both an embedding and an embedded clause. Modal sentences would then involve control, or syntactic raising of the subject. The times in question could then be contributed by a tense morpheme associated with the lower clause.

Another possibility is that a modal is also a tense marker, saying not only in which accessible worlds a fact must hold, but also the times at which it must hold. I will give reasons for not adopting any of these possible answers and propose instead that we adopt the syntactically simplest structure for modal sentences. Such a syntax underdetermines the temporal interpretation of the modal sentence and requires us to look elsewhere for it. Finding a mechanism to provide the temporal interpretation of the modal sentence is the project of this dissertation.

1.1 Times in the interpretation of a modal sentence

We can show that in a modal sentence, the time of the necessity or possibility is not necessarily the same as the time of the other-worldly events or states that make the sentence true. One way to make the case is with adverbial expressions. Consider the following.

- (1) The way the law is currently written, Mary must register for the draft next year when she turns 18.
- (2) As things now stand, John can go to the party next week.

The adverb *currently* underscores that in (1), the necessity under discussion is claimed to hold now, at the time of speech, although the required registration is for next year. The expression *as things now stand* in (2) underscores that John's being able to go to the party is a possibility that holds at the time of speech, although the party itself is next week. In both cases, these modal facts can change. Mary might not need to register for the draft next year if the law suddenly changes. John might become unable to go to the party, for example if his parents ground him. In neither case is the occurrence or non-occurrence of future events mentioned in the sentence responsible for this change in truth value of the modal sentence. It is not the fact of Mary's registering or not that makes the difference but the law stating the

requirement. It is not John's actual going to the party or not, but the circumstances that make him able to or not.

The following sentences indicate that a possibility or a necessity has ceased to hold.

- (3) Mary no longer needs to register for the draft next year when she turns 18.
- (4) John can no longer go to the party next week.

The expression *no longer* in (3) indicates that a necessity that held previously does not now hold, and in (4) this expression indicates that a possibility that previously held does not hold any longer. The actions previously required or permitted are still in the future, however.

Another way to see that necessities and possibilities are tied to times different than the events that make them hold is by tracking the truth values of modal sentences at different times. Consider the sentences in (5) and (6).

- (5) The US might invade Iraq this coming February.
- (6) The US will invade Iraq this coming February.

In December, when UN inspections of Iraq's weapons facilities are going smoothly, (5) might be true but not (6). There are possible sequences of events in which the US ends up attacking Iraq in February, but there are other sequences of events, not to be ruled out, in which the US is prevented from attacking Iraq. Suppose by the end of January, however, US military forces have been assembled in the region, and there is no way they are going home without fighting a war. All plausible sequences of events in which the US is prevented from attacking Iraq can now be ruled out. (6) is true. (5) is false, or, if not false, at least it is insufficiently informative.

This example brings up an important difference between modal sentences and sentences that merely contain tense. The interpretation of a modal sentence involves two

propositions in a way that the interpretation of a tensed sentence does not. Consider a past sentence such as (7).

(7) John took the test on November 28, 2002 at 3pm.

Prior to November 28, 2002 at 3 pm, this sentence is strongly infelicitous, and probably just false. After that date and time, it is true or false, depending on whether the person in question took the test in question on that date and time or not. If it is ever true, it remains true forever. The only thing that counts is what happens at that time, and that the time of speech is later than that date. There is no way for this sentence to be true at one time and to become false later.

Now consider a modal sentence with a future interpretation such as (8).

(8) John must register for the draft on December 10, 2002 at 3pm.

After the time in question, this sentence would be strongly infelicitous, in much the same way that (7) would be strongly infelicitous before the time mentioned in that sentence. But there is a difference. (8) can be true at a time prior to December 10, 2002 at 3 pm but false at a later time still prior to December 10, 2002 at 3 pm. We have seen this in an earlier example. The law that makes a certain legal necessity hold can be changed, making the necessity no longer hold.

This discussion has bearing on the question of whether the auxiliary *will* in English is semantically a modal or not. Earlier, I claimed that (6) could be false at one time before February and true at a later time, also before February. That means (6) is unlike (7), a non-modal sentence, but that it is like (8), a modal one. To deny that *will* is a modal is to deny the intuition that (6) could be false at one time before February, and true another time before February.

The interpretation of a modal sentence involves two sets of times, and each set of times is associated with a proposition. There is the time at which the necessity or possibility holds, and the corresponding set of worlds at which this necessity or possibility holds for that time. There are also the times at which certain facts hold that make the modal sentence true or false, and the sets of worlds at which these facts hold for those times. We are interested in how these sets of times get into the interpretation, and how the propositions get into the interpretation. One possible answer is to posit a syntactic structure involving an embedding sentence and an embedded sentence. The embedding sentence contributes to the interpretation the set of worlds at which the necessity or possibility holds, and might also contain a tense morpheme responsible for the time at which the necessity or possibility holds. With Condoravdi (2001), we might call this tense the *outer tense* and the time it contributes the *temporal perspective*. I assume there is such a tense, but I will refer to it simply as the *matrix tense* and the time it contributes the *time of the modality*. The embedded sentence would contribute to the interpretation the set or sets of worlds at which the relevant other-worldly facts hold. This embedded sentence might contain a tense which contributes the time or times at which these facts hold. Condoravdi recommends the terms *inner tense* and *temporal orientation* respectively. Condoravdi denies that there is an inner tense in the syntax of the modal sentence, and I agree with her on this point. I will adopt Huddleston's (1984) term, the *time of the residue*, for the times associated with the other-worldly facts that make the modal sentence true or false.

Abusch (1997, 1998) assumes that the underlying form for *will* and *would* is the morpheme *woll* which is embedded under a tense head, PRESENT or PAST respectively. Abusch does not necessarily intend that *will* or *would* are modals, but we can take them as

such while still adopting her proposal. (I will refer to the underlying form as *will* instead of *woll*.) We can also extend the treatment to other modals in English, saying that *can* and *could*, *may* and *might*, and *shall* and *should* are in some cases the same modal appearing under different tense heads. Adopting this extension does not imply that the past tense morphology on a modal like *could* always means that the modal is embedded under PAST. In fact, I will assume that there are at least two *coulds*. One is the past of *can*, and the other is the present form having a hypothetical or irrealis meaning. These two forms appear in the following sentences.

(9) Mary could run a six-minute mile (when she was younger).

(10) I could lift that weight (if I tried).

In the first sentence, we have the past form of *can*, and in the second, a present form of the more hypothetical *could*. Similar assumptions hold for other modals, which group into the pairs *may/might*, *shall/should*. The modal *must* does not happen to have a morphologically close counterpart which a past meaning. The pair *have to/had to* shows that there is no semantic reason for this gap, if we assume that *have to* is essentially synonymous with *must*. I therefore take it as an accident of the grammar that there is no past of *must*.

In terms of syntax, I assume that a modal heads a modal phrase (MP), and that this modal phrase is the complement of a tense phrase (TP). This assumption is not the only one possible, however. We could simply put the modal as the highest head in the expanded inflectional phrase and say that there is a tense feature within the modal responsible for its temporal interpretation. That would mean an MP is not embedded within a TP. In fact, modals do not allow *do*-support.

Consider the following sentence.

(11) John walked to school.

In this sentence, we see a past-tense morpheme affixed to the matrix verb. Let's assume the following syntactic analysis for the relevant portions of the sentence.

(12) $[_{TP} \text{John}_i [_{T'} \text{PAST} [_{VP} t_i \text{walked to school}]]]$

By this analysis, I have adopted the VP-internal subject hypothesis. The subject in the specifier of TP is associated with a trace in the specifier of the VP. The matrix tense head position is occupied by PAST, and an overt past-tense feature is affixed to on the verb. This structure is analogous to the structure proposed for a modal sentence such as (9), given in

(13).

(13) $[_{TP} \text{Mary}_i [_{T'} \text{PAST} [_{MP} \text{could} [_{VP} t_i \text{run a six-minute mile}]]]]]$

But now consider a set of sentences related to the kernel sentence in (11) involving negation, question formation, and tag-questions.

(14) John didn't walk to school.

(15) Did John walk to school?

(16) John walked to school, didn't he?

These sentences involve *do*-support, presumably because a main verb in English cannot occupy the head position of TP at surface or overt syntax.

For the modal, none of the corresponding sentences with *do*-support is grammatical.

(17) *Mary didn't can run a six-minute mile.

(18) Mary couldn't run a six-minute mile.

(19) *Did Mary can run a six-minute mile?

(20) Could Mary run a six-minute mile?

(21) *Mary could run a six-minute mile, didn't she?

(22) Mary could run a six-minute mile, couldn't she?

Let's assume these sentences are okay because a modal can occupy the head of TP at surface structure (T^0). We could say that the modal starts out in a lower head and then raises to the head of the TP. From that position, it is free to raise again, to the CP head in question formation, for example. This would explain why the modal sentences without *do*-support are acceptable. The question of concern here, however, is what is wrong with the *do*-support sentences. If the modal occupies a head below the tense head, just as a main verb does, why can't the TP head be filled with a past form of *do*? The data suggests that there is no covert TP head above the modal after all, as is assumed in (13).

As a response to this worry, let us begin by pointing out that the auxiliary *have* does not allow *do*-support either. From modal sentences, we know that *have* starts out in a lower head, as in the following.

(23) John must have eaten.

(24) $[_{TP} \text{John}_i [_{T'} \text{PRESENT} [_{MP} \text{must} [_{AspP} \text{have} [_{VP} t_i \text{eaten}]]]]]$

have cannot appear with *do*-support, as the following sentences show.

(25) *John didn't had eaten.

(26) John hasn't eaten.

(27) *Did John has eaten?

(28) Has John eaten?

(29) *John had eaten, didn't he?

(30) John had eaten, hadn't he?

If we allow *have* to raise to the tense head, we can explain the grammatical sentences. The problem is to account for the ungrammatical ones. One way to account for these would

be to say that there is no tense head above *have* available to hold a form of *do*, but since *have* can start out in its own head position as shown in (24), there is no reason to assume that it doesn't start out in its own head position in (31), as shown in (32).

(31) John had eaten.

(32) $[_{TP} \text{John}_i [_{T'} \text{PAST} [_{AspP} \text{have} [_{VP} t_i \text{eaten}]]]]$

Consequently, we need a different explanation for why there is no *do*-support associated with the auxiliary *have*.

The exact same points can be made for the auxiliary *be*. Examples with modals or *have* show that *be* starts out in its own head position. However, *be* is not compatible with *do*-support. These points are illustrated in the following.

(33) John has been asleep.

(34) Mary must be eating.

(35) *Does Mary be eating?

The generalization is that *do*-support is only compatible with main verbs. Since *do*-support is impossible with auxiliaries in general, we cannot use *do*-support to detect a T^0 position above the auxiliary position that is either phonologically empty at S-structure, or into which the auxiliary has moved by S-structure. What holds for the general case holds for modals. We cannot use the incompatibility of *do*-support with modals to detect a T^0 position above the modal, not because such a position does not exist but because *do*-support is not available.

These arguments do not show that there is such a T^0 position. I think it is convenient to hold that there is such a syntactic head, for a reason alluded to earlier. That reason is that by positing such a head, we can not only capture the temporal difference between such pairs

as *can* and *could*, as in (36) and (9), but we can also capture the difference between the two *coulds* in (9) and (10), for example.

- (36) Jane can run a six-minute mile. (present of *can*)
 (9) Mary could run a six-minute mile. (past of *can*)
 (10) I could lift that weight. (present of *could*)

These assumptions are illustrated by the following analyses.

- (37) [_{TP} Jane_i [_{T'} PRESENT [_{MP} can [_{VP} t_i run a six-minute mile]]]]]
 (38) [_{TP} Mary_i [_{T'} PAST [_{MP} can [_{VP} t_i run a six-minute mile]]]]]
 (39) [_{TP} I_i [_{T'} PRESENT [_{MP} could [_{VP} t_i lift that weight]]]]]

Earlier we saw that two propositions and two sets of times are involved in the interpretation of a modal sentence for a particular speech time. A natural assumption is that the syntactic structure of a modal sentence involves an embedding clause and an embedded clause. This assumption would make modal sentences analogous to such sentences as the following.

- (40) Mary says that John is on his way home.

There are two propositions involved in the interpretation of this sentence. There is the proposition that John is on his way home and there is the proposition that Mary has just expressed the proposition that John is on his way home.

The interpretation of (40) falls out from the syntactic structure attributed to this sentence, such as the one in (41).

- (41) [_{TP} Mary [_{T'} PRESENT [_{VP} say [_{CP} that [_{TP} John [_{T'} PRESENT [_{VP} be on his way home]]]]]]]]]

Each proposition in the interpretation is associated with a clause in the syntax, the matrix TP,

and the embedded CP or TP. The temporal interpretation of each clause is fixed in some way by the tense morpheme that appears in each, although this interpretation may be complicated by rules of sequence of tense, in ways that do not affect the point to be made here. The implication for modal sentences is clear. Perhaps these sentences should be analyzed as involving embedding and embedded clauses, with tense heads determining the temporal interpretation of each.

I have already stated my assumption that the modal is embedded under a tense head in matrix position. By the position currently being considered, there is an additional tense head under the modal. Take a modal sentence like (42).

(42) John must go.

One difference between (42) and (40) is immediately apparent. (42) has no overt subject in the position of the embedded clause. That might not be a problem. By standard assumptions, there are embedded subjects in sentences such as the following.

(43) John promised to go.

(44) Mary seems to be tired.

The respective analyses for these sentences are as follows, where for simplicity I have not indicated the place of origin of the subjects within the VP.

(45) $[_{TP} \text{John}_i [_{T'} \text{PAST} [_{VP} \text{promised} [_{TP} \text{PRO}_i \text{ to } [_{VP} \text{go}]]]]]$

(46) $[_{TP} \text{Mary}_i [_{T'} \text{PRESENT} [_{VP} \text{seems} [_{TP} \text{ti} \text{ to } [_{VP} \text{be tired}]]]]]$

(45) shows a control structure, with the reference of the null pronoun subject in the embedded clause fixed by the matrix subject. (46) shows a raising structure, in which the subject of the embedded clause is moved to the subject position of the matrix, leaving behind a trace.

However, neither of these analyses are promising for the modal case, since control and raising both involve non-finite clauses. The following sentences are both ungrammatical.

(47) *John_i promised PRO_i will go.

(48) *Mary_i seems t_i is tired.

The non-finite nature of the embedded clauses in (43) and (44) is shown by the appearance of *to*, by assumption a tense head. The modal sentences contain no such morpheme, showing there is no embedded non-finite clause. If we posit covert tense phrases under the modal, we cannot explain the absence of overt embedded subjects.

Notice that the VP-internal subject hypothesis allows subject raising within finite TPs, but only as high as the specifier position. That is shown in the following example.

(49) Mary has left.

(50) [_{TP} Mary_i [_{AspP} has [_{VP} t_i left]]]

By the proposed structure, the subject has raised from the Spec of VP to the Spec of TP. The problem with (47) and (48) is that the subject has raised from the Spec of the lower TP to the Spec of the higher TP.

Any analysis in which the modal phrase embeds a finite TP is subject to this objection. Condoravdi (2001) mentions analyses from McCawley (1971) and Steedman (1997) in which “modals compose with tensed sentences.”¹ The idea apparently is that under a modal, present or future tense morphemes are covert, and the past morpheme shows up as *have*. There are different ways to take this suggestion. One way to take it is to say that we aren’t talking about tenses that are syntactically present. Condoravdi could perhaps be read

¹ Condoravdi (2001), p. 7.

as taking the suggestion this way, when she writes, “Present and future tenses are assumed to have no overt morphosyntactic manifestation in non-finite contexts, while past tense shows up as perfect.” If the context is non-finite, it shouldn’t contain any tenses. We can’t have non-syntactic tenses, however, since tense is just that item in the syntax that gets a temporal interpretation. Another way to take the suggestion is that we have phonologically null tense morphemes under the modal phrase. Later, Condoravdi mentions “implicit tense operators”², reinforcing the idea that what is being talked about are phonologically null elements in the syntax. Under this rendition, however, we run into the problem that both control and raising are impossible into or from tensed phrases. This problem should lead to the conclusion that inner tense is impossible, given English word order, under Condoravdi’s definition of inner tense as that tense in the scope of a modal. Condoravdi herself is led by other considerations to reject accounts of the temporal interpretation of modal sentences in which modals compose with tensed sentences and for these the reader is referred to her paper.

What should the syntax of a modal sentence look like? I will assume a syntax which takes the surface morphology at face value. In other words, the rules in Chomsky (1957) for auxiliary structure are taken as descriptively correct.

- (51) S → NP Aux VP
 Aux → T (M) (have+en) (be + ing) (be + en)
 T → PRESENT, PAST

The affix-hopping transformation places the suffixes in the desired locations.

² Condoravdi (2001), p. 8.

My descriptive rules are as follows.

- (52) TP → T⁰ MP/AspP/VP
 MP → M⁰ AspP/VP
 AspP → Asp⁰ AspP/VP

Selection restrictions are used to rule out sentences such as the following.

- (53) *John had be tired.
 (54) *John has making bread.

Given these rules, the modal head selects for a verb phrase, or an aspect phrase containing perhaps another aspect phrase and a verb phrase. The syntactic analyses of several sentences are given by way of illustration, where I have put all subjects in their VP-internal position for the sake of simplicity.

- (55) John must be tired.
 (56) [_{TP} PRES [_{MP} must [_{VP} John be tired]]]
 (57) Jane will have left.
 (58) [_{TP} PRES [_{MP} will [_{AspP} have [_{VP} Jane left]]]]
 (59) Fred might have been sleeping.
 (60) [_{TP} PRES [_{MP} might [_{AspP} have [_{AspP} been [_{VP} Fred sleeping]]]]]

Note that I can get the surface word order by allowing subjects to raise from their VP-internal position to the Spec of TP. This movement is within the tensed phrase and is therefore not subject to the restrictions discussed earlier.

1.2 The variation of temporal interpretation within modal sentences

In the previous section, I argued that the modal phrase is embedded in a tense phrase, but that there is no tense phrase within the modal phrase. Sentences like (61) and (62) will have the

respective analyses in (61)' and (62)', where I have represented the subject of each sentence within the SPEC of VP.

(61) John must leave (soon).

(62) Mary must have left (already).

(61)' [TP PRES [MP must [VP John leave]]]

(62)' [TP PRES [MP must [AspP have [VP Mary left]]]]

The matrix tense head gives the time at which the necessity or possibility holds. The time of the residue, however, does not come from any inner tense. We still need to explain how the syntactic structures in (61)' and (62)' are interpreted to give the appropriate temporal interpretations, where the residue for (61), with a deontic interpretation for the modal, is future with respect to the time of speech, while in (62), with the modal interpreted epistemically, the residue is past with respect to the time of speech.

One solution would be to put tense-marking into the lexical semantics of the modal. Consider *must* in (61). We could give a lexical entry for this modal which would give for (61) truth conditions of the following sort.

(63) *John must leave* is true at a world w and a time t just in case for every world w' accessible to w , there is a time t' such that *John leaves* is true in w' at t' .

The deontic meaning of the modal could be captured by how we define the accessible worlds. Enç (1996) gives such truth conditions for *will*.

For (62), a lexical entry could be given for *must* under its epistemic reading which would give truth conditions such as the following.

(64) *Mary must have left* is true at a world w and a time t just in case for every world w' accessible to w , there is a time t' such that *Mary leaves* is true in w' at t' .

In this case, accessibility would be epistemic accessibility.

The truth conditions in (63) talk about times future with respect to the time of speech. The truth conditions in (64) talk about times past with respect to the time of speech. The pastness here is undoubtedly associated with the morpheme *have* that appears in (62), but why is one sentence future and the other non-future at all? Are we seeing two completely different *musts*, homonyms of each other? If so, there is nothing in particular to explain about the temporal interpretations. The lexical entry for deontic *must* says that it marks for future tense, and the lexical entry for epistemic *must* says it marks for non-future tense.

However, these two *musts* are actually part of a larger paradigm, illustrated in (65)~(68).

(65)	a.	John might win the race.	future
	b.	John might be asleep.	present
(66)	a.	John will win the race.	future
	b.	John will be asleep.	present
(67)	a.	John must go home.	future
	b.	John must be asleep.	present
(68)	a.	John can get some milk at the store.	future
	b.	John can't be an undergraduate.	present

In each pair of sentences, we see morphosyntactically identical modals participating in a regular alternation between present and future interpretations. (Using the auxiliary *have*, epistemic past examples could be easily constructed.) For example, in (65)a we have a future reading for *might* and in (65)b, an epistemic reading for the morphosyntactically identical modal. It is worth noting that each epistemic reading in (65)~(68) is non-future, which

suggests that there is a generalization here to capture.

Are the modals within each pair homonyms? If so, it is a little surprising that those with non-future interpretations (for the residue time) are all epistemics. However, Kratzer (1977) has already given us reason to believe that they are not homonyms at all, but across each pair the same word with the same lexical entry. Kratzer considers the different meanings which a form like *must* can have. She asks,

How many kinds of *must* do we have to distinguish? How many deontic ones? How many epistemic ones? How many dispositional ones? And how many preferential ones?³

Kratzer points out that across different occasions of use of *must*, there is a part of the meaning that is invariable. She argues that this common kernel of meaning comes about because each use *must* really involves the same word. The meanings differs across different occasions of use because *must* in its meaning is like a function which takes as different arguments different sets of propositions for these different uses. The sets of propositions are what she will refer to as conversational backgrounds in later work, where she argues that the interpretation of a modal sentence involves two distinct conversational backgrounds.⁴

If Kratzer is right, then within each pair of sentences in (65)~(68), we see the same modal with the same lexical entry. The temporal interpretations within each pair are different. The difference cannot be part of the lexical entry, because there is only one lexical entry for each word. We have already rejected the view that modal sentences with different temporal interpretations involve embeddings of tensed sentences. But since the conversational backgrounds are what varies across different occasions of use, it makes sense

³ Kratzer (1977), p. 339.

⁴ A modal base and an ordering source. See Kratzer (1991b) for example.

that the temporal interpretations of the modals (i.e. the time of the residue) should be tied to these conversational backgrounds. Making this connection will be the project in this dissertation.

It is worth noting that the alternation just seen in (65)~(68) is seen elsewhere in natural language too. Palmer (1979) discusses the following examples.⁵

(69) I suggest that you went to London.

(70) I suggest that you go to London.

(71) I insist that you went to London.

(72) I insist that you go to London.

(69) is uttered against a backdrop of present uncertainty. If the speaker knows that the addressee went to London, it would not be felicitous to utter this sentence. (69) is about the past. (70) is about the future. In (71) the speaker insists on a particular epistemic possibility, which either the speaker is not sure of, or about which there is disagreement between the speaker and the audience. This possibility is in the past. (72) again is about the future.

A similar alternation is evident in the next pair of sentences.

(73) John wants the Mets to have won.

(74) John wants the Mets to win.

(73) is about a desire for a particular state of affairs and this sentence can only be used if the speaker, or at least John, does not know whether or not the Mets have won. The past reading of (73) is due to the presence of *have* in this sentence. By (74), John wants a particular team to win, but the game, or at least its outcome, must be still in the future. In these examples we

⁵ Palmer (1979), p. 8.

see an alternation between epistemic sentences and future sentences.

Another point of interest is that in some other languages besides English the same morpheme can be used to make suppositions about the present or to speak about the future.

Consider Spanish.⁶

- (75) ahora estará en casa
 now will-be at home
 ‘S/he must be home now.’

The indicative future form *estará* in this context is used to signal epistemic probability.

We find the same phenomenon in Imbabura Quechua.

- (76) kunan punlla Juzi-ka Agatu-pi ka -nga
 now day José-topic Agato-in be-future 3
 ‘I suppose José is in Agato today.’⁷

As Cole (1985) says of this language, “the future tense is used not only to indicate future time reference, but also for probabilistic statements with regard to the present.”⁸ Notice that in this example, for all we know from the gloss, the future morpheme is associated with a weaker expression of certainty than in the Spanish example. But we have both in English. The sometimes future morpheme in (66)b expresses a stronger certainty than the sometime future morpheme in (65)b, by certain assumptions I turn to immediately.

Another point ought to be raised at this juncture. By including the auxiliary *will* in the list (65)~(68), I am suggesting that *will* should be treated as a semantic modal that gets

⁶ An anonymous reviewer of SALT XII abstracts supplied the sentence, the gloss, and the translation for the Spanish example.

⁷ Cole (1985), p. 146.

⁸ Cole (1985), p.145.

its temporal interpretation the same way that other modals in the paradigm do. This assumption is not universally shared and in fact there are several other approaches to the temporal interpretation of *will*.

Heim (1994), for example, treats *will* as a pure tense marker. The LF of (77) is given in (78), with the lexical entry for *will* given in (79).⁹ (Heim assumes that the tenseless form of *will* is *woll*.)

(77) John will cry.

(78) $\text{PRES}_1 \text{ woll } \lambda_0 [\text{John INF}_0 \text{ cry}]$

(79) $\llbracket \text{woll} \rrbracket (\text{P})(\text{t})(\text{w}) = 1 \text{ iff } \exists t' > t: \text{P}(t')(\text{w}) = 1$

According to (79), a *will* sentence is true at a world and a time just in case the denotation of the complement – Heim treats *will* as a raising verb embedding an infinitival complement, which may or may not be a CP – holds at some future time in the same world. By this entry, the interpretation of *will* involves no quantification over worlds. The world at which the *will* sentence is evaluated is the only world at which the embedded sentence is evaluated.

Abusch (1997) follows this analysis of *will* closely, though she concedes that the issue of whether *will* is a modal or not is not settled. Abusch mentions that one advantage of treating *will* as a quantifier over worlds would be that such a treatment makes it a universal counterpart of the existential *might*.¹⁰ Abusch (1998), however, pursues an analysis in which the time parameter of *will* is expanded to include all future times. In that analysis, *will* is treated as a tense operator and not a semantic modal.

Kamp and Ryle (1993) allow that the future is undetermined, unlike the past, and that

⁹ Heim (1994), p. 10.

¹⁰ Abusch (1997), p. 38.

therefore time should be modeled with a branching structure. They assert that some modals do quantify over such branches, but they deny that such quantificational meaning should be attributed to *will* in English, which they refer to as the future tense auxiliary. About the truth conditions of a *will* sentence at a world *w* and time *t*, they write,

...when someone uses the future tense, he is typically referring to whichever way the future will turn out to be, irrespective of whether the aspects of it that are relevant to the truth of his statement are already fixed or not. In other words, the future tense refers to a single continuation of *w* after *t* – to that way in which *w* continues after *t*.¹¹

Kamp and Ryle further assert that the branching model is unnecessary for the semantic analysis of *will*.

...so long as we limit ourselves to *will* and ignore the other modal auxiliaries, we can stick with models based on linear time structures.¹²

Other writers view *will* as a semantic modal, quantifying over worlds in some domain and saying that in each world in the domain, there is a time, future with respect to the speech time, at which some event occurs or some state holds. This basic idea is due to Prior (1967). Enç (1996) states truth conditions for *will* sentences in these terms, as mentioned. Huddleston (1984) and Kratzer (1981) also view *will* as a semantic modal, as does Condoravdi (2001), and the view is hardly restricted to these authors.

Even if *will* is treated like as future tense marker, the temporal interpretation of the other modals in the paradigm in (65)~(68) still needs to be explained. My assumption is that *will* is a modal like any other, which is why it can be used epistemically as well as with a future meaning. Later in this dissertation, I will consider some objections to this view and

¹¹ Kamp and Ryle (1993), p. 535.

¹² Kamp and Ryle (1993), p. 535.

what might be said in response to these objections.

1.3 Towards an explanation of the temporal facts

We have seen that in modal sentences providing nearly identical syntactic environments, there is an alternation between epistemic readings and futurity. In certain non-modal sentences, the same alternation is apparent as well, and the generalization extends to languages besides English. Why should this be so? What is there in common between epistemic readings and futurity? I think the link becomes clearer when we remember that ‘epistemic’ really means epistemically uncertain. To see this, we can compare sentences that register varying degrees of uncertainty, such as the following.

(80) John might be on the phone.

(81) John must be on the phone.

(82) John is on the phone.

The first of these, (80), registers less certainty than (81). But although (81) expresses more confidence than (80), it still can only be uttered against a backdrop of uncertainty. (81) is weaker than (82), because (81) could be true when (83) is true, but (82) could not.

(83) John is not on the phone.

This is the point in calling a sentence epistemic – not that it is used to state something known by the speaker but rather that it is used to state something that follows from what is known by the speaker. In fact, something would be wrong with an utterance of (81) by someone who knows that John is on the phone, and I will have more to say on this point later.

The connection we are after comes about if we assume that the future is open. We can then say that the syntactic environments in question are environments used to express certain kinds of openness, epistemic openness on the one hand and the openness of the future on the

other. In a summary statement of a study of future marking across approximately fifty languages, Ultan (1978) expressed much the same view.

...future tenses were most frequently found to mark the same modal categories (of obligation, volition, uncertainty, or unreality)...This close connection between future tenses and modals is probably to be attributed to the relative uncertainty inherent in both future event and most of the categories subsumed under the general heading of modals.¹³

I claim that the alternation between future and non-future readings is an alternation between expressions presupposing future openness and expressions presupposing epistemic openness. Such expressions are modal, and in my view the modality is what determines the temporal interpretation of the sentence. The theory I develop in this dissertation is meant to make this idea more concrete. I assume that modal sentences are used to go beyond what is known, or currently knowable. Past and present facts are fixed, and therefore at least some of these are knowable. Future facts are not fixed, and therefore not currently knowable. It follows that we use modal sentences to talk about unknown past or present facts, and to talk about future facts.

Given this position, certain questions arise. Do modal sentences have truth values? If they have truth values, are these truth values in principle knowable? I adopt a theory which gives truth conditions for modal sentences. Adopting this theory commits me to the view that modal sentences have truth values. The truth conditions depend in part on whether the modal is universal or existential. If the modal is universal, the sentence is true just in case a certain proposition follows from some set of facts, given certain regularities in the world. As I develop the theory, this set of facts may be past and present facts as known, or the entire set of past and present facts, whether or not known any of these are known. This difference

¹³ Ultan (1978), p. 118.

means that epistemic and future modal sentences have quite different properties.

Take an epistemic sentence like (84).

(84) John must be asleep.

This sentence is true if, what follows from what the speaker knows and regularities in the world, John is asleep. But the speaker's knowledge may be so limited that John is actually not asleep, even as (84) is true.

In contrast, consider the future sentence in (85).

(85) It will rain tomorrow.

Suppose the next day it doesn't rain but is sunny. The sentence was definitely false. But consider the objection that the sun came out only due to irregularities and so the sentence should be true, the actual outcome notwithstanding. This objection hinges on the kind of regularities involved. What is meant are laws. The truth conditions look only at worlds in which these laws are obeyed. (85) says that rain occurs in each of these worlds. The world as it actually unfolds will necessarily be one of these. This means that (84) can be true when John is awake, but (85) cannot be true when it doesn't rain the following day. An existential modal, by contrast, means the laws don't rule out a certain outcome.

Are the truth values of modal sentences knowable? Only if the set of relevant facts is knowable, and if the set of relevant laws is knowable. In practice, the entire set of relevant laws is never known, and it is almost certainly unknowable. It seems unlikely that the set of relevant facts is knowable either.

This doesn't mean we don't take modal sentences as true or false, nor that we don't intend the modal statement we utter to be true or false. It seems to me that the situation is not all that different for modal sentences than for declarative sentences. Linguists give truth

conditions for declarative sentences and speakers act not only as if these sentences are true or false but as if anyone could know whether they are true or false. There are however real limits on what we can know with absolute certainty, as philosophical skepticism is at pains to demonstrate. This fact is of little practical relevance because what counts is true or false within reasonable standards. It is of little theoretical relevance because by giving truth conditions, we are only trying to characterize the meaning of sentences. Truth conditions say that a declarative sentence is true just in case certain conditions hold, and these conditions are what the speaker must know to use the sentence correctly. Nothing hinges on the speaker's having a guaranteed way of knowing that the conditions hold. For a modal sentence, too, the task is to characterize speaker knowledge. In this case, the speaker must know the conditions under which the sentence would be true or not, but it is irrelevant whether the speaker ever could know for certain whether those conditions hold.

A further question involves the division of labor between modal sentences – whether a particular sentence is used to talk about past or present uncertainty, or to talk about the future. Why isn't there just one category of modal sentence, to talk about everything we are uncertain about? What these sentences show us is that epistemic uncertainty is one thing, and uncertainty of the future is a different thing, and language makes the distinction. The distinction allows us to express things from two different points of view. We can take an epistemically limited perspective, or we can take a perspective in which we act as if there is no such epistemic limitation.

When we take the first perspective, we have a description of the world up to the present that is assumed to be accurate but that cannot be pretended to be complete. There are holes in it. It describes this world up to the present, but it describes many other worlds as

well. We cannot tell the difference between these worlds, based on what we know. That is, we cannot tell which of these worlds we are in. When we take this perspective, we are limited to making distinctions between worlds based on differences between them up to the present.

When we take the second perspective, we act as if we had a complete description of the world up to the present. We don't make distinctions between worlds up to the present because we treat all distinctions as resolved. We only make distinctions between future continuations of the world as it is now. It is worth repeating the point that I am assuming that sentences interpreted from this perspective are still true or false, even if we have no way of knowing which. We act as if we know the difference.

In my theory, the temporal interpretation of modal sentences comes from these perspectives. Since in many cases the same modal can be used to make statements that are either epistemically uncertain or about the future, the temporal interpretation should derive from the modal one. The primary temporal interpretation does not come about from tense-marking. (Auxiliaries such as *have* can be involved, however.) I think there is an additional reason to arrange things this way. As I will argue, a modal sentence is about temporally located possibilities, and it would be redundant to locate these possibilities both in time and in logical space. Their location in logical space determines a location in time.

Therefore, in my theory the time of the residue is not represented by a variable in the syntax. Rather, the syntax provides an object that denotes a function from times to propositions. Constraints on the location of these propositions in logical space also constrain the times that are admissible arguments for the function. It follows from the theory that there is not a single pair of times involved in the interpretation of a modal sentence, but rather an

unlimited set of pairs of times. I think speaker intuitions accord with this result. Consider the following sentence.

(86) That branch will fall this winter.

It seems unlikely that this sentence is about one specific time at which the branch will fall. Many things might happen this winter, and according to what does happen, the branch may fall at different times. If an ice-storm comes early, the branch might fall in December. If not, it might only fall in a January blizzard. For every likely course of events, there is a corresponding time at which the branch falls. This is the idea that the semantics captures by involving a function from times to propositions.

My theory of the temporal interpretation of modal sentences involves a principle constraining the possible meanings of these sentences, a constraint that is independently needed, given the essential nature of these sentences. Essentially, a modal sentence expresses a logical conclusion from a set of propositions to a new proposition. In Kratzer's theory of modals, my starting point, this conclusion is already constrained by a second set of propositions, the ordering source, as will be discussed below. But an additional device is required, I will argue, to make sure that the conclusion that follows is not already part of the original set of conclusions. I will call this device the *disparity principle*, and I will show that future interpretations of modal sentences are a consequence of it. An additional constraint, the *requirement to make first distinctions first*, will guarantee that ordinary epistemic sentences are not future. Given these two additions to the theory we start with, and with the right selection of conversational backgrounds, the temporal interpretations of modal sentences is accounted for.

At the conclusion of this introductory section, I would like to mention a limitation

on my starting empirical generalization, as well as some limitations on the scope of the explanation that I intend to offer. The starting empirical generalization is that future sentences are non-epistemic and epistemic sentences are non-future. The following example, modified slightly from Condoravdi (2001), shows that such a generalization would be too sweeping.

(87) The decision has been made as to whether John will meet the dean or the provost. He might meet the dean and he might meet the provost, but I don't know which.

The second sentence in (87) contains a conjunction of *might* clauses, and these clearly have a future interpretation. The clauses are also epistemic, as they are only utterable against a background of uncertainty about the decision that has been made. A person who knew the results of the decision made about John would not be able to utter the second sentence in (87) felicitously. The modal in the sentence have existential force. They mean roughly that it can't be ruled out that John meets the dean and it can't be ruled out that he meets the provost. But as far as the facts of the world, one of these possibilities can be ruled out. The decision has been made. It is with respect to the speaker's epistemic state that neither possibility can be ruled out. The sentence is both future and epistemic.

Beyond this, the neatness of the correlation between temporal and modal interpretation seen in (65)~(68) comes about because I have only included what Huddleston (1984) calls *prototypical modal sentences*. When we look at a broader base of sentences, the correlation fails. For example, it is not the case that every deontic *must* sentence is future. Huddleston gives the following example.

(88) Applicants must have postgraduate qualifications in psychology.

Huddleston regards this sentence as a move away from the prototypical case, and says that

the sentence is about the fulfillment of a condition rather than the performance of an action, as are the deontic sentences we have looked at. Note that (88) can hardly be said to be a future sentence. It is in fact difficult to say what its temporal interpretation is.

As for these non-prototypical sentences being about the fulfillment of conditions, it is perhaps worth noting that the conditions can be either necessary or sufficient. (88) is about a necessary condition: to apply for the position, it is necessary for one to have postgraduate qualifications. By contrast, the following sentence involves a sufficient condition.

(89) Eighteen year-olds must register for the draft.

Being eighteen is a condition sufficient to make registering for the draft necessary. The temporal interpretation of this sentence is also unclear.

I assume that modal sentences without a clear temporal interpretation are generic, and this includes (88) and (89). But not all generic sentences are necessarily deontic. The following sentence from Kratzer (1991b) is not deontic, but I suspect it is generic.

(90) Hydrangeas can grow here.

It wouldn't be fair to say that this sentence has a future interpretation. The truth of the sentence would lead one to believe that if one planted a hydrangea now, it would grow, but the sentence is not about any specific hydrangeas to be planted in a specific future.

To get a clear understanding of the temporal reading of modal sentences, it will be necessary to avoid generic ones, at least at first. That is what I intend to do here. I will use sentences about specific agents or objects, and particular actions or states. It is a project for future research to combine a theory of the temporal interpretation of modal sentences with a theory of generics to account for the temporal interpretation of generic modal sentences, but this goes beyond the scope of this dissertation.

Chapter 2 The future and the past in language

2.1 Representing the past and the future

I've claimed that modal sentences get the temporal interpretation that they do because modal sentences are about facts open with respect to some background, and the relevant background concerns either what is known or what is future. For this account to work, the future must be open in a way that the past (or present) is not, but it is not uncontroversial that this is so. In this section, I review some possible positions on future openness and the relevance of these positions to a linguistic theory explaining the temporal interpretation of modal sentences. I will introduce some terms and concepts that will be useful for the development of the theory, and give a model for indeterminate futures. Finally, since my treatment of *will* as a quantifier over possible worlds presupposes indeterminate futures, I will review some arguments against such a modal treatment of *will* that will have to be answered once the theory of temporal interpretation is in place.

One can view the future as closed, or as open. These are the positions of determinism or indeterminism, respectively. Determinism views the future as being like the past, fixed and unchangeable. We might be ignorant about the future, but ignorance about the future is like ignorance about the past. The facts are already in place and any uncertainty is in the perceiver, not in courses of events themselves. By indeterminism, in contrast, the future is unlike the past. The facts of the past – and the present – are fixed, but future facts are not. We can have ignorance about the past or the future, but ignorance about the future is of a different order. We might not know a past fact, but it holds or doesn't in the world we are in. Future facts are not like this. We don't know them, and, moreover, we couldn't know them. They are still up for grabs.

The view adopted by indeterminism is often diagrammed as a set of branching times. (Prior (1967), Thomason (1984), Belnap (1992), Kamp and Ryle (1993)) Determinism can be diagrammed as a single straight line, representing the unalterable course of events from the past into the future. Within indeterminism, there is more than one possible position. Burgess (1978) distinguishes two, *actualism* and *antactualism*. The actualist, according to Burgess, accepts that the future is not fixed, but thinks that it still makes sense to talk about an actual world. If indeterminism is represented as a set of branching worlds, the actualist takes one of the branches to be the actual one. The antactualist denies that there could be an actual world, if worlds branch. The idea of branching is taken to mean that no actual world can be distinguished from among the branches.

The controversy between determinism and indeterminism could be taken at different levels. Most simply, it could be taken as a controversy about what reality is like. Alternately, it could be taken as a controversy about how humans perceive reality, or, as a controversy about language. If it is a question about language, we would want to know whether natural languages operate against a background of branching futures or against a background of a linear future, whether all languages operate against the same background, and whether any given language is internally consistent in this respect. For example, it be possible that there are constructions in some language whose interpretation presupposes branching futures and other constructions, in the same language, whose interpretation presupposes a linear future.

There might also be interesting relations between the three levels mentioned in the last paragraph. For example, a commitment to indeterminism as the proper description of reality might be compatible with the view that as far as natural language is concerned, the future is closed, but the reverse might not be true. If the future is really closed, it might be

impossible to maintain that language treats it as open. Consider, for example, the position of Kamp and Ryle (1993). We return first to the quotation given earlier.

...when someone uses the future tense, he is typically referring to whichever way the future will turn out to be, irrespective of whether the aspects of it that are relevant to the truth of his statement are already fixed or not. In other words, the future tense refers to a single continuation of *w* after *t* – to that way in which *w* continues after *t*.

They further assert,

...so long as we limit ourselves to *will* and ignore the other modal auxiliaries, we can stick with models based on linear time structures.¹⁴

The commitment to linear time is clear from these remarks, at least for a semantic analysis of *will*. However, Kamp and Ryle concede that futures branch. They write

It is part of our conception of ourselves and our role in the world in which we live that the future is ‘open’ while the past is ‘closed’. What the future will be like is to a significant degree undetermined, and we ourselves are among those who can help shape it. As to the past, nothing we can do can make any difference.¹⁵

From this passage, Kamp and Ryle consider branching futures at least to be part of the human conception of reality, if not reality itself. But given their treatment of *will*, Kamp and Ryle seem to be saying that the human conception of branching times does not entail that language has to treat time as branching. Or they could be seen as antactualists. Times branch, but *will* only makes reference to a distinguished member of the branching, the actual world.

This position on *will* is complicated by their assumptions about other modals. Deontic *must* is interpreted with respect to branching times in Kamp and Ryle’s view. Once again, this could be viewed as antactualism, or they could be taking the view that natural language is not consistent. For some constructions, e.g. sentences with deontic *must*, the future is

¹⁴ Kamp and Ryle (1993), p. 535.

¹⁵ Kamp and Ryle (1993), p. 534.

viewed as open, and for other constructions, e.g. sentences with *will*, the future is viewed as closed.

In this dissertation, I take the position that the future is open, that it is part of the cognitive hard-wiring of humans to see it as open, and that natural language presupposes that it is open. The position is that every expression in every language with a future meaning involves interpretation against a structure of branching times, that is, branching worlds. I take this position because it seems most natural that all languages would presuppose the same view of time and the future, and because it is the position most subject to falsification and therefore the most interesting.

This position also promises to allow for a unified treatment of the modals in their core uses. In a later section, I will argue that there are entailment relations between modals such as *must*, *will*, *should*, and *can* given future interpretations of these modals. For example, I propose that denotic *must* entails future *will*, in the sense that (91) entails (92).

(91) John must register for the draft next week.

(92) John will register for the draft next week.

My claimed entailment from (91) to (92) is not standardly recognized and not, I think, immediately obvious, but I will argue that it is correct. Deontic *should* under a future interpretation, by contrast, does not entail future *will*, in the sense that (93) does not entail (92).

(93) John should register for the draft next week.

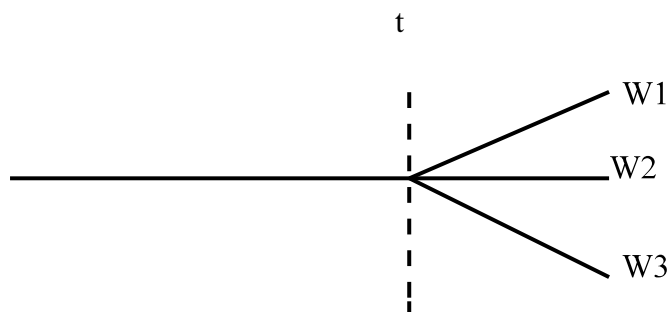
Among other entailments, one holds between *will* and the potential *can*, in the sense that (92) entails (94).

(94) John can register for the draft next week.

To make it possible to capture these entailments and others in a straightforward manner, I want to treat *will* as being interpreted in much the same way as other future modals, against a structure of future-branching worlds.

As mentioned, indeterminist time is often diagrammed as a branching structure, with the branching usually to the right. The branches represent different futures, the point of branching being the present time. I will refer to these branching structures as *broomsticks*. A broomstick whose point of branching is at time t will be called a *t-broomstick*.

Illustration 1. Branching worlds (a broomstick): w_1 , w_2 , and w_3 are proxies at t



We are adopting a possible worlds semantics, so it is important to ask what exactly a broomstick is, and what its branches are, with respect to possible worlds. Some theorists regard broomsticks as bundles of histories. Thomason (1984), for example, builds histories using times as primitives, making no mention of worlds. Belnap (1992) follows Thomason in regarding broomsticks as made of histories. Belnap's primitives are not times but event-points, and he makes his models consistent with relativity theory. Each branch in the broomstick joined with the handle, is a history. That being the case, we want to know the relation between histories and worlds.

I regard worlds as extended from the beginning of time to the end, if there is a beginning and end to time, and otherwise as limitless in extent. Worlds can diverge from one

another. From my present perspective, I can see a large tree through the window. I can conceive of the tree being struck by lightning tomorrow at 4 pm, or not. I am entertaining two sets of worlds, one set in which the tree is struck by lightning and one set in which it is not. The worlds in these sets would be identical up to 4 pm, and afterwards they would diverge. From my present perspective, I actually belong to multiple worlds, all identical up to this moment. Yesterday at the same time, I belonged to multiple worlds, all identical up to that moment. Every world I am in presently is also a world I was in yesterday, but there are worlds I was in yesterday that I am no longer in today. As I move forward in time, worlds are constantly falling by the wayside, as determined by events that might have happened in the worlds I am in but did not. But everything I have said about worlds could equally well have been said about histories. I see no reason to consider them as different objects. That means a diagram of a broomstick shows a set of branching worlds.

This indeterminist picture makes the notion of the actual world problematic. The actual world is by definition the world I am in, but indeterminism holds that I am simultaneously in many worlds, and I will remain in many worlds, even as worlds are constantly falling by the wayside. No one of these worlds can presently be designated as the actual world. Otherwise, we are back to determinism, or at least actualism. If there is an actual world, it is pointless to say that I actually inhabit multiple possible worlds at this moment, since none of the other worlds are really candidates for the future course of events. The only way to maintain indeterminism is to say that I now inhabit multiple possible worlds, and all of these are candidates for the actual world. The selection of one world as the actual world could only take place at the end of time.

The broomstick shows strong identity of worlds up to the branching-point. One is in

all of these worlds at once because there is no fact of the matter holding in the present that distinguishes one from the other. The notion is not one of similarity, which would allow for some difference. If the worlds in the broomstick were merely very similar up to the point of branching, the handle of the broomstick would not be a single line but multiple closely parallel lines. In that case, since I can only be in one line or the other, there are facts presently holding that distinguish these worlds. This is not the view of indeterminism.

Given indeterminist, antactualist assumptions, it doesn't make sense to talk about the actual world. Any of the worlds I am in presently might one day be the actual world, but only at the last moment of time can a world be so designated. It only makes sense to talk about the actual world from the point of view of the end of time, or at least the end of all interesting time.

Suppose I want to refer to the actual course of events up to the present, in terms of possible worlds. Any world that I currently inhabit would do just as well. I suggest the notion of *proxies for the actual world at a time*. At the present time t , I am in a t -broomstick. All the worlds in this broomstick have the same status. Any of them could end up being the actual world. For now, they are all just proxies for the actual world. To talk about the actual course of events up to the present, I can refer to any of the worlds, since they are all equally good representatives of it, as things now stand. In general, any two worlds in the same t -broomstick will be proxies to each other at t .

There is a possible objection to the term *proxies for the actual world*. By this objection, since the actual world doesn't exist, it makes not sense to designate worlds as representatives of it. How can there be representatives of something not existing? In response, I think it is misleading to say that the actual world does not exist. The world that

is to be the actual world does exist, in the sense that any possible world can be said to exist. However, the designation *the actual world* cannot yet appropriately be applied to it because it is not fixed as the actual world. Consider the following analogy. Suppose that the United States has taken over Iraq and is in the process of installing a democratic government. As there has been no time for democratic elections, the United States for now designates someone as a proxy for the democratically elected president of Iraq. Note that the democratically elected president of Iraq exists, in the sense that the person who will be president exists. Who that is is undecided. It would be inappropriate to refer to the proxy or anyone else as the democratically elected president. But there is no problem in referring to the designated person as a proxy for the democratically elected president of Iraq. It is even okay if the designated proxy becomes the democratically elected president of Iraq. In the same way, it makes sense to talk about a proxy for the actual world, even if the designation *the actual world* cannot be appropriately applied now to any world and even if the proxy might itself become the actual world.

In model-theoretic semantics, sentences are interpreted with respect to a model. To build indeterministic models, we need broomsticks, and in order to have broomsticks, we need worlds that overlap. Overlapping means that worlds at some point in time are identical. In what follows, I consider one way in which overlapping worlds might be put into the model.

2.2 Modeling indeterminism

Cresswell (1972), following the approach of Wittgenstein's *Tractatus*, builds worlds from more basic parts. This treatment can guide our own attempt to build worlds from world stages. We begin with the *Tractatus*. Here Wittgenstein suggests worlds are made up of

atomic facts. What is an atomic fact, and when is something small enough to be an atomic fact? The following passages from the *Tractatus* give some clues.

- 1. The world is all that is the case.
- 1.11 The world is determined by the facts, and by their being all the facts.
- 1.2 The world divides into facts
- 2.061 States of affairs are independent of each other.¹⁶

Wittgenstein envisioned facts, which I take to be atomic facts, as the stuff that reality is composed of, and worlds as total collections of these facts. The size of a fact is hinted at in 2.061. A fact, or state of affairs, is something small enough to vary independently of other facts, to hold or not to hold without affecting other facts.

Cresswell (1972) constructs a semantics using an underlying atomistic metaphysics. He begins with a set *B* of *Basic Particular Situations (BPS)*. These are like atomic facts in that a BPS can be present or absent without affecting other BPSs. Cresswell constructs a domain *D* from members of *B*, from relations between members of *B*, and from any set that can be derived from these sets of members or relations. One important subset of *D* is the set of basic individuals. Intuitively, these are objects, states and events, processes, and so on. A basic individual is a function σ from a world to a part of that world. Propositions are sets of possible worlds.

Cresswell offers a concrete illustration of this metaphysics. Take *B* to be the set of space-time points. The actual world is the set of space-time points actually occupied for all times. A different set of occupied space-time points is a different possible world. Stressing that this example is only an illustration and that his metaphysics does not commit him to materialism, Cresswell writes,

¹⁶ Wittgenstein (1921/1961).

The members of B play a role analogous to that of theoretical entities in physical theories and what sorts of things we take them to be will of course depend on a thorough-going analysis of the particular language we are interested in.¹⁷

We will follow Cresswell's approach except we build world stages as intermediate between facts and worlds.

Start with a set of times T. For any $t, t' \in T$, $t < t'$, $t' < t$, or $t = t'$. When necessary, intervals can be constructed from times. (95) is a standard approach to constructing intervals from moments of times.

(95) I is an interval just in case $I \subset T$ and for any $t_1, t_3 \in I$ such that $t_1 < t_3$, if t_2 is such that $t_1 < t_2 < t_3$, then $t_2 \in I$.

Suppose that for every time $t \in T$, there is a grid to be filled in with positive values or neutral values. The grid represents all possibilities for a moment of time. Any point on the grid can be occupied or unoccupied at t , without affecting other points at t . It is a fact if a point x on the grid at t is occupied and a different fact if a point x on the grid at t is unoccupied. Call the grid for a time t with all values set *a world stage at t*.

Next we define *worlds*. Let a world be a collection of world-stages, one for every $t \in T$. Represent a world-stage at t as w_t , and a world as w . For every $t \in T$, $w_t \in w$.

What remains is to introduce *overlap* and *branching*.

Overlap between worlds depends on identity between world stages. Two world stages, w_t and w'_t are identical just in case the same facts hold in each. Two worlds, w and w' overlap at time t just in case $w_t = w'_t$.

¹⁷ Cresswell (1972), p. 6.

Branching is a special kind of overlap. We can have left branching or right branching.

Two worlds, w and w' , are left branching from t just in case $w_t = w'_t$ and for every $t' < t$, $w_{t'} \neq w'_{t'}$. w and w' are right branching from t just in case $w_t = w'_t$ and for every $t', t < t'$, $w_{t'} \neq w'_{t'}$.

I assume that worlds do not converge over time so I want to prevent left-branching in our models. The following axiom does so.

(96) For any $w, w' \in W$, if for some $t \in T$, $w_t = w'_t$, then for all $t' \in T$, $t' < t$, $w_{t'} = w'_{t'}$.

This axiom says that if two worlds share a world stage at any time, they share world stages for any earlier time.

2.3 Arguments against a modal treatment of *will*

With branching-world models in place, we can turn to the analysis of modals with future and non-future readings. Modals with future readings will be interpreted with respect to broomsticks containing proxies for the actual world. Modals with non-future readings will be interpreted with respect to multiple speech-time broomsticks. But one member of our paradigm of modals with both future and non-future readings, the auxiliary *will*, has received particular attention in the literature. We have already seen the claim from Kamp and Ryle (1993) that this auxiliary is best understood as a future-tense marker interpreted against a linear model of time. As it turns out, there are a number of arguments against treating *will* as a semantic modal, that is, as a quantifier over possible worlds. At the close of this chapter we review some of the arguments against a treatment of *will* such as the one that will be offered here. After the theory has been developed, it will be necessary to come back and respond to the arguments that would undermine it.

The first kind of argument I will call the *wait-and-see* argument. The idea behind this

argument is that to know whether a *will* sentence is true or not, we simply wait and see. Take, for example, a dialogue such as the following.

- (97) A: Lucky Stars will win tomorrow. (said of a race horse)
 B: (later, after the race) You were right. Lucky Stars did win.

In the dialogue A predicts that Lucky Stars will win. After the race in which Lucky Stars does indeed win, and B asserts that A was therefore right in making the earlier statement. Given a linear view of the future, the result is straightforward. A's statement means that at a future time tomorrow in the world of utterance, Lucky Stars wins the race. The event of Lucky Stars winning the race verifies the statement. But now consider the dialogue as analyzed against a theory in which *will* is a universal quantifier over different possible futures. A's statement would mean that in every relevant future, Lucky Stars wins the race. When the race actually takes place, Lucky Stars wins it, but that does not mean that Lucky Stars won it in every world originally quantified over. It seems that B's congratulations to A for a correct prediction ought to be inappropriate, if *will* is a modal quantifier.

Notice that by the modal account of *will*, a prediction can be disconfirmed, even if not verified. Consider the following dialogue.

- (98) A: Lucky Stars will win tomorrow.
 B: (later, after the race) You were wrong. Lucky Stars didn't win.

By the linear time theory, A again has said that at a future time tomorrow, Lucky Stars wins the race and Lucky Stars not doing so falsifies the sentence. By the modal theory for *will*, what A has said is again that in every relevant future, Lucky Stars wins the race. As it turns out, Lucky Stars loses. That means that what A said is false, and B's remark fits with the analysis.

Next, consider what I will call the *disjunctions-as-tautologies* argument. This argument is given in Thomason (1970). Take a sentence like the following.

(99) Either it will rain tomorrow or it won't.

Intuitively, (99) is a tautology – it can't be false – and this is because there are only two possibilities for tomorrow's weather, rain or no rain, which is exactly what the sentence says. For the linear future theorist, this interpretation is no problem. The sentence says simply that either, at some time tomorrow, it rains, or, at no time tomorrow does it rain. But suppose *will* is a modal, a universal quantifier over futures. (99) is in the form of a disjunction, with the modal appearing separately within each disjunct. The second disjunct contains negation, which has scope under the modal. We would therefore expect the entire disjunction to be interpreted as saying that either in all relevant futures it rains or in all relevant futures it doesn't rain. Under this interpretation the sentence would not be a tautology because it is not necessarily true. We can easily imagine a broomstick containing some worlds in which it rains tomorrow and some worlds in which it does not rain. With respect to such a broomstick, (99) under the proposed interpretation would be false, and hence cannot be a tautology.

We would do well at this point to make sure about our intuitions about (99). Suppose we are wrong about the scope of the negation in the second disjunct. What if the negation in this disjunct has scope over the modal? In that case, the entire disjunction would be interpreted as saying that either in all relevant futures it rains tomorrow, or not in all relevant futures does it rain. Under this interpretation the sentence would be a tautology and the modal account of *will* would be rescued, at least for this example. If we can give a syntactic reason that the modal must take scope over the negation in (99), we are off the hook.

However, this strategy won't work, because the second disjunct cannot be interpreted that way. Let us fill in the VP-ellipsis in (99) and look at the sentence contained in the second disjunct in isolation.

(100) It won't rain tomorrow.

Suppose (100) is uttered on Tuesday and on Wednesday it rains. (100) is falsified. The intuition here is very clear. If the sentence means that it doesn't rain tomorrow in all relevant futures, it shouldn't be falsified in these circumstances.

Or take the following sentence.

(101) *It might rain tomorrow and it won't rain tomorrow.

This sentence is sharply ruled out, although (102) is perfectly fine.

(102) It might rain tomorrow and it might not rain tomorrow.

The second disjunct in (102) has an equivalent interpretation to the one we are considering for (100). These examples show that in isolation, the second disjunct of (99), fully spelled-out, puts the negation under the scope of the modal, and not vice versa.

It is implausible that the same sentence embedded within a disjunction would exhibit different scope relations. However, consider the following sentence.

(103) Either George W. Bush will win re-election two years from now, or he'll lose.

This sentence is a disjunction with precisely the same tautological flavor as (99). Once again, the sentence presents no problem for the linear future theorist, but it is a problem for the view that *will* is a quantifier over possible futures. In this case, there is no negation within the second disjunct, so there is no possibility of trying to fix the scope of the negation to say that the sentence means, either in all relevant futures, GWB wins, or in some relevant futures, he doesn't win. It must be interpreted to mean that either in all relevant futures, GWB wins or

in all relevant futures, he loses. There is no reason why the sentence couldn't be false under that interpretation, and this goes against the observed fact that (103) is a tautology.

Finally, consider what I will call the *retrospective future* argument. The following sentence is again from Thomason (1970).

(104) There is space travel; therefore it was the case that space travel would come about.

(104) seems to represent a true inference. The idea, as discussed in Ryle (1966) is that whatever happens was going to happen. But (104) contains the modal *would*, which is plausibly seen as a past form of *will*. Suppose we unembed the *will* sentence.

(105) Space travel will come about.

Now we can say that because there is now space travel, at all past times before space travel, (105) was true. If *will* is just a future marker, that should be true. If *will* is a quantifier over possible futures, there is no reason (105) should always have been true. We can imagine scenarios in which a nuclear war wiped out the human race before any astronaut ever got off the ground. But the claim is general. All past *would* sentences seem to be automatically true if the predicted event has come to pass.

Chapter 3. A theory of modals

3.1 General discussion

As pointed out in Kratzer (1979 and elsewhere), what is apparently the same morphosyntactic modal in English can occur across a great variety of contexts, each time with a similar but not necessarily the same meaning. One can imagine at least two basic approaches to explaining this. One might, for example, appeal to a homonym theory by which each modal with a different meaning is a different word with a separate lexical entry. Deontic *must* would be an altogether different word than epistemic *must*, and in fact there

might be different *musts*, given such sentences as the following.

(106) Given what the law requires, you must register for the draft by next week.

(107) Given what science tells us, you must boil unclean water before drinking it.

In the same way, *will* with a future interpretation, even if it is a modal, is a different word than epistemic *will*, as in the following sentences.

(108) That branch will fall. (future)

(109) That will be John at the front door. (epistemic)

Kratzer argues that what I am calling the homonym theory leads to an implausible proliferation of modals. She posits instead that there is a single lexical item for each basic form. Associated with each such lexical item is a core meaning and a contextually varying meaning. The contextually varying meaning is associated with conversational backgrounds. That is not to say that any modal can be associated with just any conversational background, but rather, the same modal is not always associated with the same conversational background on every occasion of use. Kratzer's theory helps explain why in every occurrence of *must*, for example, it functions as a universal quantifier over worlds while at the same time its meaning is not always the same.

My project is to explain the temporal interpretation of a modal as a result of the contextually-dependent part of its meaning. It is common to analyze modals as quantifiers over possible worlds. A quantifier has a certain force, and a domain over which it quantifies. We assume that modals have existential or universal force, and what they quantify over are worlds in their domain. The simple idea is that a modal sentence says that all, or some, of the worlds in the domain have a certain property. How is the domain to be given? In a Saul Kripke fashion, they can be given by a primitive accessibility relation. Kratzer provides a

premise semantics for modals, where a contextually given set of propositions, the *modal base*, does the work of the accessibility relation. In the Kripke-type approach, for example, some set of worlds might just be given as epistemically accessible. In the premise-semantics approach, there is the set of propositions known by the speaker. Each proposition is represented by a set of worlds, so the intersection of these propositions is the set of epistemically accessible worlds – worlds consistent with what the speaker knows.

This is a good start, but we run into problems. First, how can the device of quantification over worlds provide for temporal interpretations of a sentence? Take a sentence containing a modal with universal quantificational force. The sentence is analyzed as saying that every world in some domain is a p-world. How is this proposition p associated with an event holding at some past, present, or future time? Here is another way to put the problem. I am assuming that a broomstick is a bundle of worlds, completely extended in time, and that *will* is a quantifier over worlds. It seems that what we really want is a quantifier over futures, over the branches, not over the entire worlds.

There is a second problem, involving the intuition that modal sentences are about open possibilities. I said earlier that epistemic sentences and future sentences are both with respect to open possibilities. Consider the following sentences, for illustration.

(110) John must be sleeping.

(111) That branch will fall.

The sentence in (110) is about the proposition that John is sleeping, and this must be open with respect to the worlds in the domain, not true in all of them or false in all of them. The sentence in (111) is about the proposition that the branch falls, and that proposition, being future, must be open – that is – true in some but not all worlds in the appropriate

broomstick. But now a conflict arises with universal quantification. A universal quantifier says that some property holds in all members of the domain. The property brought up in a modal sentence, however, should be open – that is – not true in every world in the domain. We need to have it both ways.

It turns out that accessibility is not the only issue for with respect to quantification – the worlds in the domain are not equal in every respect. Take the set of epistemically accessible worlds. Worlds can be compatible with everything a speaker knows and still be wildly improbable. It makes sense that a modal quantifier should ignore such improbable worlds, or worlds that are not well-behaved in other respects. One way to capture the inequalities between worlds is by ordering them. One way to order the worlds is with a set of premises, and this is the method Kratzer employs in her premise semantics where she appeals to a second conversational background, an *ordering source* in the interpretation of a modal sentence.¹⁸

Kratzer (1991b) discusses three cases which show the need for two conversational backgrounds in the interpretation of a modal sentence.¹⁹ The first case involves deontic modality. Kratzer asks us to imagine a country in which previous legal judgments are the basis for deciding whether an action is allowed or not. Previous judgments may be in conflict with each other. Still following Kratzer’s example, suppose that one judge has ruled that owners of goats are liable for any damage the goats caused, and a different judge has ruled the opposite. In this case, the set of propositions that determine what is allowed are themselves inconsistent. Anything follows from an inconsistent set of propositions, so it

¹⁸ Lewis (1981) compares Kratzer’s premise semantics to various ordering semantics.

¹⁹ Kratzer (1991b), pp. 642~643.

would seem that any proposition whatsoever should be allowed or required, given such sets of judgments. But this consequence only comes about if the set of inconsistent judgments is seen as part of the modal base. A modal base cannot be inconsistent or its intersection will be the empty set. The inconsistent judgments can be part of the ordering source, however. Worlds are compared using an ordering source by comparing how many propositions from the ordering source are true in each world. It can be seen that now it doesn't matter if there are contradictory propositions in the ordering source set.

The second case Kratzer considers involves the interpretation of a conditional. Here we suppose an internally consistent conversational background and that denotation of the antecedent clause is not compatible with that background. Let the interpretation of conditionals involve adding the antecedent proposition to the conversational background. The prediction is that any consequent proposition should follow. Specifically, Kratzer considers a case where the following proposition is in the conversational background.

(112) No murder occurs.

If this proposition is in the background, it follows that any conditional with the antecedent *if a murder occurs* will be true. That result comes about once we put the proposition that a murder occurs into the conversational background. The resulting set of propositions is inconsistent, and from such a set of propositions, any consequent proposition follows.

The solution is again to have two conversational backgrounds. The proposition that no murder occurs is part of the ordering source. The antecedent proposition is added not to the ordering source but to the modal base. No contradiction with propositions in the modal base occurs.

The third case Kratzer considers involves graded modality. The standard idea of

possibility as compatibility with a set of worlds allows no refinement that would capture different strengths of modality. Kratzer considers sentences which include the following.

- (113) a. It is barely possible to climb Mount Everest without oxygen.
 b. It is easily possible to climb Mount Toby.

Compatibility with a set of propositions is all or nothing, so there is no way of expressing something's being barely possible or easily possible. Once an ordering source is introduced, however, we can have a hierarchy of modal notions. Modal concepts that correspond to being barely possible or easily possible can be defined as part of this hierarchy.

The idea of interpreting a modal sentence against two conversational backgrounds helps with the first problem I raised above, that is, the conflict between universal quantification and the idea of open possibilities. We no longer need a universal modal to quantify over every accessible world or over every world in the intersection of the modal base. If there is an ordering source, the modal needs only to quantify over some privileged subset of worlds in the intersection of the modal base, a privileged subset based on the ordering source ordering. The modal can say that every world in the subset is a *p*-world, even while *p* is an open possibility with respect to the modal base.

What about the temporal interpretation of the modal sentence? The interpretation of a modal sentence against two conversational backgrounds allows us to introduce a principle into the theory of modals by which the proposition a modal sentence is about *must be* an open possibility with respect to the domain of worlds quantified over. With respect to a set of worlds that can be arranged into a broomstick, the only propositions that can be open propositions are those tied to future facts. This idea will be made clearer as we go along.

Next, I review Kratzer's modal theory. This will clear the way to introduce

modifications by which the temporal interpretation of modal sentences can be explained given the new principle I have introduced.

3.2 Some details of the theory

We are adopting a theory in which modal sentences are interpreted against two contextually-dependent conversational backgrounds. The long term goal is to make the temporal interpretation of a modal be contextually-dependent too, which means it will be tied to these conversational backgrounds. In this section, we get more specific about these backgrounds as formal objects and introduce a modification into Kratzer's formulation of the modal base. That modification will help to capture the temporal interpretation of the target sentences. Note that Kratzer herself explicitly ignores temporal issues in the development of her theory of modals.

A conversational background is a set of premises invoked in a particular context. Kratzer proposes that conversational backgrounds are functions from worlds to sets of propositions. Let us represent Kratzer's *modal base* and *ordering source* as f and f' , respectively. For Kratzer, the function f itself would be the modal base and the function f' itself would be the ordering source. I will sometime find it convenient to refer to these as the modal base *function* and the ordering source *function*, respectively. I will also find it convenient to use the terms *modal base* and *ordering source* to mean the value of the functions for particular inputs. The set of worlds in the intersection of the modal base proposition, $\bigcap f(w)$, I will call the *modal base set*.

The following definition from Kratzer (1991b) shows how a modal base function f can be put in terms of an accessibility relation R_f and vice versa.

(114) For all $w, w' \in W$, $w R_f w'$ just in case $w' \in \bigcap f(w)$.²⁰

This definition says that a world w' is accessible from w relative to the accessibility relation R_f just in case w' is contained by the modal base $f(w)$. I will say that worlds found in $\bigcap f(w)$ are *selected by f at w* .

Consider an epistemic sentence such as (115), uttered against a context set c at time t .

(115) John must have left the lights on.

Given an epistemic modal base function f in Kratzer's theory, the epistemic modal base $f(w)$ is the set of propositions known by the speaker in a world w . These propositions might include the propositions that the lights are on, John is out, and John was the last person here. The set of worlds epistemically accessible to the speaker in w , the set of candidates for the actual world given what the speaker knows, is $\bigcap f(w)$, the set of worlds consistent with this knowledge. However, notice that at two different times, it's quite likely that the speaker's state of knowledge is different and the sets of worlds consistent with those states of knowledge are different. A function that simply takes a world as an input does not reflect this difference. I suggest that f should be a function from a world and a time to a set of propositions. Given such a function, for two different times t and t' , it is quite possible that $f(w, t) \neq f(w, t')$, and $\bigcap f(w, t) \neq \bigcap f(w, t')$.

The epistemic modal base is the one involved in the interpretation of sentences in the first part of the alternation between epistemic uncertainty and futureness. The second part of the alternation involves futureness. We want a function f that for a world w and a time t ,

²⁰ This definition is from Kratzer (1991b), p. 642.

gives a set of propositions whose intersection is the set of proxies for w at t , a set of worlds that can be thought of as a t -broomstick that includes w . What set of propositions would give a such t -broomstick?

We get a hint from Kratzer's (1981b, 1991b) totally realistic conversational background. A totally realistic conversational background is a function from a world w to a set of propositions whose intersection is the singleton set containing that world, $\{w\}$. In other words, the function yields a set of propositions that characterize the world completely and uniquely. Kratzer has used this function in her analysis of counterfactual conditionals. Her idea is that although f provides one way to characterize w completely and uniquely, there are other functions that provide different complete and unique characterizations of w . These functions can differ in the way they lump facts together. Our interest at this point is not in the analysis of counterfactual conditionals. Rather, we want a description of a world w that is unique and complete up to a time t . Suppose we have a function f that is a *totally realistic modal base up to a time*. This function takes a world w and a time t and gives back a set of propositions that completely and uniquely characterizes w up to t . *Uniquely*, that is, in the sense that it uniquely characterizes w up to t and any other worlds identical to w up to t , and no other worlds. That means that the intersection of these propositions, $\bigcap f(w, t)$ is the set of proxies for w at t , a set of worlds that can be organized into a t -broomstick containing w .

Next we turn to the second conversational background, the ordering source. We look at the formal definition from Kratzer and consider whether or not any changes need to be made in that definition. The informal idea is that the ordering source is a set of propositions that imposes an ordering on the set of worlds selected by the modal base. A world from the modal base set in which more ordering source propositions hold is closer to the ideal

represented by the ordering source than a world from the modal base set in which fewer of these propositions hold. More formally, the ordering source is a function f' from a world to a set of propositions. For any $w', w'' \in W$, for any $f'(w) \subseteq \mathcal{P}(W)$, $w' \leq_{f'(w)} w''$ just in case $\{p: p \in f'(w) \text{ and } w'' \in p\} \subseteq \{p: p \in f'(w) \text{ and } w' \in p\}$. w' is at least as close to the ideal represented by $f'(w)$ as w'' is, just in case every proposition of $f'(w)$ true in w'' is also true in w' .²¹

I will assume that just as the modal base function f has been modified to reflect changes of time, taking a world and a time as arguments, so should the ordering source function f' take a world and a time as arguments.

The earlier example can be used to illustrate the function of the order source.

(115) John must have left the lights on.

The worlds in the modal base are worlds that agree on everything the speaker knows: that the lights are on, etc. These same worlds can differ in any other respect. In some worlds, John is the one who left the lights on. In other worlds, a person who has no access to the house left the lights on. But these worlds are not equally likely, and the function of the ordering source in this case is to put the worlds into a hierarchy from more likely to less likely. Worlds in which someone who lives in the house and has access to the lights left them on are more likely than worlds in which someone who does not live in the house and has no access to the lights left them on and so is closer to the ideal. The more likely worlds, those closest to the ideal, are the worlds that matter, because these are the worlds that suggest how reality might be.

²¹ Modified from Kratzer 1991b, p. 644.

Now that we've looked at the modal base and ordering source in more detail and have a better idea about the differences between these conversational backgrounds, I want to look at the idea of ordering itself in general terms. Not only will this tell us more about the interaction of the two conversational backgrounds, but it will reveal something about the meaning of modal sentences and provide another clue as to how their temporal interpretations should be derived.

To order a set of entities, several things are needed. You need a set of things to order. The set must contain more than one member. You also need a basis on which to order them. A couple of obvious points can be made here. First, for any non-trivial ordering of a set to be possible, the set must contain more than one member. Second, the members of the set can only be ordered on the basis of how they differ.

Let us say that ordering is basic to the meaning of a modal sentence. We can say that modal sentences are about some set of worlds, and it is about differences between these worlds. That is why two conversational backgrounds are needed, one to give the set of worlds to order, and the other to order them. The idea of differences between worlds should remind us of open possibilities.

We have a hint for deriving temporal interpretations. Consider modal sentences with a future interpretation. The modal base for these is a broomstick. A broomstick is a set of worlds selected on the basis of past and present facts. The worlds in the broomstick differ as to future facts. If there were no differences, there would be only one world. If there were no differences, there would be no basis for ordering these worlds. To explain the future interpretation of these sentences, we need a principle that says they must be about differences in these background worlds. Notice how this explanation relies on the assumption of

indeterminism. If there were no future differences between the worlds in the set, there would be only one world in the set: the actual world.

Non-future epistemic sentences are interpreted with respect to sets of worlds that differ by past, present, and future facts. For speech time t , the worlds in this set cannot be organized into a single t -broomstick but only into multiple t -broomsticks. My theory here will say that the point of these sentences is to compare broomsticks. To compare broomsticks, you need to ignore future facts, because with respect to a future fact, worlds in a single broomstick cannot agree. To explain the non-future interpretation of epistemic sentences, we will need a principle that says they must be about differences between the t -broomsticks that are compatible with what a speaker knows.

3.3 Truth conditions for modal sentences

We are treating modals as quantifiers over sets of accessible possible worlds. The double conversational background theory gives a set of accessible worlds and an ordering of these worlds. The statement of truth conditions for modal sentences depends on assumptions made about the ordering of the accessible worlds. The discussion in this section is based on Kratzer (1981) who defines a range of modal notions beginning with *necessity*, and Lewis (1981) who discusses the interaction between assumption about ordering and the statements of truth conditions.

The simplest truth conditions for *necessity* require the assumption that there are closest accessible worlds. In terms of the double background theory, these are worlds closest to the ideal represented by the ordering source. The intuition is that a statement is a necessity just in case it holds in all of these closest worlds. The following is the formal statement.

(116) p is a necessity in a world w with respect to modal base function f and ordering

source function f' just in case p holds at every f' -closest world in $\cap f(w)$.²²

In terms of an earlier example,

(117) John must have left the lights on.

$\cap f(w)$ is the set of worlds consistent with what we know to be true. The f' -closest worlds are those worlds where normal conditions hold. The sentence is true just in case in all these closest worlds, John left the lights on.

It may not be warranted to assume that there are closest worlds in every case. As Lewis discusses (see also Kratzer 1979), it is plausible that no matter how close you get to some ideal, you can always imagine some way of getting even closer. An alternative definition of *necessity* can be given, not in terms of closest worlds but rather in terms of worlds that are at least as close as some other.

The statement of truth conditions would be as follows.

(118) p is a necessity in a world w with respect to a modal base function f and an ordering source function f' just in case there is some world j in $\cap f(w)$ such that for every world k in $\cap f(w)$, either p is true in k , or $j \leq_{f'(w)} k$ but not $k \leq_{f'(w)} j$.²³

Two assumptions are still at work in this definition. First, there is the assumption that all accessible worlds can be strung together in a single ordering, a so-called *total ordering*. The ordering may go on for infinity, which is why there may not be closer worlds. However, if at some point in the direction of increasing closeness to the ideal, all worlds belong to the proposition in question, then it is a necessity. A second assumption underlying the first is that all accessible worlds are comparable. If all worlds are comparable, then for any two worlds,

²² Adapted from Lewis (1981).

²³ Adapted from Lewis 1981, p. 230.

one is closer than the other to the ideal, or they are both equally close or even identical.

These assumptions might not be warranted either. It may be wrong to suppose that all accessible worlds are comparable. Lewis (1981) suggests that such total orderings can be cumbersome and the more likely relevant orderings are not total.²⁴ Suppose that we give up the assumption that there are necessarily accessible worlds closest to some ideal as well as the assumption that all accessible worlds are necessarily comparable. The final, most neutral statement of truth conditions for *necessity* is as follows.

- (119) A proposition p is necessary in a world w with respect to a modal base function f and an ordering source function f' just in case for every world h in $\bigcap f(w)$, there is a world j in $\bigcap f(w)$, $j \leq_{f'(w)} h$, and for all k in $\bigcap f(w)$, if $k \leq_{f'(w)} j$, $k \in p$.²⁵

Kratzer (1991b) defines a range of modal notions in terms of each other or in terms of the same set of primitives. Besides *necessity*, these notions are *possibility*, *good possibility*, *at least as good a possibility*, *better possibility*, *weak necessity*, and *slight possibility*. The virtue of setting up the system in this way is that although different languages express modal notions differently, particular mappings from the modal notions to particular expressions in a language can be tested by looking at entailment patterns. For example, *possibility* is defined in terms of *necessity*, as shown in the following definition.

- (120) A proposition p is a possibility in a world w with respect to modal base function f and ordering source function f' just in case $\neg p$ is not a necessity.²

Suppose *necessity* is mapped to *will* in English, and *possibility* is mapped to *might*. This

²⁴ Lewis 1981, p. 225.

²⁵ See Lewis (1981) and Kratzer (1991b).

² From Kratzer 1991b.

mapping can be checked by seeing whether (121) is false just in case (122) is true.

(121) John won't sing.

(122) John might sing.

In this dissertation, I treat *will*, *must*, and *should* as expressing *necessity*, and *may*, *might*, and *can* as expressing *possibility*.

Chapter 4. Representing time

In this section I look at some recent treatments of tense in the semantic literature. My coverage will not be exhaustive, but I want to look at some representative theories with an eye towards choosing a suitable framework within which to cast my theory. This section interrupts the flow from discussing modal theory to showing how a constraint on modal sentences can be used to account for the future interpretation of some modal sentences, but as we will be discussing the representation of tense shortly, it is now a good time to review the basics.

Ogihara (1996) has a useful discussion of two general approaches to tensed sentences which differ in whether times are used as indices, or whether they are represented exclusively in the semantic translation of a sentence. I will borrow from his discussion in what I say here.³

For concreteness, I will center my discussion around a particular sentence and talk mostly about the simple past tense. Consider the sentence in (123) with a partial LF given in (124).

(123) John left.

³ See Ogihara (1996), pp. 26~28.

(124) John PAST left.

Let's begin with treatments in which times are an indices used. The first one is Priorian, which translates (124) into a temporal logic formula such as (125).

(125) PAST (John leaves)

By this translation, the past tense morpheme is an operator. Truth conditions say that (125) is true at a time t just in case at some time t' , $t' < t$, the sentence 'John leaves' is true. Notice that although times are mentioned in the meta-language, there is no mention of them in the translation of the sentence.

The second approach is from Dowty (1979), although I am following Ogihara (1996) here. A translation for (124) is given in (126).

(126) $\exists t[t < \text{now} \ \& \ \text{AT}(t, \text{leave}'(j))]$

Notice here that there are time-denoting expressions in the translation language. Unlike in the most of the following treatments of tense, the verbal predicate does not take a temporal argument. Instead, special work is done by the predicate 'AT'. As Ogihara explains, for w , t_0 , and g , $\llbracket \text{AT}(t, \phi) \rrbracket_{w, t_0, g}$ is true just in case $\llbracket \phi \rrbracket_{w, g(t), g}$ is true. The interpretation of the 'AT' predicate requires times to be represented in the translation language, *and* be used as indices.

The second general approach represents times in the translation language and does not interpret tensed sentences with respect to temporal indices. The first such approach I will consider is Ogihara's (1996).

The LF in (124) for (123), both repeated here, is the same.

(123) John left.

(124) John PAST left.

Ogihara's system would give the following translation for this LF.

(127) $\exists t[t < s^* \ \& \ \text{leave}'(j,t)]$

Temporal variables appear in the translation. t is existentially bound, and the special temporal variable s^* will always get as its value the time of speech. In this case, the verbal predicate takes a temporal argument. This sentence can be interpreted with respect to worlds and assignment functions. There is no need for temporal indices.

Some different approaches to this sentence that also do not rely on temporal indices start from a different LF. (128) is the kind of LF needed.

(128) John PAST₁ left.

We see that in the syntax, the past tense morpheme takes a numerical index.

Enç (1987) adopts such an approach. She writes, 'I will assume that tense bears an index like all other referential expressions...'⁴ Ogihara provides the following kind of translation to instantiate Enç's assumptions.⁵

(129) $t < s^* \ \& \ \text{leave}'(j,t)$

The only difference with Ogihara's own translation is that the temporal variable t is unbound and must get its value from a contextually-given assignment function. Notice that as in Ogihara's system, the temporal variable is fed to the verbal predicate and the pastness of the sentence is part of the meaning represented in the translation.

One theory presented in Heim (1994), in her extended comments on earlier work by Abusch, starts from the same kind of LF as in (128) and presumably would give the following kind of translation, if there were translations in Heim's system.

⁴ Enç (1987), p. 640

⁵ Ogihara (1996), p. 85.

(130) $\text{leave}'(j, t_1)$

This translation sentence would be interpreted with respect to an assignment function g that assigns a time interval to the index. (Heim's assignment functions operates directly on the numerical index in the syntax.) Notice that the pastness of the sentence in (123) is not reflected in the translation in (130). That's because the pastness is made part of the presuppositions of the sentence. If the assigned interval is not past, the sentence under this assignment is not interpretable.

Abusch (1998) approaches the analysis of tense somewhat differently. A translation for (123) as it would come out by her 1998 system is shown in .

(131) $\exists e[e \subseteq (-\infty, n) \ \& \ \text{leave}'(j, e)]$

In this translation, the verbal predicate takes, not a temporal argument, but an eventive argument, which is the existentially bound variable e . The values this variable can take are temporally constrained to be part of an interval starting with the speech time and stretching back infinitely far in time. $(-\infty, n)$ denotes this interval, with n being the so-called *now parameter*, which in matrix contexts is interpreted as the time of speech. In Abusch's system, PAST is translated $\lambda Q[Q((-\infty, n))]$, PRES is translated $\lambda Q[Q(n)]$, and *will* is translated $\lambda Q\lambda t[Q((t, \infty))]$ so that in combination with the present tense morpheme, contributes the expression (n, ∞) to the translation which denotes an interval from the speech time to the infinite future.

von Stechow (1995) presents a theory of tense which he subsequently modifies to deal with cases of adverbs of quantification and frame-setting adverbs. I will review his theory and the modification. von Stechow begins with a single index on a tense morpheme, which would give an LF for (123) very close to (128) except that von Stechow uses letter

indices instead of numerical indices. That LF is given in (132).

(123) John left.

(132) John $PAST_i$ left.

His translation rules for $PAST$, $PRES$, *have*, and *will* are given here. (He treats a supposed underlying form *woll*.)

(133) $PRES_i: \lambda P[t_i \circ t_0 \ \& \ P(t_i)]$

(134) $PAST_i: \lambda P[t_i < t_0 \ \& \ P(t_i)]$

(135) *have*: $\lambda t \lambda P \exists t' [t' < t \ \& \ P(t')]$

(136) *will*: $\lambda t \lambda P \exists t' [t < t' \ \& \ P(t')]$

The difference between past and *have* is that the latter involves existential quantification over the temporal variable, whereas the former introduces an unbound temporal variable, as in Enç (1987) or Heim (1994). I will adopt the assumption that the past tense morpheme and *have* differ in this way. By rule (134), von Stechow would arrive at a translation very close to that given for Enç's (1987) theory. That translation is given in (137).

(137) $t_i < t_0 \ \& \ \text{leave}'(j, t_i)$

To capture facts pertaining to adverbs of quantification and frame-setting adverbs, von Stechow introduces a second temporal index on the tense morphemes. New translation rules are given here, with corresponding truth conditions.⁶

(138) $PAST_{(j)i} \Rightarrow \lambda P[PAST(t_0)(t_j)(t_i) \ \& \ P(t_i)]$

(139) $\llbracket PAST \rrbracket(k)(j)(i) = 1$ just in case i is the maximal t such that $t \subseteq j$ and t is before k .

(140) $PRES_{(j)i} \Rightarrow \lambda P[PRES(t_0)(t_j)(t_i) \ \& \ P(t_i)]$

⁶ von Stechow (1995), p. 378.

(141) $\llbracket \text{PRES} \rrbracket(k)(j)(i) = 1$ just in case i is the maximal t such that $t \subseteq j$ and t overlaps k .

I will use an extra temporal variable to denote a frame interval, when needed. When it makes no difference to the outcome, I will suppress mention of this variable. I will also adopt a translation language in which both times and worlds are represented and in which verbal predicates have both a time and a world argument.

To conclude this section, I provide a sample derivation of a past perfect sentence to show the system I adopt in operation. Consider the sentence in (142) with the LF representation in (143).

(142) John had left.

(143) $[_{TP} \text{ PAST } [_{AspP} \text{ have } [_{VP} \text{ John leave}]]]$

The translation is as follows.

(144) <u>translation</u>	<u>type</u>
1. $[_{VP} \text{ John leave}] \Rightarrow \lambda t_0 \lambda w_0 [\text{leave}'_{w_0, t_0}(j)]$	$\langle i, \langle s, t \rangle \rangle$
2. $\text{have} \Rightarrow \lambda Q \lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ Q(w_0)(t')]$	$\langle \langle i, \langle s, t \rangle \rangle, \langle i, \langle s, t \rangle \rangle \rangle$
3. $[_{AspP} \text{ have } [_{VP} \text{ John leave}]] \Rightarrow$ $\lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ \text{leave}'_{w_0, t'}(j)]$	$\langle i, \langle s, t \rangle \rangle$
4. $\text{PAST}_i \Rightarrow \lambda Q \lambda w_0 [t_i < s^* \ \& \ Q(w_0)(t_i)]$	$\langle \langle i, \langle s, t \rangle \rangle, \langle s, t \rangle \rangle$
5. $[_{TP} \text{ PAST } [_{AspP} \text{ have } [_{VP} \text{ John leave}]]] \Rightarrow$ $\lambda w_0 [t_i < s^* \ \& \ \exists t' [t' < t_i \ \& \ \text{leave}'_{w_0, t'}(j)]]$	$\langle s, t \rangle$

Chapter 5. Extending the theory of modals

5.1 A non-temporal constraint on modals

My aim is to explain the temporal reference of modal sentences without assigning fixed temporal meanings to the lexical entries for modals. In other words, I don't want to say that

future *will* has a different lexical entry than epistemic *will* or that part of the lexical meaning for each modal is a specification of its temporal reference. Nor do I want to say that the lexical entry for epistemic *must* says that it has non-future reference, or the lexical entry for deontic *must* says that it has future reference. We need to find a general property of modal sentences that can interact with the contextually variable aspect of the meaning of a modal to explain the temporal reference.

I believe that the a general property we are looking for can be seen in a certain non-temporal constraint in operation on epistemic modals. Consider the following sentences.

(145) John must be inside.

(146) John is inside.

(147) John is not inside.

An apparent constraint on (145) is that it cannot be felicitously uttered by someone who knows that (146) is true. A speaker who knows that John is inside should not assert that John must be inside. In addition, and more obviously, (145) cannot be sincerely uttered by someone who knows that (147) is true. A speaker who knows that John is not inside should not assert that John must be inside.

I want to explain the constraint on (145) in terms of the modal theory presented in the previous section. The explanation involves a distinction between two kinds of facts or propositions that was not actually made in Kratzer's theory but that is a direct consequence of that theory. In that theory, a set of modal base propositions intersects to yield a set of worlds. In the general case this set of worlds is not a singleton set, which it would be if the set of modal base propositions exhaustively described any one world. That means that the worlds in the modal base set do not agree on certain propositions, although they agree on all

propositions in the modal base. The distinction I want to make is between *modal base facts* and *disparity facts with respect to a modal base*. For a value of the modal base function f at a world w and a time t , $f(w, t)$, the modal base, is the set of modal base facts (propositions). Facts that hold in some but not all worlds in $\cap f(w, t)$ are disparity facts with respect to $f(w, t)$. It is on the basis of modal base facts that the worlds in the modal base set are selected in the first place, and it is on the basis of disparity facts that these worlds can be ordered with respect to each other. As discussed, ordering presupposes differences between the items to be ordered.

I propose an interpretive principle which in its simplest version says that a modal sentence only receives an interpretation in which the syntactic complement of the modal denotes a disparity fact with respect to the modal base. The principle is called the *disparity principle*. This interpretive principle will be revised later because I do not think that the complement of a modal is a syntactic object whose denotation is a proposition, but in this section we can assume that the complement does denote a proposition.⁷

What are the consequences of the disparity principle for a sentence like (145)? This sentence contains the modal *must* under its epistemic reading. The associated modal base is epistemic. The disparity principle in this case puts limits on the range of situations in which the sentence can be uttered. Remember that modal base facts for an epistemic are propositions known to be true by the speaker and disparity facts are facts neither known by the speaker to be true nor known to be false. A consequence of the disparity principle is that a sentence like (145) can only be sincerely uttered when the speaker doesn't know that (146)

⁷ Groenendijk and Stokhof (1975) observed the constraint discussed here and Condoravdi (2001) formalizes it in her *diversity condition*.

is true and doesn't know that (147) is true. The disparity principle therefore encodes the constraint on an epistemic sentence that it can only be uttered when the proposition denoted by the complement of the modal is neither known to be true by the speaker nor known to be false.

There is a possible objection to the explanation for the constraint on (145) just given. This objection says that there is no need for the disparity principle to explain the constraint because the constraint is simply due to a scalar implicature. The utterance of a weaker sentence in general implicates that a stronger version of the sentence is either false or not known to be true by the speaker, the idea here being that (146) is stronger than (145) and so the utterance of (145) implicates that (146) is not known to be true by the speaker.

We can examine the logic underlying scalar implicatures by examining the following pair of sentences.

(148) Mary worked on her paper for eight hours without stopping.

(149) Mary worked on her paper for ten hours without stopping.

Suppose a speaker utters (148) and not (149). The audience is entitled to believe that (149) is either not true, or that the speaker doesn't know whether or not (149) is true. The inference that the audience makes is explained as the result of a scalar implicature. The explanation begins with the claim that (149) is a more informative statement than (148). What does it mean to be more informative? In this case at least, we have a straightforward test. (149) entails (148) but (148) does not entail (149). We know this from native speaker judgments. In any situation in which (149) is judged to be true, (148) will also be judged to be true. The reasoning continues as follows. By the Gricean maxims of quantity and quality, if a statement is both informative and the evidence shows it is true, assuming that it is relevant, it should

be uttered. (149) was not uttered in a situation in which (148) is relevant, so (149) is either not true or the speaker lacks evidence for it. If we assume that the speaker has access to all relevant evidence, it must be that (149) is not true. The inference from the utterance of (148) to the conclusion that (149) is not true is an implicature.

A similar derivation might seem to explain the constraint on (145). Assume first that (146) is a stronger statement than (145). Upon hearing (145), therefore, one would be entitled to infer that (146) is not known to be true by the speaker. Given the combined quantity and quality maxims, since (146) is informative, it should have been uttered but was not. It is either not true or the speaker lacks evidence for it. The speaker presumably does not think that (146) is false, given that the speaker has uttered (145). It must be that the speaker lacks evidence for (146) and therefore does not know (146) to be true.

However, this reasoning is based on the intuition that (146) is more informative than (145). What could such an intuition be based on? In the first case of scalar implicature just considered, there was an entailment from the more informative to the less informative, and not the other way around. In the modal case, there is no similar entailment. (146) does not entail (145) and neither does (145) entail (146). If single direction entailments were the only way basis for judgments of greater or lesser informativity, the scalar implicature account could not work.

The intuition that there is no entailment from (146) to (145) is supported in the literature. Kratzer (1991b), for example, says as much in her discussion of the relative strengths of declarative sentences and their modal counterparts. Specifically, Kratzer considers the following sentences.

(150) She climbed Mount Toby.

(151) She must have climbed Mount Toby.

Kratzer makes the point that (151) cannot be purely epistemic, or it would entail (150), which it doesn't. Her explanation for this is that a non-empty and non-epistemic ordering source is involved in the interpretation of this sentence. Kratzer indicates that she thinks there is no entailment from (150) to (151). Discussing data semantics, she notes the lack of entailment from (151) to (150), but writes that in data semantics "unfortunately, (20a) is predicted to imply (20b)." In other words, the entailment predicted in data semantics from (150) to (151) is contrary to the facts in Kratzer's view.

We therefore have a judgment that one sentence is stronger than the other, but this judgment is not based on entailment patterns. Without the right entailments, it would seem that a scalar implicature account cannot get off the ground. However, perhaps entailments are not the only possible basis for judgments of relative strength. Consider a person running with a bucket in hand who shouts,

(152) My office is flooded!

This utterance is likely to have more impact than the following.

(153) The secretary says my office is flooded!

In the first case, we might have an impulse to run for help. In the second, we might wonder why he has not checked the office first. The first statement has more impact than the second, we could say, because it is more informative. In fact, if a person uttered (153) and not (152), we might say there is an implicature that (152) was not known by the speaker. But in this case there is not entailment relation between the sentences, in either direction. We appear to have a notion of informativity that licenses a scalar implicature, but no entailment pattern to support it.

Let us concede, for the sake of argument, that informativity judgments are not always based on entailments. But they must be based on something. In the case of the flooded office, they were apparently based on the principle that first-hand reports are often more reliable than second-hand reports. That is a principle grounded in world knowledge, whereas the entailment case involves a linguistic principle. I suggest that informativity judgments must be based on some principle, linguistic or otherwise. The question for the modal case is therefore on what principle to base the judgment that (146) is stronger than (145).

It is hard to see how it could be based on anything but a linguistic principle. What sort of world knowledge tells us that (146) is stronger than (145)? It seems that to know that one sentence is stronger than the other involves understanding what these sentences mean. There is some data to suggest that a linguistic principle is involved. Consider the following sentences.

(154) ??If John is inside, then he must be inside.

(155) ??John is inside which means that he must be inside.

These sentences suggest that (145) and (146) are incompatible within the same discourse. The following sentences show that the other pairs under consideration are not similarly incompatible.

(156) If Mary worked on her paper for ten hours without stopping, then she worked on her paper for eight hours without stopping.

(157) Mary worked on her paper for ten hours straight which means that she worked on her paper for eight hours straight.

(158) If my office is flooded, then the secretary said my office is flooded.

(159) My office is flooded, which means the secretary said my office is flooded.

The last two sentences would make sense in some contexts. Take, for example, a context in which the secretary was known to always state the obvious.

It might be claimed, however, that if the clauses in (154) and (155) are reversed, the resulting sentences are fine.

(160) If John must be inside, then he is inside.

(161) John must be inside which means he is inside.

It is not clear what these reversals tell us, if they are legitimate. I think it is likely that there is a context shift from the first clause to the second. In other words, the speaker accepts the conclusion expressed by the modal sentence as grounds for accepting the non-modal sentence as true. The following discourse presents a case where such a shift is likely to be resisted.

(162) A: The red one must be the deactivation switch.

B: ??If the red one must be the deactivation switch, then it is the deactivation switch.

Here a higher level of proof is needed for the sake of physical safety, and the shift in context will not be welcome. The sentence still shows that such a shift can take place, which is why the conditional sentence might be judged as false instead of just odd.

We have made the concession that scalar implicatures need not be based on entailments alone, but we still have to say what they would be based on in this case. We need an explanation of why a declarative sentence is stronger than its modal counterpart, which is a necessary part of a scalar implicature account of the observed fact, and we appear to need a linguistic, rather than an extra-linguistic, explanation. One solution is to say that the disparity principle itself explains the relative strength of these sentences. If the disparity principle is made part of the true conditions for a modal sentence, then for epistemic *must*

we have a guarantee that the modal sentence is weaker than its declarative counterpart.

Consider (145), repeated here, again. If the disparity principle is made part of the truth conditions, this sentence can only be true if (146), also repeated, is false in at least some modal base worlds.

(145) John must be inside.

(146) John is inside.

The modal base is epistemics, so if (146) is false in some modal base worlds, the speaker does not know that John is inside. This account does not rule out, by the way, a scalar implicature from the utterance of (145) to the conclusion that (146) is not known by the speaker. (145) is a weaker statement than (146), so the speaker must have had some reason for not uttering the stronger statement. But it is also part of the meaning of (145), in my theory, that (146) is not true in all the worlds in the modal base. It is a case of two paths leading to the same destination. But beyond this, we need an explanation of why (146) is stronger than (145), even though there is no entailment from (146) to (145). The disparity principle gives the required explanation.

If it is part of the meaning of (145) that (146) is not true in all the worlds in the modal base, and there is not merely an implicature from the utterance of (145) to the conclusion that the speaker does not know (146), then no cancellation of the implicature should allow the declarative sentence to be uttered in the same epistemic context as their modal counterparts. In general, implicatures can be cancelled, as the following sentences show.

(163) Mary worked for eight hours on her paper without stopping. In fact, she worked for ten hours on her paper without stopping.

(164) John has three children. In fact, he has four children.

The scalar implicature would be cancelled in these cases, because the assertion of the stronger statement puts to rest any notion of it not being believed by the speaker. For each of these sentences, a scenario can be imagined which would make it reasonable for the speaker to first assert the weaker sentence and to follow this up with an assertion of the stronger sentence. Take (163), for example. Suppose someone has just asserted that of all the students in the class, only John worked as long as eight hours on his paper without stopping. (163) as a response first supplies evidence that John is not the only one who worked for eight hours, and follows this up by complete information about how long Mary actually did work. (164) might be said in response to a query as to whether John has three children, when having three children is a minimal criterion to qualify for a loan, for example. The speaker follows the initial assertion, correct for the purposes at hand, with more complete information of how many children John has in total.

Some sentences suggest that the stronger declarative sentence can be asserted subsequent to an utterance of the modal counterpart sentence, and this might be seen as evidence of cancellation of a scalar implicature. Consider the following sentences.

(165) John must be inside. In fact, he is inside.

(166) Mary must be an American. In fact, she is an American.

The problem is to give a plausible scenario in which these sentences might be said that does not involve a shift in the epistemic context of the speaker. (165) might be said by someone who first just sees the light on in John's house, and then sees John in the window. In that case, the epistemic state of the speaker has changed before the utterance of the second sentence. (166) might be said by someone who first infers that Mary is an American on the basis of certain facts, and then remembers for sure that she is an American. The event of

remembering changes the epistemic state of the speaker and makes a felicitous utterance of the declarative sentence possible. Either (165) or (166) could also be uttered by someone who is first echoing a sentence said by someone else, and then supplying an assertion based on their own knowledge. In any event, these scenarios are different than those mentioned in the last paragraph, where there was no epistemic shift. I cannot think of plausible scenarios for the utterance of (165) or (166) that do not involve an epistemic shift, and because of that, these sentences do not seem to me to involve the mere cancellation of a scalar implicature. I conclude that the disparity principle is a necessary part of the explanation of why an epistemic modal sentence is only properly uttered when the declarative counterpart of the sentence is not known by the speaker, scalar implicatures notwithstanding.

5.2 Explaining the constraint

In this section I give a preliminary syntax and translation for a modal sentence in order to show how the disparity principle can be made part of the truth conditions. In this syntax, a tense phrase is embedded under a modal phrase, and by the translation I give for it, the modal denotes a function whose first argument is a proposition, the denotation of the embedded TP. However, I have already argued that the claim that the MP embeds a TP is incorrect, and consequently in later sections the syntax will need to be changed and the semantics revised accordingly. These revisions will help explain the temporal interpretations of modal sentences, but for now, the point is to show how the disparity principle explains the constraint on utterance of epistemic sentences discussed in the last section, and not to account for temporal interpretations.

The first sentence to look at is in (167). (167) is an epistemic sentence and the fact that interests us here is that it can only be uttered sincerely or appropriately by a person who

neither knows that John is asleep nor that John is not asleep. To get us started, a partial LF for (167) is given in (168).

(167) John must be asleep.

(168) $[_{TP} PRES [_{MP} must [_{TP} PRES [_{VP} John be asleep]]]]$

In (168), the higher tense head selects a modal phrase, and the modal head in turn selects a tense phrase. As discussed earlier, I think this syntactic analysis is incorrect and among other things would prevent the subject *John* from moving to the SPEC of the highest TP, getting the word order wrong. For now I am going to ignore these difficulties and pretend that it is possible for the subject to move ultimately to the highest SPEC. This will allow us to get the right temporal interpretation of the sentence for the meantime.

I assume the following translation for the modal *must*.

(169) $must \Rightarrow \lambda Q \lambda t_0 \lambda w_0 [must'_{w_0, t_0}(Q)]$ $\langle\langle s, t \rangle, \langle i, \langle s, t \rangle \rangle\rangle$

According to this translation, the first argument of the modal is type $\langle s, t \rangle$ which denotes a proposition. It is quite standard, by the way, to assume that the complement of a modal is a proposition-denoting clause of some kind, but as I said, I dispute this assumption.

Now consider a derivation of a translation for (168).

(170)	<u>translation</u>	<u>type</u>
1.	$[_{VP} John be asleep] \Rightarrow \lambda t_0 \lambda w_0 [asleep'_{w_0, t_0}(j)]$	$i \langle s, t \rangle$
2.	$PRES \Rightarrow \lambda Q [Q(t_0)]$	$\langle i, \langle s, t \rangle \rangle, \langle s, t \rangle$
3.	$[_{TP} PRES [_{VP} John be asleep]] \Rightarrow \lambda w_0 [asleep'_{w_0, t_0}(j)]$	$\langle s, t \rangle$
4.	$must \Rightarrow \lambda Q \lambda t_0 \lambda w_0 [must'_{w_0, t_0}(Q)]$	$\langle s, t \rangle, \langle i, \langle s, t \rangle \rangle$
5.	$[_{MP} must [_{TP} PRES [_{VP} John be asleep]]] \Rightarrow$ $\lambda t_0 \lambda w_0 [must'_{w_0, t_0}(\lambda w_0 [asleep'_{w_0, t_0}(j)])]$	$\langle i, \langle s, t \rangle \rangle$

6. $\text{PRES} \Rightarrow \lambda Q[Q(t_0)]$ $\langle i, \langle s, t \rangle \rangle, \langle s, t \rangle$
7. $[_{\text{TP}} \text{PRES} [_{\text{MP}} \text{must} [_{\text{TP}} \text{PRES} [_{\text{VP}} \text{John be asleep}]]]] \Rightarrow$
 $\lambda w_0[\text{must}'_{w_0, t_0}(\lambda w_0[\text{asleep}'_{w_0, t_0}(j)])]$ $\langle s, t \rangle$

The VP denotes a function from times to propositions. The VP combines with a tense, and the combined object, a phrase headed by the present tense morpheme, denotes a proposition. The tense phrase combines with the modal, to denote another function from times to propositions. The modal phrase combines with the higher present-tense head to form a tensed phrase, which denotes another proposition.

In the derivation, the translations of both tense heads contain the variable t_0 . t_0 is a designated temporal variable whose value is always the time of speech. This stipulation guarantees that the modal sentence gets a present interpretation, with the result that the time of the residue is the time of speech. This result I will later seek to derive from general interpretive principles.

For now, the translation of the sentence is in the final line of (170), repeated in (171).

$$(171) \lambda w_0[\text{must}'_{w_0, t_0}(\lambda w_0[\text{asleep}'_{w_0, t_0}(j)])]$$

The sentence is of type $\langle s, t \rangle$, denoting a set of worlds.

We need to specify truth conditions for (167). The translation in (171) is an expression of type $\langle s, t \rangle$, denoting a set of worlds, or equivalently, a function from worlds to truth values. We want to consider truth conditions at an arbitrary world w . The truth conditions are relative to a model M , an assignment function g , a modal base function f , an ordering source function f' . I suppress mention of the model, here and in future statements, to make it easier to read. I assume that any assignment function g assigns to t_0 the time of speech. Let's start with the following.

- (172) Given an assignment function g , a modal base function f , and an ordering source function f' , for a world w and a speech time t ,
- $$\llbracket \lambda w_0 [\text{must}'_{w_0,t}(\lambda w_0 [\text{asleep}'_{w_0,t}(j)])] \rrbracket_{g,f,f'}(w) = 1 \text{ iff for } g' = g[w_0/w],$$
- $$\llbracket \text{must}'_{w_0,t}(\lambda w_0 [\text{asleep}'_{w_0,t}(j)]) \rrbracket_{g',f,f'} = 1 \text{ iff for any world } h \in \cap f(w,t), \text{ there is a world}$$
- $$j \in \cap f(w,t), j \leq_{f'(w,t)} h, \text{ such that for any } k \in \cap f(w,t), \text{ if } k \leq_{f'(w,t)} j,$$
- $$\llbracket \lambda w_0 [\text{asleep}'_{w_0,t}(j)] \rrbracket_{g',f,f'}(k) = 1.$$

At this point, the theory is in effect that of Kratzer (1991b) enhanced with a translation language by which we treat the modal sentence as an expression of type $\langle s,t \rangle$. In the next step, however, we introduce the disparity principle and this represents a novel deviation from Kratzer's theory.

The intuition behind the disparity principle is clear. The proposition denoted by the clause embedded under the modal contains some but not all worlds in the modal base set. The truth conditions just given guarantee that the proposition contains some worlds in the modal base set. All we need to add is a clause that ensures that the proposition does not contain all the worlds in the modal base set. Such a clause appears in the restatement of the truth conditions in (173).

- (173) Given an assignment function g , a modal base function f , and an ordering source function f' , for a world w and a speech time t ,
- $$\llbracket \lambda w_0 [\text{must}'_{w_0,t}(\lambda w_0 [\text{asleep}'_{w_0,t}(j)])] \rrbracket_{g,f,f'}(w) = 1 \text{ iff for } g' = g[w_0/w],$$
- $$\llbracket \text{must}'_{w_0,t}(\lambda w_0 [\text{asleep}'_{w_0,t}(j)]) \rrbracket_{g',f,f'} = 1 \text{ iff for any world } h \in \cap f(w,t), \text{ there is a world}$$
- $$j \in \cap f(w,t), j \leq_{f'(w,t)} h, \text{ such that for any } k \in \cap f(w,t), \text{ if } k \leq_{f'(w,t)} j,$$
- $$\llbracket \lambda w_0 [\text{asleep}'_{w_0,t}(j)] \rrbracket_{g',f,f'}(k) = 1, \text{ and } \llbracket \lambda w_0 [\text{asleep}'_{w_0,t}(j)] \rrbracket_{g',f,f'} \cap \cap f(w,t) \neq \cap f(w,t).$$

The additional clause requires that the intersection of the proposition and the modal base set

is not equal to the modal base set. That means that there are worlds in the modal base set not contained in the proposition that is denoted by the clause embedded under the modal.

The use of *must* in (167) is epistemic. We capture the epistemic interpretation of the modal by the choice of the modal base function f . The value of an epistemic modal base function f for a world w and a time t is the set of propositions known by the speaker in w at t . The intersection of these propositions is the set of worlds consistent with what the speaker knows in w at t . The truth conditions in (173) require that John is asleep in some worlds in this set. That means the speaker does not know that John is not asleep. The disparity clause in (173) requires that there are worlds in the set in which John is not asleep. That means the speaker does not know that John is asleep. The entire statement together requires that the speaker knows neither that John is asleep nor that John is awake, which is the constraint we set out to explain.

If the speaker of (167) knows that John is not asleep, the sentence is of course false. But also, because of the disparity clause, the sentence is false if the speaker knows that John is asleep. The result might seem too strong. Surely, if a person utters (167), repeated here, while knowing (174), their utterance is infelicitous but not false.

(167) John must be asleep.

(174) John is asleep.

The essence of the objection is that the utterance of (167) is at worst a pragmatic violation and the disparity principle should not be part of the semantics.

In response to this objection, consider first the case of someone who knows (175) uttering (167).

(175) John is not asleep.

For me, this case has a similar feeling of a pragmatic violation, but by the simplest truth conditions, unadorned with the disparity clause, the person would have also spoken falsely. In addition, an earlier point can be raised again. The inference from the utterance of (167) to the conclusion that the speaker does not know (174) cannot be cancelled. As I claimed above, a sentence such as (176) can only be understood as involving a shift in the epistemic context of the speaker.

(176) John must be asleep. In fact, he is asleep.

For these reasons, I think it is appropriate that the disparity principle is part of the semantics.

5.3 Deriving future readings

In the last section, we saw how the disparity principle constrained epistemic modal sentences to be about facts neither known by the speaker to be true nor known by the speaker to be false. The disparity principle as given in that section said that the first argument of a modal must denote a proposition that is a disparity fact with respect to the relevant modal base. Since the modal base was epistemic in the case considered, the proposition would be one that was consistent with the speaker's knowledge, and whose complement would also be consistent with the speaker's knowledge. In this section, I consider how the disparity principle might be modified to derive temporal interpretations of modal sentences, in this case, future interpretations. The leading idea is that if the worlds in the domain are selected by certain temporal properties they have, disparity facts with respect to this domain will contain worlds that also have certain temporal properties.

The first problem we have to confront is that in the previous section, we stipulated that a modal selects a tensed sentence. A tensed sentence denotes a set of worlds with particular temporal properties, but that isn't what we want. The tensed sentence would have

to be future, that is, one containing a future morpheme. But the only candidate for a future morpheme is *will*, and that is the morpheme whose futureness we are trying to explain. The strategy instead is to get a set with some property that guarantees that all the worlds in that set have certain temporal properties. The property the set should have is that it is a disparity fact with respect to the modal base.

In addition, we have seen that embedding a tensed sentence under the modal would get the word order wrong. Given the VP-internal subject hypothesis, the subject of a simple modal sentence starts out in the SPEC of VP and must raise all the way to the SPEC of the highest TP. But if the VP were embedded directly under a finite TP, the subject would presumably be trapped in the specifier of this phrase, since various data shows that raising is only possible out of non-finite TPs in English. Consider the following.

(177) $[_{TP} \text{John}_i \text{ seems } [_{TP} t_i \text{ to } [_{VP} t_i \text{ be happy}]]]$

(178) $*[_{TP} \text{John}_i \text{ seems } [_{TP} t_i \text{ is } [_{VP} t_i \text{ happy}]]]$

(179) $[_{TP} \text{It seems that } [_{TP} \text{John}_i \text{ is } [_{VP} t_i \text{ happy}]]]$

(180) $[_{TP} \text{John}_i [_{MP} \text{must } [_{TP} t_i \text{ FUT } [_{VP} t_i \text{ be happy}]]]]]$

(181) $*[_{TP} \text{It } [_{MP} \text{must } [_{TP} \text{John}_i \text{ FUT } [_{VP} t_i \text{ be happy}]]]]]$

In (177), the subject has moved from the VP specifier to the specifier of the non-finite TP to the specifier of the highest TP. In (178), the second movement is blocked, presumably because the embedded TP is finite. (179) shows that the subject can stay in the specifier of the embedded finite TP.

(180) shows the movement that would be required within the modal sentence to get the subject in the right position. However, this would involve NP movement out of the specifier of the finite TP. (181) shows the word order that would result if the subject stayed

within the embedded TP, but the resulting string is not a grammatical sentence.

The same conclusion was drawn above for a control account of modal sentences: the embedded TP would have to be non-finite and this would defeat the whole purpose of having an embedded TP in the first place which was to account for the time of the residue in the interpretation.

Instead of a TP, I will assume that the modal simply embeds a VP, or, when indicated by the morphology, an aspect phrase. The sentence in (182) warrants only the selection of a VP, so the syntax is as in the partial LF in (183).

(182) The tower of Pisa will fall.

(183) $[_{TP} \text{ PRES } [_{MP} \text{ will } [_{VP} \text{ the tower of Pisa falls}]]]$

If a verbal predicate takes a temporal argument, its denotation should be a function from times to propositions. That can be seen by translating the sentence in (184) whose partial LF is in (185).

(184) The tower of Pisa fell.

(185) $[_{TP} \text{ PAST } [_{VP} \text{ the tower of Pisa falls}]]]$

The translation of (185) is as follows.

(186) <u>translation</u>	_____ type
1. $[_{VP} \text{ the tower of Pisa falls}] \Rightarrow \lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0}(\text{the-tower-of-Pisa}')]]$	$\langle i, \langle s, t \rangle \rangle$
2. $\text{PAST} \Rightarrow \lambda Q \lambda w_0 [t < t_0 \ \& \ Q(t)(w_0)]$	$\langle i, \langle s, t \rangle \rangle, \langle s, t \rangle$
3. $[_{TP} \text{ PAST } [_{VP} \text{ the tower of Pisa falls}]] \Rightarrow$ $\lambda w_0 [t < t_0 \ \& \ \text{fall}'_{w_0, t}(\text{the-tower-of-Pisa}')]]$	$\langle s, t \rangle$

As the derivation shows, semantically a VP is an entity in search of a time. If the time is

supplied by the past tense morpheme, the result is a proposition, or a function from worlds to truth values.

With this translation for the VP in place, we can derive a translation for (183) as follows.

<u>(187)</u>	<u>translation</u>	<u>type</u>
1.	$[_{VP} \text{ the tower of Pisa falls}] \Rightarrow \lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0}(\text{the-tower-of-Pisa}')]]$	$\langle i, \langle s, t \rangle \rangle$
2.	$\text{will} \Rightarrow \lambda Q \lambda t_0 \lambda w_0 [\text{will}'_{w_0, t_0}(Q)]$	$\langle i, \langle s, t \rangle \rangle, \langle i, \langle s, t \rangle \rangle$
3.	$[_{MP} \text{ will } [_{VP} \text{ John be asleep}]]] \Rightarrow$ $\lambda t_0 \lambda w_0 [\text{will}'_{w_0, t_0}(\lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0}(\text{the-tower-of-Pisa}')])]]$	$\langle i, \langle s, t \rangle \rangle$
4.	$\text{PRES} \Rightarrow \lambda Q [Q(t_0)]$	$\langle i, \langle s, t \rangle \rangle, \langle s, t \rangle$
5.	$[_{TP} \text{ PRES } [_{MP} \text{ will } [_{VP} \text{ John be asleep}]]] \Rightarrow$ $\lambda w_0 [\text{will}'_{w_0, t_0}(\lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0}(\text{the-tower-of-Pisa}')])]]$	$\langle s, t \rangle$

The modal denotes a function whose first argument is the very function denoted by the VP. Once this argument is supplied, the resulting function requires a time as input to give a proposition as output. The resulting translation for (183) is the last line in (187), repeated in (188).

$$(188) \quad \lambda w_0 [\text{will}'_{w_0, t_0}(\lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0}(\text{the-tower-of-Pisa}')])]]$$

(188) names a function from worlds to truth values, that is, a proposition. The designated temporal variable t_0 will get as its value the time of speech.

Several changes have been introduced into the analysis of the modal sentence, and so the truth conditions must be adjusted to reflect these changes. In the syntax, the modal selects not a TP but a VP. Semantically, the modal denotes a function whose first argument

is not a proposition but a function from times to propositions. The following truth conditions reflect these changes.

- (189) Given an assignment function g , a modal base function f , and an ordering source function f' , for a world w and a time t , $\llbracket \lambda w_0 [\text{will}'_{w_0, t_0} (\lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0} (\text{the-tower-of-Pisa}')])]] \rrbracket_{g, f, f'}(w) = 1$ iff for $g' = g[w_0/w]$, $\llbracket \text{will}'_{w_0, t_0} (\lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0} (\text{the-tower-of-Pisa}')])] \rrbracket_{g', f, f'} = 1$ iff for any world $h \in \cap f(w, t)$, there is a world j , $j \in \cap f(w, t)$, $j \leq_{f'(w, t)} h$ and for any k , $k \in \cap f(w, t)$, if $k \leq_{f'(w, t)} j$, then for some time t' , $\llbracket \lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0} (\text{the-tower-of-Pisa}')])] \rrbracket_{g', f, f'}(t')(k) = 1$.

The VP denotes a function from times to propositions. The times that are to be arguments for this function are not directly represented in the sentence but are part of the truth conditions. To get the right temporal interpretation for the sentence, some constraint must be put on these possible temporal arguments of the function denoted by the VP. The idea I want to pursue is that if we put a condition on the sets of worlds that are admissible values for the function, we can indirectly constrain the times that are admissible arguments for the function. This constraint will come about through the disparity principle.

We will constrain the possible values of the function by saying that we only accept values that are disparity facts with respect to the modal base set. To bring about this constraint, we add a disparity clause to the truth conditions, as shown here.

- (190) Given an assignment function g , a modal base function f , and an ordering source function f' , for a world w and a time t , $\llbracket \lambda w_0 [\text{will}'_{w_0, t_0} (\lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0} (\text{the-tower-of-Pisa}')])]] \rrbracket_{g, f, f'}(w) = 1$ iff for $g' = g[w_0/w]$, $\llbracket \text{will}'_{w_0, t_0} (\lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0} (\text{the-tower-of-Pisa}')])] \rrbracket_{g', f, f'} = 1$ iff for any world $h \in \cap f(w, t)$, there is a world j , $j \in \cap f(w, t)$, $j \leq_{f'(w, t)} h$ and for any k , $k \in \cap f(w, t)$, if $k \leq_{f'(w, t)} j$, then for some time t' , $\llbracket \lambda t_0 \lambda w_0 [\text{fall}'_{w_0, t_0} (\text{the-tower-of-Pisa}')])] \rrbracket_{g', f, f'}(t')(k) = 1$.

$$\llbracket \text{tower-of-Pisa}' \rrbracket_{g,f}(t')(k) = 1,$$

$$\text{and } \llbracket \lambda t_0 \lambda w_0 [\text{fall}'_{w_0,t_0}(\text{the-tower-of-Pisa}')] \rrbracket_{g,f}(t') \cap \bigcap f(w,t) \neq \bigcap f(w,t).$$

The unadorned truth conditions ensure that for any admissible temporal argument for the VP-function, there are worlds in the modal base set included in the proposition that is a value for the function applied to this argument. The disparity clause shown in (190) now ensures that there are also worlds in the modal base set not included in the proposition.

By assumption, the modal base function f in (190) is totally realistic for a world up to a time. For a world w and a time t , $f(w,t)$ is the set of proposition that uniquely describe w up to t . The intersection of these propositions, $\bigcap f(w,t)$, is the set of worlds identical to w up to t . That means that in effect, $\bigcap f(w,t)$ is a t -broomstick. Now take the function denoted by the VP in (190), $\llbracket \lambda t_0 \lambda w_0 [\text{fall}'_{w_0,t_0}(\text{the-tower-of-Pisa}')] \rrbracket_{g,f}$. As an argument for this function, we are only interested in such times for which the function denotes a proposition containing some but not all worlds in the modal base set. If some time t' is a past time or a present time, the resulting proposition will either contain all the worlds in the modal base set, or none of the worlds in the modal base set. The only way to meet the requirements on the resulting proposition is to choose a time t' that is at least partially a future time with respect to the time of speech. But this guarantees that the modal sentence has a future interpretation, or in other words, that the times in the residue are future times.

This is the result that we wanted. The temporal interpretation of the sentence arises from its modal nature and is not an auxiliary property. Syntactically, the modal embeds a VP, which does not contain a time specification but rather denotes a function from times to propositions. Possible arguments for this function are constrained by a principle requiring that its values are propositions that exclude some accessible worlds. This requirement

ensures that the ordering involved in the interpretation is not pointless and, given our choice for the modal base function, it also ensures that the sentence has a future interpretation.

The following is a general statement of truth conditions for a future modal sentence of the form $\lambda w_0[M_{w_0,t_0}(\psi)]$ interpreted with respect to a world and the time of speech, where ψ is type $\langle i, \langle s, t \rangle \rangle$, and where M is a universal modal.

- (191) Given g , an assignment function, f , a totally realistic modal base function up to a time, and f' , a stereotypical ordering source function, for a world w and speech time t , with $g' = g[w_0/w]$, $\llbracket M_{w_0,t_0}(\psi) \rrbracket_{g',f,f'} = 1$ iff for any world $u \in \cap f(w,t)$, there is a world $v \in \cap f(w,t)$, $v \leq_{f'(w,t)} u$, such that for any $z \in \cap f(w,t)$, if $z \leq_{f'(w,t)} v$, there is a time t' such that $\llbracket \psi \rrbracket_{g',f,f'}(t')(z) = 1$, and
- $$\cap f(w,t) \cap \llbracket \psi \rrbracket_{g',f,f'}(t') \neq \cap f(w,t).$$

5.4 An asymmetry between Past and Future

The theory that has been developed derives the temporal interpretation of modal sentences from a requirement to make distinctions within the worlds in the modal base set. This requirement can be seen as linked to a prohibition against vacuous ordering. The interpretation of a modal sentence involves a modal base and an ordering source, and the ordering source provides criteria for ordering these worlds. If a modal sentence did not involve distinctions between the worlds in the modal base set, ordering the worlds in the modal base set would be unnecessary.

In the case of future sentences, the temporal interpretation comes about because the worlds in the modal base set only differ by future facts. It follows that any distinctions that can be drawn between these worlds is based on future differences.

This derivation of the future reading leads to a prediction which is quite different than

the predictions made by theories in which *will* in its primary meaning is a future-tense marker. Such theories treat *will* sentences as being in effect the reverse of past-tense sentences. A past-tense sentence says that some event takes place at a past time and a *will* sentence says that some event takes place at a future time. In these theories, there is a symmetry in meaning between the past-tense morpheme and *will*. In the theory offered here, *will* is quite different than the past-tense morpheme. Since the temporal interpretation is not part of the actual meaning, there should be no expectation of a symmetry between the past morpheme and *will*.

The data appears to go both ways on this question. Some sentences do suggest a symmetry between the past morpheme and *will*, as seen in the following examples.

(192) John washed the car today.

(193) John will wash the car today.

The meanings of these sentences are symmetrical in this sense. (192) can only be true of a car-washing that John has completed, and (193), it would seem, can only be true of a car-washing that John has not yet started.

But this symmetry does not carry over to all sentences. Consider the following examples.

(194) John cleaned the entire house today.

(195) John will clean the entire house today.

Like its counterpart in (192), (194) can only be true of a house-cleaning that has been completed, but unlike its counterpart in (193), (195) can be spoken truly of a house-cleaning that has already begun. The facts change for (192) and (193) with the insertion of an expression emphasizing the extended nature of the activity, such as *from top to bottom*.

(196) John washed the car from top to bottom today.

(197) John will wash the car from top to bottom today.

As before, (196) can only be true of a car-washing that has already been completed, but now (197) is unlike (193) in that the car-washing can have already begun by the speech time.

Another kind of sentence without symmetry between Past and Future sentences is illustrated by the following.

(198) Mary painted just the west wing of the house today.

(199) Mary will paint just the west wing of the house today.

(198) requires the painting of the west wing to be completed by the time of speech, but (199) does not require the painting to be wholly in the future.

Sentences about a complex event with many sub-parts show an asymmetry. Consider the following.

(200) Mary shook everybody's hand today.

(201) Mary will shake everybody's hand today.

(200) requires that Mary has already shaken each person's hand. (201) is appropriate even if Mary has already begun shaking people's hands. The sentence only requires that she goes on to shake the hands of those remaining. It does not require that she go back and shake each person's hands again.

The facts relating to the following sentences are somewhat complicated.

(202) The baby cried all day today.

(203) The baby has cried all day today.

(204) The baby will cry all day today.

(202) can only be said at the end of the day, or at least after the relevant time period today

in which the baby might cry. (203) can be said at midday, and it does not mean that the baby will continue crying for the rest of the day. (204) can be said at midday, and it means that the baby has cried all morning and will continue to cry the rest of the day.

As a final example, sentences with matrix negation show a similar kind of asymmetry, as in the following.

(205) The baby didn't cry today.

(206) The baby hasn't cried today.

(207) The baby won't cry today.

(205) can only be spoken at the end of the day, or at least after the relevant crying period has passed. (206) means the baby hasn't cried today so far. What happens later in the day is of no relevance to the sentence. (207) means the baby has not cried today and will not cry for the rest of the day.

In the cases of interest, some event is portrayed as happening over an extended interval of time, or as not happening over such an interval. We will need a semantic theory explaining how tenses interact with temporal adverbs, and a theory of how tenses and temporal adverbs interact with sentence negation. Let us begin with a theory of frame times, as in von Stechow (1995).

von Stechow (1995) applies what he calls the *definite theory of tense* to the problem of combining tense with temporal adverbs, and notes that the original idea for this approach is Kratzer's (1978) dissertation. von Stechow's solution covers problems associated with Partee's famous sentence in (208) and the sentence in (209).

(208) I didn't turn off the stove.

(209) I didn't turn off the stove yesterday.

The problem with (208) is to explain why the sentence doesn't mean that the speaker *never* turned off the stove, but simply that the speaker didn't turn off the stove during some relevant interval of time. A problem with (209) is to explain why the sentence doesn't mean that there was a time yesterday at which the speaker didn't turn off the stove, but rather it means that there was no time yesterday at which the speaker turned off the stove. Intuitively, the solution for (209) is to make the negation extend over the entire interval contributed by *yesterday*, and the solution for (208) is to have an implicit interval that the negation can extend over.

von Stechow's theory for the past and present tense morphemes is repeated here.

$$(210) \text{ PAST}_{(j)i} \Rightarrow \lambda P[\text{PAST}(t_0)(t_j)(t_i) \ \& \ P(t_i)]$$

$$(211) \llbracket \text{PAST} \rrbracket(k)(j)(i) = 1 \text{ just in case } i \text{ is the maximal } t \text{ such that } t \subseteq j \text{ and } t \text{ is before } k.$$

$$(212) \text{ PRES}_{(j)i} \Rightarrow \lambda P[\text{PRES}(t_0)(t_j)(t_i) \ \& \ P(t_i)]$$

$$(213) \llbracket \text{PRES} \rrbracket(k)(j)(i) = 1 \text{ just in case } i \text{ is the maximal } t \text{ such that } t \subseteq j \text{ and } t \text{ overlaps } k.$$

The idea is that two indices are syntactically affixed to the tense morpheme, and three temporal variables are involved in the interpretation of each tense morpheme. t_i is assigned a time i , t_j is assigned a time j , and t_0 is assigned the speech time k . i is the reference time, that is, the time of the eventuality, and j is the so-called frame time. (von Stechow is not using the term *reference time* in a Reichenbachian sense.) The frame time is the semantic contribution of an adverb like *yesterday*, which would contribute the temporal interval comprising yesterday. When there is no such adverb present the frame time presumably corresponds to some time the speaker has in mind. The past morpheme says that the reference time is the largest subinterval of the frame time that is before the time of speech. The present morpheme says that the reference time is the largest subinterval of the frame

time that overlaps with the time of speech.

Let us begin with an analysis of the positive counterpart of (208), as in (214).

(214) John turned off the stove.

A partial LF for this sentence is in (215), with the translation in (216) and truth conditions in (217).

(215) $[_{TP} \text{ PAST}_{(1)2} [_{VP} \text{ John turn off the stove}]]$

(216) $\text{PAST}(t_0)(t_1)(t_2) \ \& \ \text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}')$

(217) $\llbracket \text{PAST}(t_0)(t_1)(t_2) \ \& \ \text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}') \rrbracket_g = 1$ iff

$g(t_2)$ is a maximal subinterval in $g(t_1)$ and $g(t_2)$ is before $g(t_0)$ and $\llbracket \text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}') \rrbracket_g = 1$

By these truth conditions, (214) means that during the largest sub-interval of the frame time that is also before the time of speech, John turned off the stove. To understand the truth conditions, we have to know that the denotation of $\text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}')$ with respect to g is true just in case John turns off the stove at some time during this interval.

Now, following von Stechow's treatment, an LF for (208) is given in (218), with a translation in (219) and truth conditions in (220).⁸

(218) $[_{TP} \text{ PAST}_{(1)2} [_{NEG} \text{ not } [_{VP} \text{ John turn off the stove}]]]$

(219) $\text{PAST}(t_0)(t_1)(t_2) \ \& \ \neg[\text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}')$

(220) $\llbracket \text{PAST}(t_0)(t_1)(t_2) \ \& \ \neg[\text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}') \rrbracket_g = 1$ iff

$g(t_2)$ is a maximal subinterval in $g(t_1)$ and $g(t_2)$ is before $g(t_0)$ and $\llbracket \neg[\text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}') \rrbracket_g = 1$

⁸ See von Stechow (1995), p. 379. I have changed some terms in von Stechow's representations to be consistent with the system I am using here.

By (220), (208) means that throughout the largest sub-interval of the frame time that is also before the speech time, the speaker did not turn off the stove. To get this interpretation, we need to know that the denotation of $\neg[\text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}^*)]$ with respect to g is true just in case John didn't turn off the stove ever during the interval $g(t_2)$.

Before we analyze (209), let us deal with the positive counterpart of (209) in (221).

(221) John turned off the stove yesterday.

A partial LF for (221) is given in (222), with a translation in (223) and truth conditions in (224).

(222) $[\text{yesterday} [\text{TP PAST}_{(1)2} [\text{VP John turn off the stove}]]]$

(223) $\text{yesterday}'(\lambda t_1 [\text{PAST}(t_0)(t_1)(t_2) \ \& \ \text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}^*)])$

(224) $\llbracket \text{yesterday}'(\lambda t_1 [\text{PAST}(t_0)(t_1)(t_2) \ \& \ \text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}^*)]) \rrbracket_g = 1$ iff

$g(t_2)$ is a maximal subinterval in $\llbracket \text{yesterday}' \rrbracket_g$ and $g(t_2)$ is before $g(t_0)$ and $\llbracket \text{turn-off}_{w_0,t_2}^*(j, \text{the-stove}^*) \rrbracket_g = 1$ iff

$\llbracket \text{turn-off}_{w_0, \text{yesterday}'}^*(j, \text{the-stove}^*) \rrbracket_g = 1$

(221) contains the adverb *yesterday* which in the translation maps to an expression of type $\langle\langle i, \langle s, t \rangle \rangle, \langle s, t \rangle \rangle$. Here, the variable t_1 for the frame time is λ -bound. By (224), (221) means that during the largest sub-interval of yesterday John turned off the stove. The largest sub-interval of yesterday is yesterday, so (221) means that during yesterday, John turned off the stove. To get this interpretation, we need to know that the denotation of $\text{turn-off}_{w_0, \text{yesterday}'}^*(j, \text{the-stove}^*)$ with respect to g is 1 just in case John turned off the stove sometime yesterday.

Now, returning to von Stechow's analysis, an LF for (209), repeated here, is given in (225), with a translation in (226) and truth conditions in (244).

(209) I didn't turn off the stove yesterday.

(225) $\llbracket \text{yesterday} \llbracket_{\text{TP}} \text{PAST}_{(1)2} \llbracket_{\text{NEG}} \text{not} \llbracket_{\text{VP}} \text{John turn off the stove} \rrbracket \rrbracket \rrbracket$

(226) $\text{yesterday}'(\lambda t_1 \llbracket \text{PAST}(t_0)(t_1)(t_2) \ \& \ \neg[\text{turn-off}'_{w_0,t_2}(\text{j,the-stove}') \rrbracket \rrbracket$

(227) $\llbracket \text{yesterday}'(\lambda t_1 \llbracket \text{PAST}(t_0)(t_1)(t_2) \ \& \ \neg[\text{turn-off}'_{w_0,t_2}(\text{j,the-stove}') \rrbracket \rrbracket \rrbracket_g$ iff

$g(t_2)$ is a maximal subinterval in $\llbracket \text{yesterday}' \rrbracket_g$ and $g(t_2)$ is before $g(t_0)$ and $\llbracket \neg[\text{turn-off}'_{w_0,t_2}(\text{j,the-stove}') \rrbracket \rrbracket_g = 1$ iff

$\llbracket \neg[\text{turn-off}'_{w_0,\text{yesterday}'}(\text{j,the-stove}') \rrbracket \rrbracket_g = 1$

(209) also contains the adverb *yesterday* and the variable t_1 is again λ -bound in the translation. By (244), the sentence in (209) is true just in case the speaker did not turn off the stove at any time yesterday.

In von Stechow's treatment, since the reference time is a maximal subinterval of the frame time that meets the other conditions put on it by the tense morpheme, the reference time variable can be replaced by the translation language name of the frame time whenever the frame time itself meets those other conditions. In (244), for example, the reference time variable t_2 that is subscripted to the translation of the predicate is replaced by *yesterday'*, the translation name of the frame time, because the interval denoted by *yesterday* is always before the time of speech. But now we have slightly different procedures for the positive and the negative cases for knowing when the denotation is 1. When there is no negation, what matters is that the eventuality took place at some time in the frame time. When there is negation, what matters is that the eventuality took place at no time in the frame time.

Another feature of von Stechow's system which is worth noticing is that three times are involved in the interpretation of each tense morpheme, the time of speech, the reference time, and the frame time and that the maximality requirement is part of the interpretation of the tense morpheme. The semantic rules specifically say that the reference time is a maximal

sub-interval of the frame time that meets the further condition specified with respect to the time of speech, being earlier than the time of speech or overlapping the time of speech.

It seems to me that it would be desirable to relate the maximality requirement on the reference time to the negation on the predicate. If there is negation, we would have a maximality requirement and if there is no negation, we would not have a maximality requirement. This is in keeping with an intuition about the difference between a positive and a negative search. With a positive search, you keep looking until you find what you are looking for, and then you stop. With a negative search, you keep looking until there is nowhere left to search. The frame time is where the search takes place. With a positive sentence, you just want to make sure that the reference time, the time of the eventuality, is inside the frame time. The sub-interval requirement is enough. With a negative sentence, you need the sub-interval requirement and the maximality requirement because you want to make sure that at no sub-interval does the eventuality take place. In von Stechow's system, the tense morpheme and the predicate are interpreted separately. The maximality requirement is associated with the interpretation tense morpheme, and not with the predicate. It follows that the maximality requirement is always needed, whether or not there is negation. The reason that the system is set up this way is presumably that what is wanted is a reference time that is a maximal sub-interval that meets the other conditions put on it of being earlier than the speech time or overlapping the speech time. That is, what is wanted is either the notion of 'maximal and past' or 'maximal and present'.

What if it turned out that the maximality requirement were entirely separate from the other conditions on the reference time? In that case, the maximality requirement would be associated with the interpretation of the predicate and not with the interpretation of the tense

morpheme. I think the data may suggest making such a separation. Consider the following sentences.

(228) The baby cried today.

(229) The baby has cried today.

(230) The baby will cry today.

According to my intuitions, (228) like (229), can be spoken at any time of the day. This is unlike (205), repeated here, that can only be spoken at the end of the day, or at least after the relevant time for crying has passed.

(205) The baby didn't cry today.

This difference suggests the maximality requirement holds for negative sentences but not positive sentences. (230) can also be spoken at any time, and it does not mean that the baby will cry all day, which would mean there is no maximality requirement for this positive sentence. The negative counterpart of (230), repeated here in (207), does suggest that the non-crying interval will span the entire day.

(207) The baby won't cry today.

Let me revise the semantics to disassociate the maximality requirement from the interpretation of the tense morpheme and associate it instead with the interpretation of negated predicates.

We begin with the semantics for the past and present morphemes.

(231) $PAST_{(j)i} \Rightarrow \lambda P[PAST(t_0)(t_i) \ \& \ P(t_i)(t_j)]$

(232) $\llbracket PAST \rrbracket(k)(i) = 1$ just in case i is before k .

(233) $PRES_{(j)i} \Rightarrow \lambda P[PRES(t_0)(t_i) \ \& \ P(t_i)(t_j)]$

(234) $\llbracket PRES \rrbracket(k)(i) = 1$ just in case i overlaps k .

For the past morpheme, the reference must be before the speech time. For the present morpheme, the reference time must overlap the speech time.

We move on to the semantics for non-negated predicates

(235) $\llbracket P \rrbracket(i)(j) = 1$ just in case i is a sub-interval of j and P holds at i . (P is not of the form $\neg Q$)

The reference time must be a sub-interval of the frame time. I still have to say what it is for a predicate to hold at a particular reference time.

In the semantics for negated predicates we finally see the maximality requirement.

(236) $\llbracket \neg P \rrbracket(i)(j) = 1$ just in case i is a maximal sub-interval of j and for no sub-interval h of i does P hold at h .

The reference time is a maximal sub-interval of the frame time. The predicate P holds at no sub-interval of the reference time. That the maximality requirement only holds for the negated case captures the idea of a negative search. To make sure something is not the case, the searcher must keep looking throughout the entire domain. In a positive search, by contrast, the search can be stopped as soon as something is found.

I have to say what it is for a predicate to hold at an interval. This depends on whether the predicate is eventive or stative.

(237) P_{eventive} holds at i just in case the event denoted by P begins at the beginning of i and ends at the end of i

(238) P_{stative} holds at i just in case the state denoted by P persists throughout i from beginning to end

Equipped with this semantics, we can now explain some of the earlier judgments. I claimed that (228) could be uttered at midday, whereas (205) could not. (Both sentences are

repeated here.)

(228) The baby cried today.

(205) The baby didn't cry today.

The following are semantic analyses of (228) and (205) respectively, using our new rules.

(239) $[\text{today} [\text{TP PAST}_{(1)2} [\text{VP the baby cried}]]]$

(240) $\text{today}'(\lambda t_1 [\text{PAST}(t_0)(t_2) \& \text{cry}'_{w_0,t_2,t_1} (\text{the-baby}')])$

(241) $\llbracket \text{today}'(\lambda t_1 [\text{PAST}(t_0)(t_2) \& \text{cry}'_{w_0,t_2,t_1} (\text{the-baby}')]) \rrbracket_g = 1$ iff

$\llbracket \text{PAST}(t_0)(t_2) \& \text{cry}'_{w_0,t_2,\text{today}'} (\text{the-baby}') \rrbracket_g = 1$ iff

$g(t_2)$ is before $g(t_0)$ and $g(t_2)$ is a subinterval in $\llbracket \text{today}' \rrbracket_g$ and $\llbracket \text{cry}'_{w_0,t_2} (\text{the-baby}') \rrbracket_g$

$= 1$ iff the baby cried at some earlier time today.

(242) $[\text{today} [\text{TP PAST}_{(1)2} [\text{NEG not} [\text{VP the baby cried}]]]]$

(243) $\text{today}'(\lambda t_1 [\text{PAST}(t_0)(t_2) \& \neg[\text{cry}'_{w_0,t_2,t_1} (\text{the-baby}')]])$

(244) $\llbracket \text{today}'(\lambda t_1 [\text{PAST}(t_0)(t_2) \& \neg[\text{cry}'_{w_0,t_2,t_1} (\text{the-baby}')]]) \rrbracket_g = 1$ iff

$\llbracket \text{PAST}(t_0)(t_2) \& \neg[\text{cry}'_{w_0,t_2,\text{today}'} (\text{the-baby}') \rrbracket_g = 1$ iff

$g(t_2)$ is before $g(t_0)$ and $g(t_2)$ is a maximal subinterval in $\llbracket \text{today}' \rrbracket_g$ and $\llbracket \neg[\text{cry}'_{w_0,t_2}$

$(\text{the-baby}') \rrbracket_g = 1$ iff the baby did not cry throughout the earlier time constituting

today.

The maximality requirement does not appear in the interpretation of the non-negated sentence. Consequently, the only requirements on the reference time are that it be before the speech time and part of today. The maximality requirement does appear in the interpretation of the negated sentence. There are two requirements on the reference time here. One is that it be before the speech time, and the other that it be a maximal sub-interval of today. It

follows that the sentence in question can only be said at the conclusion of the day.

The same restriction was not found with perfect sentences. Let us recall (229) and (206), repeated here, both of which are sentences containing the perfect.

(229) The baby has cried today.

(206) The baby hasn't cried today.

Either of these sentences can be said at any time of the day. Without providing a complete analysis, I will assume that the interpretation of the perfect involves an extended now, an interval extending up to the present.⁹ There is clearly an interaction between the extended now and the interval denoted by the adverb *today*. Formally, I will capture this by positing a function, *xn*, that takes the time of speech variable and the adverb denotation as arguments. The value of the function will denote the interval that is the intersection of the extended now and the interval constituting today. The semantics of the perfect specify a reference time which is to be related to this interval.

(245) $\text{PERF}_k \Rightarrow \lambda Q[\lambda t_i \lambda t_j Q_{tk, xn}(t_i, t_j)]$

(246) $[\text{today} [\text{TP PRES}_{(1)2} [\text{AspP PERF}_3 [\text{VP the baby cried}]]]]$

(247) $\text{today}'(\lambda t_1 [\text{PRES}(t_0)(t_2) \& \text{cry}'_{w0, t3, xn}(t_2, t_1) (\text{the-baby}')])$

(248) $\llbracket \text{PRES}(t_0)(t_2) \& \text{cry}'_{w0, t3, xn}(t_2, \text{today}') \rrbracket_g (\text{the-baby}') \llbracket_g \text{iff}$

$g(t_2)$ overlaps $g(t_0)$ and $g(t_3)$ is a subinterval in $\llbracket xn(t_2, \text{today}') \rrbracket_g$ and $\llbracket \text{cry}'_{w0, t3} (\text{the-baby}') \rrbracket_g = 1$ iff the baby cried at some earlier time today.

(249) $[\text{today} [\text{TP PRES}_{(1)2} [\text{AspP PERF}_3 [\text{VP the baby cried}]]]]$

(250) $\text{today}'(\lambda t_1 [\text{PRES}(t_0)(t_2) \& \neg[\text{cry}'_{w0, t3, xn}(t_2, t_1) (\text{the-baby}')]])$

⁹ See McCoard (1978) and Stump (1985) for discussion.

- (251) $\llbracket \text{PRES}(t_0)(t_2) \ \& \ \neg[\text{cry}'_{w_0,t_3,xn(t_2,\text{today}')}(\text{the-baby}')]\rrbracket_g$ iff
 $g(t_2)$ overlaps $g(t_0)$ and $g(t_3)$ is a maximal subinterval in $\llbracket xn(t_2,\text{today}')\rrbracket_g$ and for no
sub-interval l of $g(t_3)$ does the baby cry at l which is all true just in case the baby has
not cried at any earlier time today.

The difference between the past negated sentence and the perfect negated sentence is that in the latter, the extended now intersects with the time frame resulting in a narrower interval over which the expressed eventuality does not take place. Therefore, in the case of (206), the entire day does not have to have already passed for an appropriate utterance of the sentence and we have accounted for the observed difference between (205) and (206).

We can now turn to the original sentences with which I started the discussion and try to account for the observed asymmetries. First, we need to see how temporal adverbs interact with the modal *will*. Let's begin with the following sentence.

- (252) The tower of Pisa will fall tomorrow.

The following is a derivation of the semantic translation of this sentence.

- (253) translation _____ type
1. $[\text{VP the tower of Pisa falls}] \Rightarrow \lambda t_1 \lambda t_0 \lambda w_0 [\text{fall}'_{w_0,t_0,t_1}(\text{the-tower-of-Pisa}')] \langle i, \langle i, \langle s, t \rangle \rangle \rangle$
 2. $\text{will} \Rightarrow \lambda Q \lambda t_1 \lambda t_0 \lambda w_0 [\text{will}'_{w_0,t_0}(Q(t_1))] \langle i, \langle i, \langle s, t \rangle \rangle \rangle, \langle i, \langle i, \langle s, t \rangle \rangle \rangle$
 3. $[\text{MP will } [\text{VP the tower of Pisa falls}]] \Rightarrow \lambda t_1 \lambda t_0 \lambda w_0 [\text{will}'_{w_0,t_0}(\lambda t_0 \lambda w_0 [\text{fall}'_{w_0,t_0,t_1}(\text{the-tower-of-Pisa}')])] \langle i, \langle i, \langle s, t \rangle \rangle \rangle$
 4. $\text{PRES}_{(i)} \Rightarrow \lambda Q \lambda w_0 [\text{PRES}(t_0)(t_2) \ \& \ Q(t_2)(t_1)(w_0)] \langle i, \langle i, \langle s, t \rangle \rangle \rangle, \langle s, t \rangle$
 5. $[\text{TP PRES } [\text{MP will } [\text{VP the tower of Pisa falls}]]] \Rightarrow$

$$\lambda w_0[\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0[\text{fall}'_{w_0,t_0,t_1}(\text{the-tower-of-Pisa}')])]$$

$$\langle s, t \rangle$$

6. tomorrow \Rightarrow tomorrow' $\langle i, \langle s, t \rangle \rangle, \langle s, t \rangle$

7. [tomorrow [TP PRES [MP will [VP the tower of Pisa falls]]]] \Rightarrow

$$\text{tomorrow}'[\lambda t_1 \lambda w_0[\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0[\text{fall}'_{w_0,t_0,t_1}(\text{the-tower-of-Pisa}')])]]$$

$$\equiv \lambda w_0[\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0[\text{fall}'_{w_0,t_0,\text{tomorrow}}(\text{the-tower-of-Pisa}')])]$$

$$\langle s, t \rangle$$

An additional temporal variable is associated with the predicate embedded under the modal which is to be filled in by a frame time. The rule for the present tense has been modified so as to provide such a frame time.

Now consider truth conditions for this sentence.

- (254) Given an assignment function g , a modal base function f , and an ordering source function f' , for a world w and a time t , $\llbracket \lambda w_0[\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0[\text{fall}'_{w_0,t_0,\text{tomorrow}}(\text{the-tower-of-Pisa}')])]\rrbracket_{g',f,f'}(w) = 1$ iff for $g' = g[w_0/w]$, $\llbracket \text{PRES}(t_0)(t_2) \rrbracket_{g',f,f'}(w) = 1$ iff $g'(t_2)$ equals $g(t_0)$, the time of speech t , and $\llbracket \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0[\text{fall}'_{w_0,t_0,\text{tomorrow}}(\text{the-tower-of-Pisa}')])\rrbracket_{g',f,f'} = 1$ iff for any world $h \in \cap f(w,t)$, there is a world j , $j \in \cap f(w,t)$, $j \leq_{f'(w,t)} h$ and for any k , $k \in \cap f(w,t)$, if $k \leq_{f'(w,t)} j$, then for some time t' , $\llbracket \lambda t_0 \lambda w_0[\text{fall}'_{w_0,t_0,\text{tomorrow}}(\text{the-tower-of-Pisa}')]\rrbracket_{g',f,f'}(t')(k) = 1$ iff
- for $g'' = g'[w_1/k][t_1/t']$, $\llbracket \text{fall}'_{w_1,t_1,\text{tomorrow}}(\text{the-tower-of-Pisa}')\rrbracket_{g'',f,f'} = 1$,
- and $\llbracket \lambda t_0 \lambda w_0[\text{fall}'_{w_0,t_0}(\text{the-tower-of-Pisa}')]\rrbracket_{g',f,f'}(t') \cap \cap f(w,t) \neq \cap f(w,t)$.

These truth conditions capture the idea that the time of the falling is sometime tomorrow.

We next turn to the pairs of sentences we began with. Consider first (194) and (195).

(194) John cleaned the entire house today.

(195) John will clean the entire house today.

The contrast between these sentences seems to hinge on the word *entire*. I assume this word serves to underscore the durative nature of the activity of cleaning a house. To help capture this idea, I assume that a predicate comes with a feature, I or D, indicating whether the action or event referred to is conceived of as happening instantaneously or duratively, that is, over a period of time. In the default case, a predicate has an I-feature, which means it refers to an event that happens in an instant. I assume that the word *entire* in these sentences is incompatible with the default setting of this feature, and is only compatible with a D-feature on the predicate. The reference time for the sentence is therefore necessarily an interval rather than an instant. This part of the theory will be kept in these informal terms.

We can now give an analysis of the two sentences. A translation for each sentence is given by the following.

(255) $\lambda w_0[\text{PAST}(t_0)(t_2) \ \& \ \text{clean-the-entire-house}'_{w_0,t_2,\text{today}'}(j)]$

(256) $\lambda w_0[\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0[\text{clean-the-entire-house}'_{w_0,t_0,\text{today}'}(j)])]$

Let us now give truth conditions for these sentences.

(257) Given an assignment function g , for a world w and a time t , $\llbracket \lambda w_0[\text{PAST}(t_0)(t_2) \ \& \ \text{clean-the-entire-house}'_{w_0,t_2,\text{today}'}(j)] \rrbracket_g(w) = 1$ iff for $g' = g[w_0/w]$,

$\llbracket \text{PAST}(t_0)(t_2) \rrbracket_{g'}(w) = 1$ iff $g'(t_2)$ is before $g'(t_0)$, the time of speech t , and

$\llbracket \text{clean-the-entire-house}'_{w_0,t_2,\text{today}'}(j) \rrbracket_{g'} = 1$ iff John cleans the house at $g'(t_2)$, a subinterval of $\llbracket \text{today}' \rrbracket_{g'}$.

(258) Given an assignment function g , a modal base function f , and an ordering source

function f' , for a world w and a time t , $\llbracket \lambda w_0 [\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2} (\lambda t_0 \lambda w_0 [\text{clean-the-entire-house}'_{w_0,t_0,\text{today}'}(j)])] \rrbracket_{g',f',f'}(w) = 1$ iff for $g' = g[w_0/w]$,

$\llbracket \text{PRES}(t_0)(t_2) \rrbracket_{g',f',f'}(w) = 1$ iff $g'(t_2)$ equals $g(t_0)$, the time of speech t , and

$\llbracket \text{will}'_{w_0,t_2} (\lambda t_0 \lambda w_0 [\text{clean-the-entire-house}'_{w_0,t_0,\text{today}'}(j)]) \rrbracket_{g',f',f'} = 1$ iff for any world $h \in \cap f(w,t)$, there is a world j , $j \in \cap f(w,t)$, $j \leq_{f'(w,t)} h$ and for any k , $k \in \cap f(w,t)$, if $k \leq_{f'(w,t)}$

j , then for some time t' , $\llbracket \lambda t_0 \lambda w_0 [\text{clean-the-entire-house}'_{w_0,t_0,\text{today}'}(j)] \rrbracket_{g',f',f'}(t')(k) = 1$ iff

for $g'' = g'[w_1/k][t_1/t']$, $\llbracket \text{clean-the-entire-house}'_{w_1,t_1,\text{today}'}(j) \rrbracket_{g'',f',f'} = 1$,

and $\llbracket \lambda t_0 \lambda w_0 [\text{clean-the-entire-house}'_{w_0,t_0,\text{today}'}(j)] \rrbracket_{g',f',f'}(t') \cap \cap f(w,t) \neq \cap f(w,t)$.

(257) explicitly requires the reference time to be prior to the time of speech. With the D-feature on the predicate associated with the word *entire*, (258) only requires that for any subinterval of today under consideration, there are worlds in which John cleans the entire house at this subinterval and worlds in which he doesn't clean the entire house at this subinterval. This is consistent with John's having started to clean the house in every world in the modal base set. Any relevant subinterval could overlap with the time of speech, which means the sentence could be truly spoken of a house-cleaning that has already commenced by the time of speech. The asymmetry between (194) and (195) is explained.

The explanation for the other non-negated pairs follows the same pattern. Consider (200) and (201), repeated here.

(200) Mary shook everybody's hand today.

(201) Mary will shake everybody's hand today.

The predicate is translated *shake-everybody's-hand'* which is not analyzed further, except to say that it has a D-feature, indicating that the denoted action takes place over time. The truth conditions work out to require that in (200), the hand shaking must be completed. The

truth conditions for (201) require that the worlds in the modal base differ as to whether Mary has shaken everybody's hand today, but this is consistent with her having started to shake hands in every world in the modal base.

We can use the feature account to explain the apparent symmetry between such pairs as (192) and (193), repeated here.

(192) John washed the car today.

(193) John will wash the car today.

The symmetry is as follows. (192) is true only if the washing is completely in the past, and (193) is true only if the washing is completely in the future. In this case, the default feature on the predicate is I, which means the event is conceived of as instantaneous. These sentences are translated as follows.

(259) $\lambda w_0[\text{PAST}(t_0)(t_2) \ \& \ \text{wash-the-car}'_{w_0,t_2,\text{today}}(j)]$

(260) $\lambda w_0[\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0[\text{wash-the-car}'_{w_0,t_0,\text{today}}(j)])]$

The truth conditions for (192), as in every case, require the event, this time a car-washing, to be before the speech time. Now consider the truth conditions for (193).

(261) Given an assignment function g , a modal base function f , and an ordering source

function f' , for a world w and a time t , $\llbracket \lambda w_0[\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0[\text{wash-the-car}'_{w_0,t_0,\text{today}}(j)])] \rrbracket_{g',f,f'}(w) = 1$ iff for $g' = g[w_0/w]$,

$\llbracket \text{PRES}(t_0)(t_2) \rrbracket_{g',f,f'}(w) = 1$ iff $g'(t_2)$ equals $g(t_0)$, the time of speech t , and

$\llbracket \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0[\text{wash-the-car}'_{w_0,t_0,\text{today}}(j)]) \rrbracket_{g',f,f'} = 1$ iff for any world $h \in \cap f(w,t)$,

there is a world j , $j \in \cap f(w,t)$, $j \leq_{f'(w,t)} h$ and for any k , $k \in \cap f(w,t)$, if $k \leq_{f'(w,t)} j$, then

for some time t' , $\llbracket \lambda t_0 \lambda w_0[\text{wash-the-car}'_{w_0,t_0,\text{today}}(j)] \rrbracket_{g',f,f'}(t')(k) = 1$ iff

for $g'' = g'[w_1/k][t_1/t']$, $\llbracket \text{wash-the-car}'_{w_1,t_1,\text{today}}(j) \rrbracket_{g'',f,f'} = 1$,

and $\llbracket \lambda t_0 \lambda w_0 [\text{wash-the-car}'_{w_0, t_0, \text{today}'}(j)] \rrbracket_{g, f, F}(t') \cap \cap f(w, t) \neq \cap f(w, t)$.

By the I-feature on the predicate, any subinterval of today under consideration must be an instant. Any instantaneous car-washing in the past or present will hold in all worlds in the modal base set, or in no worlds in the modal base set. To satisfy the disparity clause, admissible times must be future.

The conclusion is different for (196) and (197), repeated here.

(196) John washed the car from top to bottom today.

(197) John will wash the car from top to bottom today.

I assume that the expression, *from top to bottom*, is incompatible with the default I-feature and therefore requires the D-feature. The relevant reference times for each sentence are therefore intervals, and the interpretation of (197) allows any of these intervals to overlap with the time of speech. This pair of sentences therefore displays the relevant kind of asymmetry.

Next we turn to the sentences containing negation. Consider (205) and (207), repeated here.

(205) The baby didn't cry today.

(207) The baby won't cry today.

An important difference between these sentences is that (205) can only be appropriately uttered at the end of the day, or at least after the relevant crying period of the day, whereas (207) can be uttered at midday, for example, and in that case requires in addition to there being no crying the rest of the day also that there was no crying in the morning. These are the facts that I want to explain.

Translations for these sentences are given respectively in (262) and (263).

(262) $\lambda w_0 [\text{PAST}(t_0)(t_2) \ \& \ \neg[\text{cry}'_{w_0,t_2,\text{today}'} (\text{the-baby}')]]$

(263) $\lambda w_0 [\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0 \neg[\text{cry}'_{w_0,t_0,\text{today}'} (\text{the-baby}')])]$

It has already been explained why (262) can only be uttered appropriately and truly at the end of the day. The explanation hinged on two rules. The rule in (232) for interpreting the past tense morpheme requires the reference time to be before the speech time. The rule in (236) for interpreting negated predicates requires the reference time to be a maximal sub-interval of the frame time. The frame time is given by *today*, and so it follows that the reference time is before the speech time but also the same interval as today, which means the sentence can only be uttered at the end of the day. Rules of use allow one in the evening to talk about the day that has just passed as *today*.

Now consider truth conditions for (263).

(264) Given an assignment function g , a modal base function f , and an ordering source function f' , for a world w and a time t , $\llbracket \lambda w_0 [\text{PRES}(t_0)(t_2) \ \& \ \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0 \neg[\text{cry}'_{w_0,t_0,\text{today}'} (\text{the-baby}')])]\rrbracket_{g',f,f'}(w) = 1$ iff for $g' = g[w_0/w]$, $\llbracket \text{PRES}(t_0)(t_2) \rrbracket_{g',f,f'}(w) = 1$ iff $g'(t_2)$ equals $g(t_0)$, the time of speech t , and $\llbracket \text{will}'_{w_0,t_2}(\lambda t_0 \lambda w_0 \neg[\text{cry}'_{w_0,t_0,\text{today}'} (\text{the-baby}')]) \rrbracket_{g',f,f'} = 1$ iff for any world $h \in \cap f(w,t)$, there is a world j , $j \in \cap f(w,t)$, $j \leq_{f'(w,t)} h$ and for any k , $k \in \cap f(w,t)$, if $k \leq_{f'(w,t)} j$, then for some time t' , $\llbracket \lambda t_0 \lambda w_0 \neg[\text{cry}'_{w_0,t_0,\text{today}'} (\text{the-baby}')]\rrbracket_{g',f,f'}(t')(k) = 1$ iff for $g'' = g'[w_1/k][t_1/t']$, $\llbracket \neg[\text{cry}'_{w_1,t_1,\text{today}'} (\text{the-baby}')]\rrbracket_{g'',f,f'} = 1$, and $\llbracket \lambda t_0 \lambda w_0 \neg[\text{cry}'_{w_0,t_0,\text{today}'} (\text{the-baby}')]\rrbracket_{g',f,f'}(t') \cap \cap f(w,t) \neq \cap f(w,t)$.

By our rule for interpreting negated predicates, any relevant subinterval must be a maximal sub-interval of the frame time as denoted by *today*. The disparity requirement is that there are worlds in the modal base set in which the baby does not cry at all today, as well as worlds

in the modal base set in which the baby does cry at some time today, and this is consistent with the baby not having cried at all today as of the speech time, in all the worlds in the modal base set, even if the speech time is in the middle of the day.

The analysis explains why (205) can only be truly and appropriately uttered at the end of the day, or after any relevant crying-time has passed, and why (207) can be uttered throughout the day – although not in the evening – and is true as long as there is no crying all day long in the well-behaved worlds in the modal base set. This accounts for the asymmetry between the negated past and negated future sentences.

A possible objection to this explanation is to say that all that this apparent asymmetry is really showing us is that we are talking about the completion of events. A past sentence says of an event that it was completed before the time of speech, and a future sentence says of an event that it will be completed after the time of speech. Since both sentences are silent about the onset of the event, it is possible for the future sentence to be about an event that is already underway by the time of speech.

I have two responses to this objection, the first showing evidence that the entire event is relevant to the interpretation, and the second showing how the facts about negated sentences cannot be explained by saying that all that counts is the culmination of an event.

For the first response, consider again (196) and (197).

(196) John washed the car from top to bottom today.

(197) John will wash the car from top to bottom today.

It is true that (197) allows the relevant washing event to have already begun, but neither sentence allows the relevant washing event to have begun before today. My account explains this fact by requiring the reference time to be a sub-interval of the frame time. Now consider

a theory by which (196) means the culmination of the washing event took place today, before the time of speech, and (197) means the culmination will take place today, after the time of speech. There is no explanation of why for each sentence the onset of the event is required to also fall within the frame time denoted by *today*.

The second response involves looking at sentences with negation. Consider again (205) and (207).

(205) The baby didn't cry today.

(207) The baby won't cry today.

These sentences don't mean, respectively, that the baby didn't stop crying earlier today, or that the baby won't stop crying later today, and this shows that it is not simply the culmination of an event that counts toward the truth of the sentence.

5.5 The temporal interpretation of epistemic sentences

The disparity principle interacts with a totally realistic modal base for a world up to a time to yield a future interpretation for a modal sentence. The disparity principle requires distinctions to be made between worlds in the modal base, and with a modal base of this kind, worlds only differ by future facts. The same principle also accounts for the constraint on epistemic sentences discussed earlier. By that constraint, an epistemic sentence like (265) cannot be truthfully uttered by someone who either knows that John is asleep or that John is not asleep.

(265) John must be asleep.

By an utterance of this sentence, a speaker who knew that John is asleep would fail to make distinctions within the modal base because the modal base is epistemic and all the worlds in the modal base are worlds in which John is asleep. A speaker who knew that John is not

asleep would similarly fail to make distinction within the epistemic modal base because in this case, John is asleep in no worlds in the modal base.

As it stands, the disparity principle does not explain the temporal interpretation of sentences interpreted against an epistemic modal base. An epistemic modal base yields accessible worlds compatible with what a speaker knows. Since no speaker ever know all past, present, or future facts, these worlds differ by past, present, and future facts. The basic truth conditions require that every adequately close accessible world with respect to the ordering source is contained in the proposition that results when the residue function is applied to some time. The disparity principle further requires that no such proposition contains all accessible worlds. Consequently, the residue function applied to past, present, and future times results in disparity facts, and there is no constraint put on the possible temporal arguments for the function in the epistemic case. But this result conflicts with the empirical facts about epistemic sentences. Those facts are that a sentence like (265) cannot be past or future, and the equivalent sentence with *have*, such as (266), cannot be present or future.

(266) John must have been asleep.

The disparity principle alone is too permissive. We need to find a way to make the theory more restrictive in the right way without undoing the results achieved with it so far.

We return to (265), applying the analysis thus far developed so that we can see its shortcomings more clearly. (265) is assumed to have the syntactic structure in (267), with the modal embedding a VP. The translation of the modal in (268) results in the sentence translation in (269).

(267) [_{TP} PRES [_{MP} must [_{VP} John be asleep]]]

(268) $\text{must} \Rightarrow \lambda Q \lambda t_0 \lambda w_0 [\text{must}'_{w_0, t_0}(Q)] \langle \langle i, \langle s, t \rangle \rangle, \langle i, \langle s, t \rangle \rangle \rangle$

(269) $\lambda w_0 [\text{must}'_{w_0, t_0}(\lambda t_0 \lambda w_0 [\text{asleep}'_{w_0, t_0}(j)])]$

Note that I am returning to the simpler analysis of the present-tense morpheme that includes no variable for a frame time. The more complex analysis will only be used when needed.

Truth conditions for the sentence under investigation, containing a disparity clause, appear as follows.

(270) Given assignment function g , modal base function f , and ordering source function f' , for a world w and speech time t , with $g' = g[w_0/w]$, $\llbracket \text{must}'_{w_0, t_0}(\lambda t_0 \lambda w_0 [\text{asleep}'_{w_0, t_0}(j)]) \rrbracket_{g', f, f'} = 1$ iff for any world $h \in \cap f(w, t)$, there is a world $j \in \cap f(w, t)$, $j \leq_{f(w, t)} h$, such that for any $k \in \cap f(w, t)$, if $k \leq_{f(w, t)} j$, there is a time t' such that

$$\begin{aligned} & \llbracket \lambda t_0 \lambda w_0 [\text{asleep}'_{w_0, t_0}(j)] \rrbracket_{g', f, f'}(t')(k) = 1, \text{ and} \\ & \cap f(w, t) \cap \llbracket \lambda t_0 \lambda w_0 [\text{asleep}'_{w_0, t_0}(j)] \rrbracket_{g', f, f'}(t') \neq \cap f(w, t). \end{aligned}$$

The disparity principle requires that the proposition resulting when the residue is applied to some time t' is not true in every world in the modal base set. Since the worlds in the modal base set differ by past, present, and future facts, the disparity principle sets no limits on possible arguments for the residue, whereas in fact there is a restriction on (265). Under an epistemic interpretation, the sentence has a default reading by which John must be asleep *now*. We need to consider what might motivate a further restriction on the interpretation of the modal.

We have assumed that the modal base for *must* in (265) is epistemic, the set of worlds compatible with what the speaker knows. Suppose we group these worlds into speech-time broomsticks. We find that we have not a single broomstick, but multiple broomsticks. Each

of these broomsticks represents an epistemically possible state of the world, ignoring all future differences between worlds. It seems that what is needed is a requirement not simply to make distinctions between worlds but rather to make distinctions between broomsticks. This makes sense, given a certain intuition of what an epistemic sentence is all about – it is about making figuring out what else holds in the world, given the facts we already know to hold. But this also would get the temporal interpretation right, because making distinctions between broomsticks is simply making distinctions between worlds while ignoring future differences.

Both kinds of modal sentences have the same ultimate goal – identifying the one world extending from the past to the future that is the actual world. If the modal base is epistemic, we sort the worlds in the modal base into broomsticks and order these. The broomstick closest to the ideal represented by the ordering source can be expected to contain the world that is to be the actual world. If the modal base is totally realistic up to a time, we start with this same broomstick and order the worlds within it. The world that is to be the actual world is surely to be found among those worlds closest to the ideal represented by the ordering source. It is a matter of doing things in order. First, ignore future differences and order worlds on the basis of facts holding up to the present. Then, order worlds that are identical up to the present, based on future differences. If we try to order worlds by future differences that are not identical up to the present, we do things in the wrong order. The principle that holds us to this order I will call the *requirement to make first distinctions first*.

The requirement to make first distinctions first entails that if the accessible worlds form multiple speech-time broomsticks, distinctions can only be made between worlds from different broomsticks. This requirement falls out from a clause is added to the truth

conditions for (265) as shown, in the following, with f_{TR} being a totally realistic modal base for a world up to a time.

- (271) Given assignment function g , epistemic modal base function f , and ordering source function f' , for a world w and speech time t , with $g' = g[w_0/w]$, $\llbracket \text{must}'_{w_0,t_0}(\lambda t_0 \lambda w_0 [\text{asleep}'_{w_0,t_0}(j)]) \rrbracket_{g',f,f'} = 1$ iff for any world $h \in \cap f(w,t)$, there is a world $j \in \cap f(w,t)$, $j \leq_{f'(w,t)} h$, such that for any $k \in \cap f(w,t)$, if $k \leq_{f'(w,t)} j$, there is a time t' such that $\llbracket \lambda t_0 \lambda w_0 [\text{asleep}'_{w_0,t_0}(j)] \rrbracket_{g',f,f'}(t')(k) = 1$, and $\cap f(w,t) \cap \llbracket \lambda t_0 \lambda w_0 [\text{asleep}'_{w_0,t_0}(j)] \rrbracket_{g',f,f'}(t') \neq \cap f(w,t)$, and for some $w' \in \cap f(w,t)$, $\cap f_{\text{TR}}(w',t) \cap \llbracket \lambda t_0 \lambda w_0 [\text{asleep}'_{w_0,t_0}(j)] \rrbracket_{g',f,f'}(t') = \cap f_{\text{TR}}(w',t)$.

The new clause says that the proposition that is the value of the residue when combined with a time contains every world in at least one speech-time broomstick containing some world from the epistemic modal base set, w' . But if the proposition contains every world in the broomstick containing w' , it does not distinguish between worlds in this speech-time broomstick or any other. The proposition in question only distinguishes between worlds in different broomsticks, and the temporal argument of the residue is a non-future time.

Our original proposal treated modals as quantifiers over possible worlds. The disparity principle then claimed that modals are about quantification *and* making distinctions between worlds. In this section we have a new requirement, the requirement to make first distinctions first. By this requirement, if the set of accessible worlds form multiple speech-time broomsticks, we must make distinctions between these – in other words, we must make distinctions between accessible worlds not based on future differences. This new requirement gets the temporal interpretation of epistemic sentences right, without positing covert tense-

marking as part of the meaning of modals under an epistemic reading.

The following are general truth conditions for a sentence with translation $\lambda_{w_0}[\phi]$ interpreted with respect to world w and speech time t . ϕ is type t ; ψ is type $\langle i, \langle s, t \rangle \rangle$; and M is a universal modal.

(272) With $\phi = [M_{w_0, t_0}(\psi)]$, given g , an assignment function, f , a modal base function, and f' , an ordering source function, for a world w and speech time t , with $g' = g[w_0/w]$, $\llbracket M_{w_0, t_0}(\psi) \rrbracket_{g', f, f'} = 1$ iff for any world $h \in \cap f(w, t)$, there is a world $j \in \cap f(w, t)$, $j \leq_{f'(w, t)} h$, such that for any $k \in \cap f(w, t)$, if $k \leq_{f'(w, t)} j$, there is a time t' such that

$$\llbracket \psi \rrbracket_{g', f, f'}(t')(k) = 1, \text{ and}$$

$$\cap f(w, t) \cap \llbracket \psi \rrbracket_{g', f, f'}(t') \neq \cap f(w, t), \text{ and}$$

$$\text{if } f \text{ is epistemic, then for some } w' \in \cap f(w, t), \cap f_{TR}(w', t) \cap \llbracket \psi \rrbracket_{g', f, f'}(t') = \cap f_{TR}(w', t).$$

Chapter 6. Some consequences and loose ends

6.1 The Upper Limit Constraint

An interesting comparison can be made between the complements of modals and those of attitude predicates. As Heim (1994) points out, attitude predicates are universal quantifiers. This universal quantification of attitude predicates helps to explain the Upper Limit Constraint of Abusch (1997) and it is worth mentioning as a case where temporal interpretation is the result of what holds in every member of some set of worlds. With modals, I have been arguing that temporal interpretation is the result of some proposition not holding of every member of some set of worlds, and this is the point of comparison. I will discuss the Upper Limit Constraint here briefly.

Abusch uses the Upper Limit Constraint to explain the range of interpretations

available for sentences like (273), which is adapted from her paper.¹⁰

(273) Just before John opened the door to his apartment, he thought that a burglar attacked him.

The point of the example is that one expects to find a certain reading of the second sentence in this discourse that is actually not available. By that reading, the sentence would describe the following scenario. John has a thought before he opens the door. The thought is, “when I open the door, I will be attacked by a burglar.” The reading is predicted by a theory Abusch discusses. According to that theory, the past tense morpheme on *attacked* can be anaphoric to the past tense morpheme on *opened*. Such an anaphoric relation would guarantee that the time of being attacked is the same as the time of the opening. However, this sentence can only be interpreted to mean that the attack is no later than the time that John thinks it is when he is entertaining the thought. As he entertains the thought before he opens the door, the thought he is described as having cannot be about something that will happen when he opens the door. Abusch calls the time that someone having a belief thinks it is at that time as the “now of the belief alternative” and calls this constraint on the interpretation of (273) the *Upper Limit Constraint*.

Another example from Abusch (1997) shows the same thing.

(274) Last Monday John believed that he was in Paris on Tuesday.¹¹

We might expect that *on Tuesday* denotes a time future with respect to the speech time and that the past tense on *was* can be anaphoric to it. There should therefore be a reading of this sentence by which what John believes is that he will be in Paris on some future Tuesday.

¹⁰ The example here is adapted from example (3), p. 4 in Abusch (1997).

¹¹ Abusch (1997), p. 16, example (27).

This reading is again excluded, according to Abusch, by the Upper Limit Constraint.

How does Abusch derive the ULC? She attempts to derive it from the branching nature of time. She says,

..let us speculate that forward reference with tenses is impossible because future times are not sufficiently determined from the perspective of the now of an intensional context...the past is determinate.

For example, we can look back for the last occurrence of a thunderstorm in Stuttgart, but ...looking in the other direction, we cannot find a unique next thunderstorm, because the possibilities branch apart. To talk about the future, we have to quantify over the branches by using modals or a similar operator.¹²

These comments are highly suggestive, although I think the remarks stop one step short of a complete explanation of the Upper Limit Constraint. If we take the final step, we can see an interesting similarity with the theory of the temporal interpretation for modals that I've been developing here.

Abusch puts the point in terms of the past being determinate and the future being indeterminate and says that because the future is indeterminate, we need something that quantifies over all the future worlds. I agree that the past is determinate, but within the set of doxastic alternatives, there are multiple pasts to choose from. Within these pasts, there might be many thunderstorms, and they might not be the same in every world.

I think we can get the argument to work as follows. Instead of talking about determinate and indeterminate, let's talk about a proposition being true in every world or not

¹² Abusch (1997), p. (24).

true in every world. We don't want to say that if something is past, it is true in every world in the set of doxastic alternatives. That would be wrong for the reason just given – there are past events we don't have beliefs about. We do want to say that if something is true in every world, it is past or present. (It's future only if it is not true in every world.) Now we bring in Heim's reminder that attitude verbs are universal quantifiers. They say that some fact is true in every world. Such a fact cannot be future and hence we have the Upper Limit Constraint.

The same explanation won't work for modals if for no other reason than these can involve existential quantification. What I think is interesting and relevant is that the explanation for the Upper Limit Constraint developed out of the comments made by Abusch provides an additional example of a temporal interpretation being the result not of tense-marking but of the temporal character of logical space.

6.2 Disparity and informativity

Stalnaker (1978) gives the following principle governing the assertion of a declarative sentence.

A proposition asserted is always true in some but not all the possible worlds in the context set.¹³

The disparity principle requires that any admissible proposition in the interpretation of a modal sentence be true in some but not all possible worlds in the relevant modal base set. These principles are strikingly similar. Is this similarity just an accident, or does it tell us something deeper about modal sentences?

Let us look at the terms into which Stalnaker puts his theory. First, there is the idea

¹³ Stalnaker 1978/1991, p. 284.

of speaker presuppositions. That is defined as follows.

Presuppositions are what is taken by the speaker to be the COMMON GROUND of the participants in the conversation, what is treated as their COMMON KNOWLEDGE or MUTUAL KNOWLEDGE.¹⁴

The context set is defined in terms of speaker presuppositions, as follows.

...the more fundamental way of representing the speaker's presuppositions is not as a set of propositions, but rather as a set of possible worlds, the possible worlds compatible with what is presupposed. This set, which I will call the context set, is the set recognized by the speaker to be the "live options" relevant to the conversation.¹⁵

Speaker presupposition corresponds to an epistemic modal base. The context set corresponds to the set that is the result of intersecting the propositions in the modal base. However, there are important differences between speaker presuppositions and an epistemic modal base.

Speaker presuppositions are not necessarily mutually known. They may not even be mutually believed. Here is what Stalnaker says about them.

The propositions presupposed in the intended sense need not really be common or mutual knowledge; the speaker need not even believe them. He may presuppose any proposition that he finds it convenient to assume for the purpose of the conversation, provided he is prepared to assume that his audience will assume it along with him.¹⁶

The propositions in the epistemic modal base, by contrast, are propositions known by the speaker and are therefore both believed by the speaker and true.

I think these differences stem from the fact that Stalnaker is offering a theory of communication, and Kratzer is offering a truth theory. In actual conversation, people can lie

¹⁴ Stalnaker 1978/1991, p. 281.

¹⁵ Stalnaker 1978/1991, p. 281.

¹⁶ Stalnaker 1978/1991, p. 281.

and mislead, and pretend that what is not true actually is. Consider a case in which I am speaking with a person who believes that some fake giant footprints carved in a rock that we are looking at are real. I humor the person and say,

(275) Those footprints must have been made by a person over ten feet tall.

I actually know that these footprints are not real footprints. I know they were carved by someone, someone under ten feet, which means I know they were made by someone less than ten feet tall. Relative to the set of worlds consistent with what I know, (275) is false. However, (275) is a perfectly felicitous contribution to the conversation. I have used as a modal base a set of propositions I am assuming for the sake of the conversation.

In terms of a communicative theory, we can see why my contribution is felicitous. In terms of a truth theory, we can see that I've lied. (275) is a false statement. It is a lie just as if I had knowingly uttered a false declarative sentence. But the statement is felicitous, because I am pretending.

The disparity principle for epistemic modals is similar to Stalnaker's principle for felicitous utterances. The idea behind both principles involves informativity. Don't say what is already known, or agreed upon, and only draw conclusions from the known to the unknown. We might also want to ask, what does the disparity principle applied to modals with a totally realistic modal base up to a time have to do with informativity? I think that is the wrong question. Future readings of modals have nothing to do with informativity.

Epistemic modals are about virtual updates. We update our state of knowledge about the world. To update is to bring ourselves up to date. A virtual update is to fill in what is likely to be the case. The other kind of reading is about the date moving up, that is, time moving forward. Here we have the idea of a set of possible moves in a game. Each passing

moment is a move in the game, eliminating other possibilities. A virtual move, a move merely considered, must exclude possibilities too, or it would be pointless. Modal sentences are about such virtual moves, whether in the epistemic realm, or the realm of branching worlds. But the idea of informativity is just a special case of this more general notion of virtual moves.

6.3 Condoravdi's paper and the problem of future epistemics

Condoravdi (2001) treats the problem of the temporal interpretation of modal sentences. Although my theory was developed independently of Condoravdi's theory, her paper appeared in print first and proper acknowledgment should be made of this fact. The two theories share an underlying intuition, but the way this intuition is developed results in different explanatory power and leads to different predictions. It may be worthwhile to examine some of the similarities and differences in the two theories, and also to discuss some data introduced by Condoravdi that is potentially problematic for my approach, data concerning future epistemic sentences.

The first similarity in the treatments is the simple recognition that the temporal readings of modal sentences appears to be related to the kind of modality that is expressed. The second similarity is that Condoravdi recognizes that the content of an epistemic modal sentence has to be open with respect to the modal base, and she draws a parallel between this kind of openness and the openness of the indeterminate future. In fact, Condoravdi has a Diversity Condition¹⁷, very much in the spirit of my Disparity Principle, which interacts with a property of Settledness.

¹⁷ Condoravdi (2001), p. 25.

One key difference between the two theories is that Condoravdi gives modals a temporal interpretation, and then seeks to derive the type of modality involved from the temporal interpretation, whereas I go in the opposite direction. Following up on an idea from Abusch (1998), Condoravdi proposes that a modal like *might* contributes the interval $[\text{now}, \infty)$ to the interpretation, an open interval starting at the time of speech and extending without limit into the future. In Condoravdi's theory, because this interval overlaps with the present and extends into the future, the same modal can have either a present interpretation or a future interpretation, depending on either of the two principles of Settledness and the Diversity Condition.

If the modal has a past or present temporal perspective (i.e. the residue time is past or present), it gets an epistemic interpretation. As Condoravdi puts it,

...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 participants in a conversation, that is, a property of common grounds.¹⁸

The idea, as I understand it, is that if the temporal perspective is non-future, the fact in question is presupposed to be settled. Why is this enough to make the modal base epistemic? Here there appears to be the suggestion that because what is past or present is settled with respect to any modal base, an epistemic modal base would be the default. The reader is again referred to Condoravdi's paper to verify this interpretation of that theory.

For a future modal sentence, Condoravdi appeals to her Diversity Condition that says in effect that the relevant proposition must not be true in every world in the modal base and

¹⁸ Condoravdi (2001), p. 24.

this ensures that the modal base is metaphysical, which for us means it selects a speech-time broomstick. The reason for the Diversity Condition is to prevent sentences like the following from being truth-functionally equivalent.

(276) John may have the flu (now).

(277) John has the flu (now).

If (276) were construed with a metaphysical modal base, it would be the same as (277), and therefore such a reading needs to be ruled out by Diversity.

Another difference between the theories concerns future perfects. By Condoravdi's theory, *may* can interact with *have* to give past readings, in sentences such as the following.

(278) John may have left.

In this theory, *have* is essentially a past marker, and past of [now,∞) is just past. In a footnote, Condoravdi states that she is ignoring future perfect readings, such as in the following sentence.

(279) He may have arrived by next week.¹⁹

It seems legitimate to ask how we can get two temporal readings for *may have*, one past of present, and the other, past of future, if *may* always contributes the same interval to the semantic interpretation.

Another crucial difference in the theories is that Condoravdi adopts a single conversational background theory of modals. A modal like *will* is a universal quantifier over all the worlds selected by the modal base, in this case all worlds branching from the present. In her discussion, Condoravdi restricts herself to existential modals like *may*. With an

¹⁹ Condoravdi (2001), p. 2, footnote 2. The example is Condoravdi's.

existential modal, the Diversity Condition makes sense, even with a single conversational background, but one wonders what the treatment of universal modals would be. In my theory, the universal modal quantifies not over all the worlds in the broomstick, but in effect over just the more well-behaved worlds in the broomstick. The second conversational background, the ordering source, makes it possible to have both universal quantification and disparity.

Because Condoravdi leaves aside the issue of ordering worlds²⁰, she is also not in a position to interrelate different kinds of modals with similar temporal meanings, such a deontic versus circumstantial, for example. I take up this issue in the next section.

As for predictions, Condoravdi's theory gives modals a basic temporal interpretation, always contributing an interval $[t, \infty)$ where t can be filled in for some time. Consequently, as far as I can tell, there is no way in this theory to account for cases in which intervals are assigned to the interpretation of a so-called future modal that actually overlap with the time of speech. Such readings were seen in sentences like the following.

(280) John will wash his car from top to bottom

(281) Mary will shake everybody's hands.

The first of these sentences can be true about a car-washing event that has already commenced, and the second can be true even after Mary has starting shaking hands. Such sentences can be handled in my theory because modals are fundamentally about differences between worlds, and activities that start out the same may end differently. In other words, in every world in the modal base, John may have started to wash his car, but he might only finish washing it in some worlds.

²⁰ She is explicit about this, for example, in footnote 11, page 13 of Condoravdi (2001).

One set of data that Condoravdi mentions in her paper does pose a challenge for the theory I have offered here. Those are sentences that appear to involve an epistemic future reading. So far I have given an account of epistemic sentences that are not future, and future sentences that are not epistemic. I have yet to give an account of sentences that are both.

The sentences at issue are illustrated below, adapting certain examples from Condoravdi (2001).²¹

(282) John will meet with one senior administrator (tomorrow).

(283) It hasn't been decided yet who he will meet with. John may see the dean and he may see the provost.

(284) It has been decided who he will meet with but I don't know who it is. John may see the dean and he may see the provost.

The second sentence in (284) is problematic for my analysis as given so far. This sentence is future which in my theory means the modal base is totally realistic up to a time and yields a set of worlds that form a speech-time broomstick. Imagine that in the situation in (284), it has been decided that John will meet the dean. That means that in all adequately close worlds in the speech-time broomstick, John meets the dean. However, the truth conditions for the second sentence in (284) say that in some adequately close worlds, John meets the dean and in some adequately close worlds, John meets the provost. Since meeting the dean and meeting the provost are mutually exclusive, the second sentence in (284) is predicted to be false, but such is clearly not the case. My theory needs to be amended to explain why this sentence is not false in a case where the decision of whom John is to meet has been made but

²¹ Condoravdi (2001), p. 22.

the speaker doesn't know the content of this decision.

The theory of modals I have adapted contains only three elements: the quantificational force of the modal, the modal base, and the ordering source. The quantificational force of the modal is obviously not at issue. *may* is an existential modal. The sentence in question has a future interpretation, which we have said is due to an interaction between the disparity principle and a totally realistic modal base for a world up to a time. The only thing left to amend is the ordering source.

The criterion of an epistemic sentence is that its truth value depends in part on what a speaker knows. Consider the following.

(285) John must be asleep.

This sentence could be true, even if in reality John is awake. The truth conditions for (285) say that the sentence is true just in case it follows from what the speaker knows that John is asleep, given certain regularities in the world as provided in by the stereotypical ordering source. The speaker's knowledge could be such that the proposition that John is asleep does follow, even when John is awake. It is in a similar sense that the second sentence in (284) is an epistemic sentence. If the speaker knew more – namely, who John was to meet – (284) would be false. Nothing in the real-world situation would be different, just the speaker's epistemic state.

We need a solution whereby epistemic facts contribute to the truth conditions of the sentence. One way to achieve this, and the only way still open to us, is to make changes in the type of ordering source used in the interpretation of the sentence. We need to make the ordering source epistemic.

Consider the following set of propositions as a possible ordering source. The set

contains only two propositions. The first proposition is that John meets the dean tomorrow, and not the provost. The second proposition is that John meets the provost tomorrow and not the dean. Those are the only propositions in the ordering source. Let the worlds in the speech-time broomstick be ordered on this basis. Accordingly, those worlds will fall into two categories, those that do well and those that don't. Worlds in which John meets the dean tomorrow and not the provost, or worlds in which he meets the provost tomorrow and not the dean, will do well. All other worlds will do poorly. This ordering source is oblivious to the fact that it has been decided that John will meet the dean and not the provost. But based on this ordering, there are adequately close worlds in which John meets the dean and not the provost, and adequately close worlds in which John meets the provost and not the dean. The second sentence in (284) is predicted to be true in the situation described, as it is.

This solution accords with the basic approach endorsed in the account. Past or present facts can be known, because knowing that a fact holds requires that one belong inalterably to the same world as that fact. Suppose I am ignorant about a past fact f . That means I don't know whether f is part of the world w that I am in, now and forever, or not. If the ignorance is erased, I know either that I belong inalterably to the same world as f or I don't.

By what has been said, however, future facts cannot be known. Suppose a future fact f' belongs to a world w' , a proxy for the actual world at speech time. At present I belong to w' . With the passage of time, w' may fall out of the set of proxies for the actual world. That means I don't yet belong inalterably to be same world as f' . What I can know about a future fact f' is whether it belongs to a well-behaved world or not and this is also the respect to which I can be ignorant of the fact. Erasing this ignorance does not tell me that f' and I belong inalterably to the same world because we cannot. This shows that ignorance about the

future is different than ignorance about the past or present, and it is sensible that the theory should capture this ignorance differently. Ignorance about the past or present is a matter of the modal base. Ignorance about the future is a matter of the ordering source.

Suppose that after the utterance of (285), the speaker's ignorance is erased. She will then know that now and forever she is in the same world as the fact of John's being awake at that time. Suppose that after the utterance of (284), the speaker finds out the content of the decision, that John is to meet the dean. That does not yet put her in the same world as John's actually meeting the dean. That fact may belong to all the well-behaved worlds in the broomstick, but as of the time of speech, the speaker belongs equally to all the crazy and outlandish worlds in the broomstick as well.

6.4 A typology of modals

We have adopted a theory whereby the meaning of a modal is contextually-dependent, dependent, that is, on two conversational backgrounds salient on a given occasion of use. By way of illustration, consider the modal *must*. In one context, this modal has an epistemic meaning, and in a different context, the same modal has a deontic meaning. There are restrictions placed on this contextual-dependency as well. The modal *must* can't take on any meaning. With a future interpretation, it is always deontic, and never means the same thing as *will*, for example. This kind of contextual dependency is somewhat like that of pronouns. Consider the pronoun in the following sentence.

(286) Mary said that she had disappeared.

The reference of the pronoun *she* is context dependent. In some contexts, the reference can be to Mary, and in other contexts, the reference can be to someone else. But although the reference is context-dependent, there are restrictions on it, based on the features of the

pronoun. The pronoun *she* is third-person, singular, and feminine. It cannot refer to the speaker or the addressee. It cannot refer to a group. It cannot refer to most inanimate objects, with the exceptions of a ship, a hurricane, and so on. It cannot refer to a male animate object.

In this section, I investigate similarities and differences between the possible meanings of certain modals, meanings that are restricted in a way not unlike the way the reference of pronouns is restricted. The meanings of modals has been reduced to quantificational force, modal base, and ordering source, and similarities and differences between modals must reduce to the same things. Take *must* and *will*, for example. By assumption, both have universal quantificational force. Given the theory advanced here, if these modals have future interpretations, they both employ the same modal base. Any differences between them must derive from differences in the ordering source. I am also interested in ways in which these modals are similar, and it stands to reason that such similarities might also relate to the ordering sources they employ.

I claim that similarities can be detected between the meanings of different modals based on entailment patterns between modal sentences. These entailment patterns are not obvious, but I argue that they can be detected by examination of certain minimal pairs, that is, modal sentences only differing by the modal appearing in each. Specifically, I claim there is an entailment in one direction from deontic *must* to future *will*, and in the other from *will* to *can*. The entailment from *must* to *will* is unexpected and also reveals a difference between *must* and *should*, since there is no entailment from *should* to *will*. The entailment from *will* to *can*, coupled with the entailment from deontic *must* to *will*, means there is an entailment from deontic *must* to *can*, which is expected.

The following sentences demonstrate the entailment I am claiming.

(287) John must register for the draft.

(288) John will register for the draft.

I maintain that in any context in which (287) is true, (288) is also true. This result is somewhat surprising, because we are accustomed to thinking of the interpretation of a *must* sentence as based on laws, and we do not think laws are inviolable. I will argue that the interpretation of a *must* sentence is based on laws, and these laws outrank any additional laws that are added in the interpretation of a *will* sentence. This is why a common response to the assertion of a *must* sentence is to deny the corresponding *will* sentence. Part of my claim is that to deny the corresponding *will* sentence is to deny an entailment of the *must* sentence, and therefore constitutes a denial of the *must* sentence. A response to the assertion of (287), for example, might be to assert (289).

(289) But he won't.

It follows from what I have been saying that the claim that John won't register for the draft entail the proposition that it is false that he must register. The dispute then reduces to a disagreement over what laws that really have sway over John's behavior. If the first speaker is right, these laws says that John registers for the draft. If the second speaker is right, they don't.

The facts for deontic *should* sentences are different. Consider the assertion of (290).

(290) John should register for the draft.

One is free to accept the truth of this sentence and still deny that John will register for the draft. That is, it makes sense to respond to (290) with (291), in a way it doesn't make sense to respond to (287) with (292).

(291) I know he should, but he won't.

(292) ??I know he must, but he won't.

These purported entailment patterns can be explained by saying that the ordering source associated with *should* in its deontic sense is not related to the ordering source associated with future *will*.

Now consider the relation between *will* and *can*. The entailment from *will* to *can*, or conversely, from *can't* to *won't*, is quite accessible to intuition. Consider the following minimal pairs.

(293) Mary will buy the complete set.

(294) Mary can buy the complete set.

(295) Mary can't buy the complete set.

(296) Mary won't buy the complete set.

It seems completely uncontroversial to say that (293) is true only if (294) is true, and in the other direction, (295) is true only if (296) is true.

We now have a new entailment, by transitivity. If *must* entails *will* and *will* entails *can*, *must* should entail *can*. To see the relation between *can* and (deontic) *must*, we need to consider negated forms of *must*. There are two conceivable ways to negate *must*, *must not* and *need not*. The modal *must* in its deontic sense conveys the meaning of a requirement. The combination of *must* and *not* conveys a negative requirement, rather than the negation of a requirement. To convey the negation of a requirement, we use the expression *need not*.

(297) John must leave now.

(298) John must not leave now.

(299) John need not leave now.

The sentence in (297) is about a requirement that John leaves at once. The sentence that

means that this requirement does not hold is not (298) but (299). (298) is rather about a requirement that John does not leave.

To check the new entailment, we can first notice that *can't* entails *need not*, as the following minimal pair shows.

(300) John can't buy the book.

(301) John need not buy the book.

The intuition is that John's inability to buy the book relieves him from any requirement to buy it. If this is so, then by contraposition, *must* should entail *can*. Consider the following minimal pair.

(302) Mary must take these books over to the Dean's office.

(303) Mary can take these books over to the Dean's office.

Our prediction is that (302) is true only if (303) is true. I believe that this prediction is borne out, as the options for the following dialogue show.

(304) A: Mary must take these books over to the Dean's office.

B1: Well, maybe she should, but she can't.

B2: ??Well, maybe she must, but she can't.

The first alternative for a response from B acknowledges that there is a requirement, but given that Mary can't, frames it as non-binding. This is shown by the use of *should*. The second alternative for a response from B frames the requirement as binding, and given that Mary can't, results in an incongruent assertion.

The following chart shows representative modals of the kind that will interest us, and gives a framework for exhibiting relations between them.

Table 1. A comparison of modals.

		1	2	3	4
modal base		epistemic	totally realistic up to a time		
ordering source		stereotypical	stereotypical	deontic	potential
quantificational force	existential	MAY/MIGHT/ CAN	MAY/MIGHT	MAY	CAN
	universal	WILL /MUST	WILL	MUST	MUST

The columns of the table divide the modals first by modal base. Column 1 contains modals as interpreted with an epistemic modal base, while Columns 3, 4, and 5 contain modals as interpreted with a totally realistic modal base for a world up to a time. The modal base interacting with general interpretive principles accounts for the temporal interpretations of the modals, or so I have claimed. Columns 2, 3, and 4 divide the modals interpreted with respect to the totally realistic base. Rows of the table divide modals by quantificational force. The table implies that the difference in meaning between modals with the same modal base and the same quantificational force but in different columns is a matter of ordering source differences. I will be seeking to characterize the relation between these different ordering sources and to say something about their content.

The entailments suggested earlier were these. Deontic *must* entails *will*, *will* entails *can*, therefore *must* entails *can*. These claims are somewhat controversial, at least the claim that *must* entails *will*, and I will return to them below. For now, assuming they are correct, we need adjust the theory so as to entail them

I assume that the ordering sources in question are the following. For potential modals, the ordering source is P. For deontic modals, the ordering source is P+D, which is the union

of P with a set D. For stereotypical modals, the ordering source is P+D+S, which is the union of P+D with a set S. Obviously, the following subset relation holds.

$$(305) \quad P \quad \subset \quad P+D \quad \subset \quad P+D+S$$

The propositions in these ordering sources can conflict. In the case of a conflict, P-propositions win over D and S-propositions, and D-propositions win over S-propositions. The intuition behind these assumptions is this. P includes, but is not restricted to, physical laws. D includes, but is not restricted to, absolute moral laws. S includes, but is not restricted to, things like intentions. If there is a conflict between a physical law and an absolute moral law, the physical law prevails. If there is a conflict between a physical law and an intention, the physical law prevails. If there is a conflict between an absolute moral law and an intention, the moral law prevails. This last claim seems counter-intuitive, but I believe the theory bears it out, as I will try to show below.

Start with $P \subset P+D$ and the assumption that P-propositions prevail over D-propositions, in case of a conflict. Suppose we have two worlds, w, w' , such that $w \leq_p w'$. What is the relation between these worlds, according to P+D? We know that $\{p \mid w' \in p \ \& \ p \in P\} \subseteq \{p \mid w \in p \ \& \ p \in P\}$, by definition. There are three possibilities with respect to P+D. Either (i) $\{p \mid w' \in p \ \& \ p \in P+D\} \subseteq \{p \mid w \in p \ \& \ p \in P+D\}$, or (ii) $\{p \mid w' \in p \ \& \ p \in P+D\} \not\subseteq \{p \mid w \in p \ \& \ p \in P+D\}$ and there are no conflicts over the facts of w' between P and D, or (iii) $\{p \mid w' \in p \ \& \ p \in P+D\} \not\subseteq \{p \mid w \in p \ \& \ p \in P+D\}$ and there are conflicts over the facts of w' between P and D. If (i) is true, then $w \leq_{P+D} w'$, by definition. If (ii) is true, then although it isn't true that $w \leq_{P+D} w'$, we can assume that for some world w'' , $w'' \leq_p w$ and $w'' \leq_{P+D} w'$. This assumption is justified because there is always some world w'' that ties with w with respect to P but which may differ with respect to D-propositions. Now consider the

case of (iii). There is at least one D-proposition true in w' which is not true in w . Eliminate any such proposition that conflicts with P to give D' , which is allowed on the strength of the assumption that P-propositions prevail over D-propositions. Now either (iv) $\{p \mid w' \in p \ \& \ p \in P+D'\} \subseteq \{p \mid w \in p \ \& \ p \in P+D'\}$, or (v) $\{p \mid w' \in p \ \& \ p \in P+D'\} \not\subseteq \{p \mid w \in p \ \& \ p \in P+D'\}$ but with no conflicts over the facts of w' between P and D' . In the case of (iv), we stipulate that $w \leq_{P+D} w'$. In the case of (v), we stipulate that there is a w'' , $w'' \leq_P w$, such that $w'' \leq_{P+D} w'$.

The following proposition is a consequence of these assumptions.

(306) For any worlds w, w' , if $w \leq_P w'$, there is a world w'' , $w'' \leq_P w$ and $w'' \leq_{P+D} w'$.

I also make the following assumption.

(307) For any worlds w, w' , if $w \leq_{P+D} w'$, then $w \leq_P w'$.

This assumption amounts to the claim that $w \leq_{P+D} w'$ only if $\{p \mid w' \in p \ \& \ p \in P\} \subseteq \{p \mid w \in p \ \& \ p \in P\}$. A necessary condition for w to be at least as close as w' with respect to P+D is that the set of P-propositions true in w' is a subset of the set of P-propositions true in w .

Next, I want to consider the relation between orderings based on P+D, and orderings based on P+D+S. Start with $P+D \subset P+D+S$ and the assumption that P and D-propositions prevail over S-propositions in case of a conflict. Suppose we have two worlds, w, w' , such that $w \leq_{P+D} w'$. What is the relation between these worlds, according to P+D+S? We know that $\{p \mid w' \in p \ \& \ p \in P+D\} \subseteq \{p \mid w \in p \ \& \ p \in P+D\}$, by definition. There are three possibilities with respect to P+D+S. Either (i) $\{p \mid w' \in p \ \& \ p \in P+D+S\} \subseteq \{p \mid w \in p \ \& \ p \in P+D+S\}$, or (ii) $\{p \mid w' \in p \ \& \ p \in P+D+S\} \not\subseteq \{p \mid w \in p \ \& \ p \in P+D+S\}$ and there are no conflicts over the facts of w' between P+D and S, or (iii) $\{p \mid w' \in p \ \& \ p \in P+D+S\} \not\subseteq \{p \mid w \in p \ \& \ p \in P+D+S\}$ and there are conflicts over the facts of w' between P+D and S. If (i)

is true, then $w \leq_{P+D+S} w'$, by definition. If (ii) is true, then although it isn't true that $w \leq_{P+D+S} w'$, we can assume that there is a world $w'' \leq_{P+D} w$ such that $w'' \leq_{P+D+S} w'$. This assumption is justified because there is always some world w'' that ties with w with respect to P+D but which may differ with respect to S-propositions. Now consider the case of (iii). There is at least one S-propositions true in w' which is not true in w . Eliminate any such proposition that conflicts with P+D to give S' , which is allowed on the strength of the assumption that P and D-propositions prevail over S-propositions. Now either (iv) $\{p \mid w' \in p \ \& \ p \in P+D+S'\} \subseteq \{p \mid w \in p \ \& \ p \in P+D+S'\}$, or (v) $\{p \mid w' \in p \ \& \ p \in P+D+S'\} \not\subseteq \{p \mid w \in p \ \& \ p \in P+D+S'\}$ but with no conflicts over the facts of w' between P+D and S' . In the case of (iv), $w \leq_{P+D+S} w'$. In the case of (v), we assume that there is a $w'' \leq_{P+D} w$ such that $w'' \leq_{P+D+S} w'$.

The following proposition is a consequence of these assumptions.

(308) For any worlds w, w' , if $w \leq_{P+D} w'$, there is a world w'' , $w'' \leq_{P+D} w$ and $w'' \leq_{P+D+S} w'$.

I also make the following assumption.

(309) For any worlds w, w' , if $w \leq_{P+D+S} w'$, then $w \leq_{P+D} w'$.

This assumption amounts to the claim that $w \leq_{P+D+S} w'$ only if $\{p \mid w' \in p \ \& \ p \in P+D\} \subseteq \{p \mid w \in p \ \& \ p \in P+D\}$. A necessary condition for w to be at least as close as w' with respect to P+D+S is that the set of P+D-propositions true in w' is a subset of the set of P+D-propositions true in w .

Now we show how deontic *must* entails *will*, given these assumptions. P+D is the set of propositions in the deontic ordering source for a world and a time, and \leq_{P+D} is the ordering based on P+D. P+D+S is the set of propositions in the stereotypical ordering source for the same world and time, and \leq_{P+D+S} is the ordering based on P+D+S. The truth conditions for *must*- ϕ say that this sentence is true just in case for any world h in MB (the

modal base set), there is a world j in MB, $j \leq_{P+D} h$, such that for any k in MB, $k \leq_{P+D} j$, $k \in q$, where q is the denotation of ϕ . The truth conditions for *will*- ϕ say that this sentence is true just in case for any world h in MB, there is a world j in MB, $j \leq_{P+D+S} h$, such that for any k in MB, $k \leq_{P+D+S} j$, $k \in q$.

(308) says that for any worlds w, w' , if $w \leq_{P+D} w'$, there is a world w'' , $w'' \leq_{P+D} w$ and $w'' \leq_{P+D+S} w'$. Consider (308)'.

(308)' For any worlds w, w' in MB, if $w \leq_{P+D} w'$, there is a world w'' in MB such that $w'' \leq_{P+D} w$ and $w'' \leq_{P+D+S} w'$.

This assumption seems justified because the criteria for membership in MB is completely unrelated to P, D , or S .

Suppose *must*- ϕ is true. For any world h in MB, there is a world j in MB, $j \leq_{P+D} h$, such that for any k in MB, $k \leq_{P+D} j$, $k \in q$. By (308)', there is a world j' in MB, $j' \leq_{P+D} j$ and $j' \leq_{P+D+S} h$. Consider any k' in MB such that $k' \leq_{P+D+S} j'$. By (309), $k' \leq_{P+D} j'$ and therefore $k' \leq_{P+D} j$. It follows that $k' \in q$. This means that for any h in MB, there is a world j' in MB, $j' \leq_{P+D+S} h$, and for any k' in MB, $k' \leq_{P+D+S} j'$, $k' \in q$. This means *will*- ϕ is true and that *must*- ϕ entails *will*- ϕ .

Next we show that *will*- ϕ entails *can*- ϕ . I assume *can*- ϕ is true at w and t just in case for some h in MB, there is a $j, j \leq_P h$, such that for any k in MB, if $k \leq_P j$, $k \in q$. For the proof, I assume that *can*- ϕ is not true. That means that there for any h in MB, there is no $j, j \leq_P h$, such that for any k in MB, if $k \leq_P j$, $k \in q$. Suppose *will*- ϕ is true. That means for every h in MB, there is a world j' in MB, $j' \leq_{P+D+S} h$, and for any k' in MB, $k' \leq_{P+D+S} j'$, $k' \in q$. By (309) and (307), for any w, w' , if $w \leq_{P+D+S} w'$, then $w \leq_P w'$. That gives us that for every h in MB, there is a world j' in MB, $j' \leq_P h$, and for any k' in MB, $k' \leq_P j'$, $k' \in q$. This contradicts the

initial assumption that *can- ϕ* is false and shows that *will - ϕ* entails *can- ϕ* .

It is now easy to show that *must- ϕ* entails *can- ϕ* . Assume again that *can- ϕ* is not true. That means that there for any h in MB, there is no j , $j \leq_p h$, such that for any k in MB, if $k \leq_p j$, $k \in q$. Suppose *must- ϕ* is true. That means for every h in MB, there is a world j' in MB, $j' \leq_{p+D} h$, and for any k' in MB, $k' \leq_{p+D} j'$, $k' \in q$. Combine this with (307) and we have that for every h in MB, there is a world j' in MB, $j' \leq_p h$, and for any k' in MB, $k' \leq_p j'$, $k' \in q$. This contradicts the initial assumption that *can- ϕ* is false, and this shows that *must - ϕ* entails *can- ϕ* .

The theory yields the entailments from *must* to *will*, from *will* to *can*, and from *must* to *can*. But do all these entailments really hold? As I mentioned above, the entailment from (deontic) *must* to (stereotypical) *will* is controversial. We can investigate it by looking at the interaction of *must* and *will* with negation, and comparing *must*-sentences with *should* sentences.

A typical objection that might be raised to the claim that *must* entails *will* is as follows. Suppose we are driving through a school zone and see a sign saying, 25 mph. You turn to me and say, “You must slow down,” or more colloquially, “You have to slow down.” Now the deontic ordering source of *must* contains laws, including the speed limit law, and therefore, if *must* entails *will*, I will slow down. But surely, the existence of the law does not mean that I will slow down. It is up to me whether I do or not, and the law cannot force me to do so.

The response to this objection is to say that the sentence you have uttered to me has a truth value, and it is either true or false. You may believe it is true, while I believe it is false. If it is true, its entailments will be true. If it is false, its entailments are not guaranteed

to be true. What about the law of driving 25 mph in a school zone? Shouldn't that be in the ordering source? That depends on whether the law is binding. Only laws that are truly binding are part of the ordering source for *must*.

But the objector can now counter, as follows. Suppose you believe that the *must* sentence is true. That means you believe it is binding that you slow down, and therefore that you will slow down. But even if you believe you must slow down, you may be unable to do so. Perhaps a mechanical malfunction will prevent you. You won't be able to. So even the belief in a *must*-sentence does not control your behavior and make you slow down.

The response here is to simply point out that this is a case where I can't slow down. I believe the *must*-statement is true, and I try to slow down. But my belief is false. The malfunction nullifies the moral requirement, rendering my belief false. The *must* statement still entails the *will* statement, but as it is false, the *will* statement is not guaranteed to be true. In fact, if I can't slow down, I won't, beliefs and intentions notwithstanding.

Dialogues such as the following may be cited as tests of the entailment.

(310) A: You must not go in there.

B: Oh yeah. Watch this.

The entailment I am claiming helps make sense of this exchange. A asserts a *must*-sentence, that, if true, entails that B will not go in. B's response is defiant, and the form of the defiance involves going into the forbidden area. This action is actually a demonstration that an entailment of A's statement is not true, showing that the statement cannot be true.

The entailment from *must* to *will* sentences becomes clearer by comparison with deontic *should* sentences. *should* sentences do not entail *will* sentences, as the following contrast reveals.

(311) John should study, but he won't.

(312) ??John must study, but he won't.

Given that *must* entails *will*, (312) should be a contradiction, and it is strange. But the other member of the minimal pair with *should* is not strange.

Consider also how the previously discussed dialogue would work with a *should* statement replacing the *must* statement.

(313) A: You should not go in there.

B: ?Oh yeah. Watch this.

In this case, B's response is somewhat incongruous. But this makes sense in terms of our theory. B cannot prove A's statement wrong by going in. The following response would make more sense.

(314) B: Well, perhaps I shouldn't, but I'm going in anyway.

How can we explain this difference? The ordering source for *must* is ideal, but limited by what is possible. The theory reflects this by having this ordering source be P+D and letting conflicts between P and D be resolved in favor of P. The ordering source for *must* is also binding. The theory reflects this by having the ordering source for *will* be P+D+S and letting conflicts between P+D and S be resolved in favor of P+D.

In contrast, the ordering source for *should* is ideal, but without being limited by what is possible. It is also not binding. The ordering source for *should* is consequently independent of that for *can* or that for *will*.

The dual of potential *can* is either *must* or *have to*, in the sense these modals can have that Kratzer (1981a) refers to as circumstantial. Given our semantics, potential *must* or *have to* should entail deontic *must*, but not *should*. The data, I think, bears this out. It may be a

little odd to say that (315) entails (316). How can a physical or biological necessity be said to imply a moral necessity?

(315) John absolutely has to sneeze. (potential)

(316) John must sneeze. (deontic)

My feeling is that such entailments are a slightly bizarre by-product of the system that make almost no detectable difference. If something is a physical necessity, the question of its moral nature is not likely to come up. The interesting and useful cases involve a conflict between physical and moral necessity.

(317) ??John has to sneeze, even though he must not.

(318) John has to sneeze, even though he shouldn't.

It is futile to have moral prohibitions against inevitable events, such as involuntary actions.

The following dialogue brings this out.

(319) A: You must not sneeze in front of the Queen.

B: But I have to.

A: Well, in that case they will have to allow it.

Compare the case with *should*.

(320) A: You should not sneeze in front of the Queen.

B: But I have to.

A: Well, you still shouldn't.

Our semantics say that *must* sentences entail *can* sentence, but this does not hold for *should* sentences. The following sentences show a difference.

(321) ??I know I must clean up right away, but I just can't bring myself to do it.

(322) I know I should clean up right away, but I just can't bring myself to do it.

must is incompatible with *cannot*, because the ordering source of *must* is limited by possibilities. This is not the case for *should*.

Since *may* is the dual of *must*, there should be interactions between *may* and *can* involving negation.

(323) ??John may pick the flowers, even though he can't reach them.

(324) John can reach the flowers, and he may pick one or two.

(325) John can reach the flowers, but he may not pick any.

What about cases with negation on both (deontic) *must* or *may*, and on *can*? The theory does not rule these out, but the expectation is that they will involve redundancy.

(326) ?John may not pick the flowers, even though he can't reach them.

(327) ?John must not pick the flowers, even though he can't reach them.

(328) ?John can't reach the flowers, and he must not pick them either.

What about the interaction of *should not* and *cannot*? Here the theory makes no prediction, and there seems to be little difference between these interactions and those between *must not* and *cannot*.

(329) John can't read the book, and he shouldn't anyway.

(330) John can't read the book, and he mustn't anyway.

6.5 A comparison with Kratzer (1981a)

The theory of modals I am developing is meant to account for their temporal interpretation. Kratzer, who set out the basic theory of modals that is my starting point, explicitly ignores temporal facts associated with these sentences. I have been at pains to make clear the interactions between modal bases and branching worlds, something that does not concern Kratzer. In addition to this basic difference, I depart from several assumptions she makes in,

for example, her (1981a) paper. The differences between Kratzer's approach and mine in particular involve what she calls circumstantial modality, which for me are modals with a totally realistic ordering source up to a time with a potential ordering source. It is worth going over some of these differences, to better understand both theories.

The examples in Kratzer (1981a) are from German. Rather than discussing the German examples she uses, I will discuss what I believe to be their English counterparts and assume my comments carry over to the German examples.

Here's what Kratzer says about the circumstantial modal base. First, she says that facts create possibilities. She also says that,

If we use a circumstantial modal, we are interested in what else may or must happen, given *circumstances of a certain kind*. Circumstances of a certain kind are facts of a certain kind... Usually, circumstances permit or exclude that certain things happen. Only sometimes do they necessitate an event or an action: We have to die, to cough, to vomit, to laugh, to cry or to realize that we are lost.²²

Kratzer allows for modal readings associated with an empty modal base. She gives the following examples as probably involving empty ordering sources.

(331) a. Diese Tasse ist zerbrechlich.

b. This cup is fragile.

(332) a. Er mußte husten.

b. He must (past) cough.

c. He had to cough.

(331)a is Kratzer's example (70) and (331)b is the gloss she gives for it.²³ (332)a is Kratzer's

²² Kratzer (1981a), p. 52.

²³ Kratzer (1981a), p. 64.

example (60), and (332)b is the gloss she gives for it.²⁴ I am assuming that (332)c renders the German as a suitable English sentence. I will talk about examples (331) and (332) but my remarks will be based on my understanding of the English sentences (331)b and (332)c.

Kratzer says of (331),

I think this is a case of ‘pure’ circumstantial modality. It is in view of certain properties inherent in the cup, that it is possible that it breaks. The ordering source seems to be empty.²⁵

The view of circumstantial modality Kratzer puts forward by these remarks and examples is quite different than the view I have endorsed. Let us examine some of her remarks more carefully to better see the view she is promoting.

Kratzer says that circumstances are facts, and these facts bring about certain possibilities. Facts would be propositions in the modal base. The set of facts for a particular value of the modal base is intersected to yield a set of worlds. Only if the modal base is totally realistic would the set of worlds be a singleton set. In that case, $\bigcap f(w) = \{w\}$. In the cases under consideration, the modal base is not totally realistic and there are a plurality of worlds in the modal base. Certain possibilities reside in a set containing a plurality of worlds

Kratzer says that circumstances permit or exclude that certain things happen. This means that given a set of worlds for a certain value of the modal base, a fact can hold in some worlds in the set, or fail to hold in any, as would be expressed by sentences containing *can* or *cannot*, respectively.

Kratzer allows that facts can necessitate an event or an action. That would mean that

²⁴ Kratzer (1981a), p. 62.

²⁵ Kratzer (1981a), p. 64.

some value of the modal base could be such that a fact holds in every world in the intersection of the modal base propositions. The intuition is that if a person has to cough, this is a biologically determined fact and they therefore cough in every world in the modal base.

A similar case is given by an unbreakable cup. For Kratzer, apparently, the unbreakability of the cup is part of its essential nature. There is no world in the intersection of the modal base in which the cup breaks. There is therefore no need to order these worlds and the ordering source can be empty.

In my view, a fact can hold in every world in the intersection of the modal base propositions only if the fact is expressed by one of those propositions. Universal modality should still involve a non-empty ordering source. A person has to sneeze. We can still imagine worlds in which they don't sneeze. The point is that in every world well-behaved with respect to biological laws, they do sneeze. The same holds for the unbreakable cup. The notion of unbreakability is a modal notion. We can conceive of worlds in which it breaks, but these are worlds in which basic structural laws are violated, and the ordering source eliminates these. There is no reason not to employ an ordering source for existential modals as well. It is not merely the circumstances that permit an event, but the circumstances, given the basic laws in place. Those laws are represented only in the ordering source and are not part of the world in the sense that they are not part of the modal base.

Consider another example from Kratzer's paper which also reveals a different distribution of labor between the modal base and ordering source in Kratzer's theory than in mine. Consider Kratzer's discussion of the following pair of German sentences.

- (333) a. Aus dieser Kanne Milch kann die Kathl ein Pfund Quark machen.
 b. From this can of milk can the Kathl one pound of cottage cheese make.

- c. Kathl can make a pound of cottage cheese from this can of milk.
- (334) a. Es kann sein, daß die Kathl aus dieser Kanne Milch ein Pfund Quark macht.
- b. It may be that the Kathl from this can of mild one pound of cottage cheese makes.
- c. Kathl may make a pound of cottage cheese from this can of milk.

(333)a is Kratzer's (26)a, with (333)b the gloss she provides. I will discuss (333)c as representative of the example in English. (334)a is Kratzer's (26)b, with (334)b the gloss she provides. I will discuss (334)c as representative of this example in English.

Kratzer wants to consider what she calls the circumstantial of (333) versus what she calls the epistemic reading of (334). Under these readings, (333) could be true in the same situation in which (334) is false. Maybe Kathl could make that much cheese, but in her actual practice she never does. That means she can but she won't. As Kratzer writes, "In a circumstantial modal, we neglect certain kinds of facts. In our case, it is facts about what Kathl always actually does."²⁶ The suggestion here again is that the circumstantial modal base leaves out certain facts.

The notion of neglecting facts is unclear to me. A modal base can include a fact, by including a proposition representing that fact. In that case, the fact holds in every world in the intersection. A modal base can also exclude a fact, by including a negative proposition representing that fact. In other words, the modal base would include a set of worlds that is the denotation of a sentence denying that the fact holds. The set of worlds would be the set of worlds in which the fact does not hold. If that proposition is in the modal base, then in no

²⁶ Kratzer (1981a), p. 53.

world in the intersection of the modal base would the fact hold. If a modal base neglects a fact, this presumably means the fact is not mentioned. But this does not exclude the fact. It simply fails to include it. That means the fact will hold in some worlds in the intersection, and not in others.

An ordering source can neglect facts in the sense that it makes no mention of these facts which ensures that the facts are not reflected in the ordering. Take the ordering source for a potential modal, *P*. Perhaps this ordering source leaves out what Kathl actually does. Consider two worlds that are maximally similar except in one, Kathl makes the full amount of cheese, and in the other, she doesn't. By *P*, these worlds will be equally ranked. In adequately close worlds as determined by *P*, there may be worlds in which Kathl makes the full amount of cheese. (333) will be true, in this case. The ordering source for *may* I assume is *P+D+S*. Here it matters what Kathl ordinarily does. Since she doesn't ordinarily make the full amount of cheese, worlds in which she does will not fare as well by *P+D+S*. Adequately close worlds will not have Kathl making the full amount of cheese, and (334) will be false in the same case that (333) was true. But the modal base is the same for both sentences. It is the modal base, in my theory, that gives the full range of future possibilities at the time of speech, the speech-time broomstick.

6.6 Imperatives and permission sentences

Imperatives and permission sentences share certain similarities with deontic modal sentences.

Consider the following.

(335) Put the book back on the shelf.

(336) You must put the book back on the shelf.

(337) Go ahead and borrow it.

(338) You may borrow it.

(335) is an imperative sentence and (336) contains a universal modal with a deontic reading. These sentences are alike in that they imply that there is a lack of choice on the part of the addressee. One difference between these sentences is that in (335), the speaker assumes a certain authority and the statement counts as a command. In (336), the authority may come from a source other than the speaker. For an addressee to disobey (335) is an affront to the authority of the speaker, whereas for an addressee to disobey (336) is a challenge to the truth of the utterance. Another difference is that the grammatical subject of a sentence like (336) need not be a second-person pronoun but an imperative is always directed at the addressee.

In form, (337) is an imperative sentence but in function, it is a permission sentence. (338) is a sentence containing an existential modal with deontic force. If the authority to utter (338) is the speaker, this sentence in effect grants permission. Otherwise, it merely counts as claim that is either true or false, as the following sentence shows, with *might* assumed to be a form of *may*.

(339) John said I might borrow it, but he was wrong. The policy forbids it.

The difference between (335) and (337), both imperatives, has to do with the presumed benefit to the addressee. Borrowing the book would be a benefit to the addressee, so (335) is a command, because it goes against the interests of the addressee, and (337) is a permission sentence, because it accords with the interests of the addressee. Why issue an imperative, in this case? Because a person may be reluctant to act in their own interest, and therefore it is more polite to give them no choice but to do so. This can be seen in the following ways of making an offer.

(340) Have a cookie.

(341) You may have a cookie.

(341) might be said to a child, because a child might have no qualms about satisfying personal appetites. It would be odd to say this to an adult, because it allows for no gracious way to subsequently take the cookie without appearing to act in their own self-interest. (340) is an appropriate way to make an offer to an adult. Since the imperative implies a lack of choice, the addressee can take the cookie out of respect for the authority of the speaker, and not as an act of naked self-fulfillment.

Commands can be delivered, and permission granted, through the use of performatives. The following are examples.

(342) I command you to clean your room.

(343) I permit you to leave the house.

A performative is a sentence in which the main verb makes the force of the resulting speech act explicit. (342) is a command, when uttered under appropriate conditions, and the matrix verb here is *command*. (343) is a permission-granting sentence, when uttered under appropriate conditions, and the matrix verb is *permit*. Performatives are the subject of Austin's (1962) work on sentences that have felicity conditions rather than truth values. Although sentences like (342) and (343) are almost never heard, the fact that commanding and permission-granting can take the form of performatives may be a clue as to the proper treatment of imperatives and other sentences with forms more commonly used to command and permit.

Of special interest here is how commands and permission sentences are future-oriented, as was implicit in the comparison with deontic modal sentences which are also

about the future. It makes sense that commands and permission sentences are about the future, because it is only in the future that an order issued now could be carried out, or permission granted now could be acted upon. This futureness has been noticed in the literature. As Burgess (1978) puts it, "...it is plainly pointless to ask whether an act that has already been performed *is* obligatory, permissible, or forbidden..." Enç (1996) also notes the futurity of both imperatives and deontics, comparing the following sentences in which what is demanded in each case is in the future.

(344) Do fifty push-ups.

(345) You must do fifty push-ups.²⁷

Enç explains this in terms of pragmatics, which "dictates that what is demanded is that some situation hold in the future."²⁸

The futureness of commands and permission sentences makes it tempting to treat them in a parallel fashion with deontic modal sentences. I shall argue that this is a mistake, and that modal sentences are unlike imperatives in that a modal sentence has a truth value. Imperatives, along with performative commands and permission sentences, have felicity conditions but are not true or false. This difference will help to explain how the force of an imperative depends on the personal authority of the speaker, whereas a universal deontic is just a claim about what is morally entailed. An account will be given which attempts to capture the close relation between commands and permission sentences on the one hand and deontic modal sentences on the other.

In this account, the futureness of an imperative is the result of an interaction between

²⁷ Enç (1996), p. 349.

²⁸ Enç (1996), p. 349.

the disparity principle and a modal base containing branching worlds. Burgess's statement implies that we can only talk about future actions as obligatory, permissible, or forbidden. The obligatory, the permissible, and the forbidden are the province of the ordering source, and we can understand the statement to mean that any ordering source concerned with the obligatory, the permissible, or the forbidden can only be used sensibly to order branching worlds, with the result that the act in question will be future with respect to the time of branching. In my account, the ordering source helps determine the truth or falsity of a deontic modal sentence, whereas an imperative is used in a speech-act which actually changes the content of the ordering source. That is why a properly used imperative or other relevant performative changes the truth values of related deontic sentences.

We will start with Lewis's (1979) game which is intended to model social interactions between people of different ranks and in this way clarify the nature of commands and permission statements. Lewis's game is played between three players, a Master, a Slave, and a Kibitzer. The game involves a set of declarative sentences. The rules of the games state that an exclamation point prefixed to any declarative sentence makes a command, and an upside-down exclamation point prefixed to any declarative sentence makes a permission sentence.

Two sets of possible worlds are relevant to the Lewis game, each set represented as a sphere. The sphere of accessibility for a world w at a time t is the set of worlds that has the same history as w at t , a set which includes w itself. As time passes, the sphere of accessibility contracts, and the contraction is irreversible. A second set of worlds in Lewis's analysis is the sphere of permissibility. The sphere of permissibility for a world w at a time t is a subset of the sphere of accessibility at w at t .

The spheres enter into the truth conditions for imperatives and permission sentences. An imperative of the form $!\phi$ is true at w at t just in case ϕ is true at t at every permissible world at w at t . A permission sentence of the form $;\phi$ is true at w at t just in case ϕ is true at t at some permissible world at w at t . The sphere of permissibility expands or contracts according to the commands and permission sentences the master utters. Consider the command $!\phi$ uttered at w at t in a case where the sphere of permissibility contains worlds in which ϕ is not true. The sphere of permissibility shrinks to eliminate such worlds. Consider the permission sentence $;\psi$ uttered at w at t in a case where the sphere of permissibility contains no worlds in which ψ is true. The sphere of permissibility is expanded to include at least one world. The role of the Slave is to make sure that the actual world is always within the sphere of permissibility. Here is what Lewis says about the job of the Slave.

If the Slave knows, at time t , that he acts in a certain way at t throughout the worlds that are permissible and accessible at t – for instance, if he knows that at all such worlds he begins a certain task at t – then he tries to act in that way at the actual world.²⁹

In Lewis's game, a command has the possible effect of shrinking the sphere of permissibility. To bring about this shrinking, Lewis suggests that the proposition associated with the core sentence within the command is intersected with the original sphere of permissibility. Suppose a command $!\phi$ is uttered at t . The proposition $[\phi \text{ at } t]$ is then intersected with P , the sphere of permissibility. If ϕ at t is not true in every world in P , the result of this intersection will be to shrink P .

Lewis points out that the opposite treatment of permission sentences brings about a

²⁹ Lewis (1979), p. 164.

problem. Suppose $\neg\phi$ is uttered at t . Suppose ϕ is not true at t in any world in P , so $\llbracket\phi \text{ at } t\rrbracket$ is unioned with P . The problem is this. Should all worlds in $\llbracket\phi \text{ at } t\rrbracket$ be added to P ? The Slave is compelled, by his actions, to try to keep the actual world in P . But if all of $\llbracket\phi \text{ at } t\rrbracket$ is added to P , the Slave has too much leeway. There are worlds in $\llbracket\phi \text{ at } t\rrbracket$ where the Slave does anything at all, as long as he does ϕ . The problem is how to keep this unwanted worlds out of the sphere of permissibility when it is expanded by a permission sentence.

One peculiar consequence of the Lewis game is that the same command or permission sentence can be said by any player in the game to any other player in the game. To use Lewis's own example, the command 'The Slave carries rocks all day' can be said by any player to any other player. This is the result of the command having a truth value. It is true just in case in all permissible worlds, the Slave carries the rocks all day. Only when the Master utters the command to the Slave, could there be a change in the sphere of permissibility, required to make a true sentence. But the command could be truly uttered by anyone else as long as the sphere of permissibility already contains only worlds in which the Slave carries rocks all day. In this feature of the game, the real-life nature of imperatives and commands is not captured. Consider the following imperative.

(346) Carry the rocks all day long.

The Master could say (346) to the Slave, to tell the Slave to carry rocks all day long. The Slave could not report the requirement to the Kibitzer or back to the Master in this same form. Neither could the Kibitzer use this form to report the command. The Lewis command appears to be like a deontic statement. Suppose the Master said (347) to the Slave.

(347) You must carry rocks all day long.

With minor changes, including a change in the grammatical subject, either the Slave or the

Kibitzer could make a report of the requirement using a sentence of the same form, as in the following examples

(348) I must carry rocks all day long.

(349) The Slave must carry rocks all day long.

Deontic sentences can be used in this way because they have truth values and they do not depend on the authority of the speaker with respect to the addressee.

Not only is the claim that commands and permission-granting sentences have truth values unusual, the temporal details in Lewis's game are not quite right. Suppose at w at t , the Master utters '!(John) eat the sandwich'. The sentence 'John eats the sandwich' is either true at t in every permission world, or the set of permission worlds is shrunk to make it so. It seems that it would be more realistic if the time of the sentence were future with respect to t . One way to ensure that might be to add a future marker, but that seems to miss the point that the action has to be future because of what commands are about. I will claim below that the disparity principle will give us the temporal interpretation that we want.

I now want to give an analysis of commands and permission granting sentences that keeps the workable elements in Lewis's game, but has fewer problems. My first point is that deontic modal sentences have truth conditions, but imperatives should not, and neither should performatives for commanding and permitting. We start the analysis by looking at imperatives.

Consider (350), with a partial LF given in (351).

(350) Eat the sandwich.

(351) [_{CP} Op [_{TP} PRO_{addressee} eat the sandwich]]

The syntax contains a null pronoun PRO_{addressee} in the subject position. Binding theory

suggests that an imperative contains such a pronoun, on the strength of sentences like the following.

(352) Clean up the mess yourself.

(353) Clean up the mess yourselves.

(354) *Clean up the mess you.

First, let me comment on the syntactic assumptions underlying (351). *yourself* is an anaphor which must be bound within its governing category, here presumably the TP. The person features on the anaphor show that the antecedent must be second person, singular or plural. *you* is a second-person pronoun, singular or plural. It cannot be bound within its governing category. That (354) is ungrammatical is further evidence of a null pronoun in subject position in imperatives whose referent is required to be the addressee or addressees. I also put a null imperative operator in the Spec of CP, under the assumption that the contents of CP contribute to the mood of the sentence.

Now I want to make something of the fact that imperatives have force or not depending on, among other things, the relation between the speaker and the addressee, and the nature of the commanded action. In particular, the speaker should have authority over the addressee, with respect to the nature of the action. A mother can tell a child to clean her room. An employer can tell an employee to write a report. However, there are limits. An employer hasn't the authority to command an employee to commit an immoral act, or, it would seem, to perform a physically impossible action. We are reminded of performatives in Austin's discussion, the force of which depends in part on the relevant authority of the speaker. Consider the following.

(355) I now pronounce you husband and wife.

(356) I baptize this baby 'John'.

There is no sensible question of whether these sentences are true or false. There is a sensible question as to whether the speaker has the authority, and whether the time and location is appropriate, and so on. If these felicity conditions are met, then there are real world effects. The effect in (355) is that two people become married, and in (356) that a baby becomes recognized as having the name 'John'.

In the case of imperatives, if the speaker has the proper authority with respect to the addressee and the required action, what would the real world effects be? The effects may include certain actions on the part of the addressee, but there is a more interesting result. Certain deontic sentences suddenly become true or false. Consider the following.

- (357) A: I have to clean my room.
 B: Why?
 A: My mother told me to.
 B: She did? What did she say exactly?
 A: She said, "Clean your room."

(358) We may have some cold pizza. Mary told us to go ahead.

In (357), because the mother issued a command to clean the room, a universal deontic sentence suddenly became true. In (358), the utterance of a permission-granting imperative has brought about the truth of an existential deontic sentence.

My theory is that when uttered under proper conditions, an imperative adds a proposition or propositions to D, where P+D is the value of the deontic ordering source function for a world and a time. The denotation of the imperative is the union of a set of appropriate disparity facts with respect to the speech time broomstick. This is not to say that

the denotation of the imperative is the very proposition that is added to D, but this condition being met along with other necessary conditions results in the addition of certain propositions to D. Because the contents of D are affected, certain modal sentences take on new truth values as a result of the utterance of an imperative.

Consider (350) again, with the partial in (351), both repeated here.

(350) Eat the sandwich.

(351) $[_{CP} \text{Op} [_{TP} \text{PRO}_{\text{addressee}} \text{eat the sandwich}]]$

Suppose the TP in (351) is translated as in (359).

(359) $\lambda t_0 \lambda w_0 [\text{eat-the-sandwich}'_{w_0, t_0, t'}(\text{you})]$

The translation contains a variable t' to be filled in with a contextually suitable frame time.

I posit that the imperative sentence (350) contains a *contributing element* to the deontic component of the ordering source f_D . A contributing element is a proposition formed in a particular way, and affecting f_D in a particular way. The contributing element for (351) is spelled out in the following. How it might affect f_D will be considered below.

(360) The contributing element of (351) is the set S formed by the union of every proposition p such that for some t, $p = \llbracket \lambda t \lambda w [\text{eat-the-sandwich}'_{w, t, t'}(\text{you})] \rrbracket_g(t)$ is a disparity fact with respect to the speech-time broomstick.

The proposition S is also a disparity fact with respect to the speech-time broomstick. We require as before that any value t must be a sub-interval of the frame time that is the value for t' . Notice there is no question of the denotation having a truth value because no claim is made as to whether the actual world, or any proxy of the actual world, belongs to this proposition or not. But how does the contributing element affect f_D ? We want the contribution to affect f_D in a non-permissive direction, making D less permissive. For our

purposes at present, we can simply assume this means the proposition is added to D.

The general rule for a denotation of an imperative is given as follows.

- (361) An imperative sentence ϕ of the form $[_{CP} \text{Op } \psi]$, where ψ is a TP of the form $[_{TP} \text{PRO}_{\text{addressee}} \delta]$ for some VP δ , uttered at a world w at a time t , makes as its contributing element to f_D the set S formed by the union of every proposition p such that for some time t' , $p = \llbracket \psi \rrbracket_g(t')$ is a disparity fact with respect to the t -broomstick containing w .

With proper conditions met, the utterance of an imperative results in the addition of certain propositions to particular values of f_D . For now we are assuming that the contributing element is simply added to these values. This addition changes the truth value of certain modal sentences. We now have an explanation of why the utterance of an imperative sentence may affect the behavior of the addressee, the Slave in Lewis's game. Let us return to our example. Suppose that (350) is uttered under suitable conditions to make the following sentence true, where John is the addressee of the sentence.

- (362) John must eat the sandwich.

Deontic *must* is interpreted with respect to the ordering source P+D. We have seen that *must* entails *will*. Therefore, if (362) is true, (363) is also true.

- (363) John will eat the sandwich.

It is not a question of John trying to act in a way to make the actual world fall into the sphere of permissibility. Rather, adequately close worlds with respect to P+D+S are all adequately close with respect to P+D, so John's behavior is forced, given that the speaker has the proper authority.

Let us now consider permission sentences. As discussed, permission often takes the

form of an imperative, but this is for politeness reasons, I have claimed. It is also the case that permission is often communicated with a deontic existential sentence. Sentences of this form can both grant permission and report the results of permission granted. Consider the following.

(364) You can have all the left-overs. (We have decided.)

By uttering (364), the speaker may be communicating that a decision has been reached to grant the permission, and this communication is apparently often the means of granting the permission. This is unlike the case of commands, for which there is a designated syntactic structure – the imperative sentence – that serves to make the command. My view is that when sentences like (364) are used to grant permission, they do so by presupposition. The sentence communicates that permission has been granted without actually granting it. Granting it here would mean affecting the ordering source f_D in such a way that the set of adequately close D-worlds expanded. But communicating that permission has been granted actually serves to grant it, and the set of adequately close D-worlds is expanded.

One way to avoid this complication might be to speak about performative permission-granting sentences, such as (365).

(365) I permit you to take tomorrow off.

This involves analyzing the syntax of such performatives, which would take us too far afield. Instead I will associate an expression in our translation language with the performative, without claiming that the expression is actually a translation of any part of the sentence. I am after a parallel treatment between commands and permission-granting sentences, after all. For (365), the associated translation language sentence is (366).

(366) $\lambda t_0 \lambda w_0 [\text{take-tomorrow-off}_{w_0, t_0, t'}(\text{you})]$

(365) is a permission-granting sentence, rather than a command. Consequently, it should make a contribution in a permissive direction.

(367) The contributing element of (366) is the set S formed by the union of every proposition p such that for some t , $p = \llbracket \lambda t \lambda w [\text{take-tomorrow-off}_{w,t,t'}(\text{you})] \rrbracket_g(t)$ is a disparity fact with respect to the speech-time broomstick.

If the appropriate conditions of authority of the speaker, etc., are met, the utterance of the sentence will have an effect on f_D , the deontic ordering source. The propositions which are in the value of the deontic ordering source for a world and a time are added to the propositions in the value of the potential ordering source for the same world and time. The effect of f_D will somehow involve these propositions.

Suppose prior to the utterance of (365) by Mary to John, (368) is true.

(368) John may not pick any flowers.

A result we don't want is that the utterance of (365) to make (368) false. This is Lewis's problem with permission. By adding worlds in which John takes tomorrow off to the set of adequately close D-worlds (or P+D-worlds), we would inadvertently add worlds in which John picks flowers too, rendering (368) false.

Lewis considers the simple idea that a permission sentence brings about the striking off of a reverse command that is in the history of commands made by the Master to the Slave. If there previously had been a command by the Master, '!You work tomorrow', that might be sufficient in this case. Any command not to pick the flowers would remain unaffected. However, suppose the previous command had been '!You work every day this week'. The permission sentence cannot strike off this command without allowing John to take the day after tomorrow off, but we know he didn't get permission to do that.

In our account, the permission granting sentence affects f_D by making a contribution to f_D in the permissive direction. Clearly, in some simple-minded way, we want the contributing element to remove its complement from the value of f_D . If it did remove its complement, worlds in which John takes tomorrow off would tie with worlds in which he doesn't take tomorrow off. But worlds in which he picks the flowers would still do worse than worlds in which he doesn't pick the flowers, so the truth value of (368) would be unaffected.

We can't be sure that this will work. Suppose previously, Mary said (369) to John.

(369) John, be at work every day this week from 9 to 5.

The contributing element of (369) is the proposition that John works every day this week from 9 to 5. This is the set of worlds in which John works every day this week from 9 to 5. Suppose this set of worlds is simply added to D . Now Mary utters (365). The contributing element here is the set of worlds in which John takes off tomorrow. We want the contributing element to strike out its complement. But even if it strikes out its complement, the proposition that John works every day this week is unaffected. And we don't want (365) to strike out that proposition or we would end up allowing John to take off the day after tomorrow as well, and permission for that has not been granted.

f_D has as its values different propositions but which ones, we cannot exactly say. The contributing element of a command affects f_D in a certain way, but the effect is not simply that the contributing element is added to the value of f_D for a world and a time. Certain propositions are added that would appear to correspond roughly speaking to atomic facts. These would be propositions entailed by the contribution. The contributing elements of a permission sentence affect f_D in a certain way too. The effect is not that the complement of

any such contribution is simply removed from the value of f_D at a world and a time. Rather, certain elements are removed from the value of f_D for a world and a time that are complements of propositions that correspond roughly speaking to atomic facts. These would be the propositions entailed by the contribution.

In the present case, f_D at w and t does not contain the set of worlds in which John works every day this week. To get the idea, let us say that the set of propositions contains instead a set of worlds in which John works Monday of this week, a set of worlds in which John works Tuesday of this week, and so on. The contribution of Mary's permission sentence is the set of worlds in which John does not work Tuesday of this week. The effect of this contribution is to remove the set of worlds in which John works Tuesday of this week. What has happened to the set of adequately close D-worlds? Previously, these were only worlds in which John worked on Tuesday. Now, otherwise similar worlds in which John works on Tuesday are tied with worlds in which he does not work on Tuesday. The result is that instead whereas previously (370) was true, (371) is now true.

(370) John must work on Tuesday.

(371) John may take Tuesday off.

The ordering source is a black box. We can see its effects, but we cannot say for sure what propositions are in the sets it yields as values for particular arguments. Certainly, the set of worlds in which John works on Tuesday is not a proposition that corresponds to an atomic fact. That example is only offered to illustrate the proposal. The ordering source, being a function, is a mathematical object, but it is restricted in various ways. Many ordering sources could have the same effect as far as ordering worlds, but, having different sets of propositions as their values, they are subject to modification in different ways.

The basic point is made by Kratzer in her (1981) analysis of counterfactuals, with respect to totally realistic modal bases. Suppose we have two functions f_1 and f_2 such that for any world w , $\bigcap f_1(w) = \{w\}$ and $\bigcap f_2(w) = \{w\}$. It is not required that for any argument, f_1 and f_2 yield the same set of propositions. $f_1(w)$ might include p and q , whereas $f_2(w)$ might include $p \cap q$. But not all functions f_n such that for any w , $\bigcap f_n(w) = \{w\}$ are cognitively viable. It might be the case that for any w , $\bigcap f_3(w) = \{w\}$, yet $f_3(w)$ contains propositions that are of an unwanted sort.

For the theory to work here, we need f_D to be a function such that for any arguments w and t , $f_D(w,t)$ is a set of propositions that represent the facts in just the right way. These propositions are subject to being struck out in response to appropriate utterances of permission sentences.

It was mentioned above that authority is not absolute. No one's authority can override physical necessities. That is why imperatives such as the following have no force.

(372) Flap your arms and fly.

Here, the contributing element is that the addressee flaps her wings and flies. This contributing element results in appropriate propositions being added to D . Such proposition will conflict with certain P -propositions and will lose the competition. The authority of the speaker is some kind of moral authority. There are no doubt certain D -propositions that can be overridden, and others that cannot be, depending on the moral authority the speaker has over the addressee and depending on the nature of the command. I will not try to pull apart all such issues here.

The requirement that the contribution of a command or a permission sentence denote a disparity fact with respect to the speech-time broomstick means that these sentences are not

strictly speaking future. These sentences should have the same odd ability to straddle the present, just as modal sentences did. Here, the issue is not whether they can be truly spoken about ongoing events, but whether they can be felicitously uttered about ongoing events. The results are familiar.

If John is already washing the car, the following sentences are inappropriate.

(373) John will wash the car.

(374) John, wash the car.

If John is already cleaning the house, however, neither of the following sentences is strange.

(375) John will clean the entire house today.

(376) John, clean the entire house today.

(377) John, I permit you to clean the entire house today.

If John has begun shaking hands with people, neither of the following sentences is strange.

(378) John will shake hands with everybody.

(379) John, shake hands with everybody.

(380) John, I permit you to shake hands with everybody.

6.7 Antactualism and retrospective predictions

In this final section of the chapter, I return to some issues for a view of *will* as a quantifier over possible worlds. The issues involve problems for any theory that treats *will* as such a quantifier, and not just for the theory presented here. The problems such theories face are English sentences that one would not expect to have the properties that they have if *will* is a quantifier over possible worlds.

As mentioned earlier, Burgess (1978) explains that actualists believe the future is open but that we can still talk about the actual world in the future. Antactualists believe the future is open which is why it is impossible to talk about the actual world in the future. Here the interest is not in the philosophical justification for either position, but in whether the language faculty can be seen as operating with one or the other view. The linguistic facts and the philosophical defensibility may not even be related. For example, it could turn out that English operates on non-determinist, antactualist assumptions, but that speakers of English are still free to adopt determinist or actualist assumptions. I am making the strong claim that *will* and other modals are quantifiers over possible worlds, and that their future reading is a consequence of an interaction between the disparity principle and the branching nature of time. Because of this, I need to show that it does not follow from the data given in these arguments given that *will* cannot be a modal.

We begin with the wait-and-see argument. Such an argument could take the following dialogue as its starting point.

(381) A: Lucky Stars will win the race tomorrow.

The next day:

B: You were right. Lucky Stars did win.

In this context, B's response seems perfectly felicitous. A predicts that Lucky Stars will win the race, and since Lucky Stars does win the race, A's prediction is correct. But this dialogue is a problem for the advocate of a modal meaning for *will*. Suppose *will* is a quantifier over possible worlds. It follows that what A has said is that in every world of some set, Lucky Stars wins the (future) race. The race happens and Lucky Stars wins it, in the actual world. Lucky Stars winning in the actual world (or more precisely, in a proxy for the actual world)

does not confirm the truth of A's statement. A's statement is true just in case the horse wins in every one of some set of well-behaved worlds. Suppose the statement is made that everyone is happy, and upon finding out that John is happy, we declare that the original statement is true. Our declaration is simply without grounds. To verify the universal statement, we would have to check every member of the domain. We have to investigate every person, and verify that they are happy, or every world, and verify that the horse won the race in that world. By this analysis, it would be wrong for B to congratulate A for being right in (381). B would lack grounds for her statement. But there is nothing wrong with what B says. It appears to be fully justified.

Now consider the other theory. Suppose that *will* is just a future marker. What A has said is that in the actual world, Lucky Stars wins the race at a future time. Lucky Stars goes on to win the race in the actual world and this confirms A's prediction. B is right to congratulate A for being right. This analysis accords with the observed fact that B's response in (381) is perfectly acceptable and is fully justified.

This piece of linguistic evidence favors the theory that *will* is just a future marker, a theory that might be adopted by the determinist or the actualist. However, the pattern observed in (381) is not limited to this case. With other modals, we get the exact same result, and there is no controversy that these modals are quantifiers over worlds. Consider the following dialogue.

(382) B draws a card face down from the deck.

B: Is this red or black?

A: It must be red.

(The card is turned up and it is red.)

B: You were right. It is red.

Here, A makes a prediction. The card could either be black or red, but A predicts that it is red. The prediction involves the modal *must*. By very conventional theories, *must* is a universal quantifier over worlds, so the *must* statement is true just in case the card is red in all worlds in a suitable domain. Turning the card up shows that it is red in the actual world, but not that it is red in every world in the domain. This again seems like a case where we declare that everybody is happy on the basis of John's being happy. Yet we find that there is nothing odd in B's congratulation of A on making the right guess. B appears to be fully justified in what she says.

For comparison, we can look at a case involving an existential modal. Consider the following dialogue.

(383) B draws a card face down from the deck.

B: Is this red or black?

A: It might be red.

(The card is turned up and it is red.)

B: You're right. It is red.

(384) B draws a card face down from the deck.

B: Is this red or black?

A: It might be black.

(The card is turned up and it is red.)

B: You're wrong. It's red.

For the second of these dialogues, (384), it is open for A to respond, *I only said it might be black*. But it is also possible that B's verdict will pass unchallenged. What is at issue seems

to just be whether the card is red or black, and the modality of the statement is no more than a side issue. For the first of these dialogues, (383), it doesn't seem to me that B's means *you were right that it might be red*. B is only talking about the card being red and the modality of the statement is ignored.

A hint we can extract from these latter two cases is that nobody really is paying attention to the modality of the statements, or the truth conditions of those sentences. There is a kind of game going on, and all that matters is whether you guess red or black. To put it another way, there are certain conventions in play when responding to a guess or a prediction that are not based strictly on the truth conditions of the relevant modal sentence. By of these conventions, it is appropriate to say that someone was right on the basis of what happens in the real world (or a proxy for it). The dialogue in (382) shows these conventions at work, as do the dialogues with existential modals in (383) and (384). But this strongly suggests that similar conventions are at work in (381), conventions that are not tied to the truth conditions of modal sentences, and therefore on the basis of such dialogues we should not draw conclusions about the truth conditions for sentences involving a future interpretation of *will*.

Where we do expect truth conditions to play a role are conjunctions with *and* in which different modals appear in each conjunct. We assume that the truth conditions for the conjunction depend on the truth conditions for each conjunct, and both conjuncts must be true for the conjunction to be true. These cases are quite unlike the prediction–affirmation pairs we looked at above. Semantic rules of function application apply, such as the following rule.

(385) For indices i , $\llbracket \phi \text{ and } \psi \rrbracket_i = 1$ iff $\llbracket \phi \rrbracket_i = 1$ and $\llbracket \psi \rrbracket_i = 1$.

There is no space between the interpretation of the conjuncts and the interpretation of the

conjunction for convention to intervene. Speaker judgments about the truth of the conjunction will depend entirely on their judgments about the truth of each conjunct.

What we find, it sentences that pit a future *will* against a future *must*, strong unacceptability of the sort we expect from a tautology. Consider the following examples.

(386) Lucky Stars might win that race and she might not win it.

(387) #Lucky Stars will win that race and she won't win it.

(388) #Lucky Stars might win that race and she will not win it.

(389) #Lucky Stars might not win that race and she will win it.

In our theory, *might* and *will* are duals. That means they have the same modal base and ordering source, but different quantificational force. *might* is an existential quantifier over worlds, and *will* a universal quantifier. Since these modals have a future interpretation, the modal base gives a set of broomsticks. The ordering source orders the worlds in the broomstick identically for each modal. The judgments given above fall out from this theory. As (386) shows, it is no contradiction to say that in some worlds Lucky Stars wins a race and in other worlds she doesn't. The sentence is a tautology, provided Lucky Stars enters the race. It would be a contradiction, however, to say that in all relevant worlds Lucky Stars wins the race, and in the same relevant worlds, Lucky Stars does not win the race, and indeed, (387) is completely unacceptable. But this sentence would also be unacceptable in a theory that treats *will* as a future marker. It is a straight contradiction.

The cases that separate the theories are (388) and (389). It would be a contradiction to say that in some members of the set of relevant worlds, Lucky Stars wins the race, but in none of the members of this set does she win it. That is exactly what the sentence in (388) says, by the theory of *will* as a universal quantifier, and this sentence is not acceptable. It

would also be a contradiction to say that in some members of the set of relevant worlds Lucky Stars does not win the race but in none of the worlds in this set does she win it. That is exactly what the sentence in (389) says, by the same theory, and this sentence is completely unacceptable too.

What about a theory in which *will* is simply a future marker? Let us look at things from the point of view of the actualist, who allows for branching worlds but says that one of these is designated as the actual world. The actualist can adopt a conventional view of *might*, as an existential quantifier over possible worlds – let's say over the worlds in the broomstick. It seems that neither (388) or (389) should be bad. (388) would say that in some possible worlds in the broomstick, Lucky Stars wins the (future) race but in the actual world, she does not. (389) would say that in some possible worlds in the broomstick, Lucky Stars does not win the race but in the actual world, she does. These predictions are not borne out.

What about the determinist? There are no branches, although perhaps there are other worlds which represent unattainable epistemic possibilities. They are epistemic possibilities, because for all we know they might be the actual world, but they are unattainable because they are not, nor could they be. With such a metaphysics, (388) would say that in some of these epistemic possibilities, Lucky Stars wins the (future) race but in the actual world, she does not. (389) would say that in some of these epistemic possibilities, Lucky Stars does not win the race but in the actual world, she does. The sentences should be fine.

However, it is one thing to be truth-conditionally acceptable and another thing to be pragmatically acceptable. All I have shown is that truth-conditionally, (388) or (389) cannot be ruled out by these theories. Perhaps they involve pragmatic violations. Look at some analogous cases involving the past.

(390) ?John might not be home but he is home.

(391) ?John might be home but he is not.

These are the same sort of cases I ruled out with the disparity principle. Here we are considering a pragmatic account in which (390) is bad because it is misleading to suggest that John might be home if I know that he is, and (391) is bad for the same kind of reason – it is misleading to suggest that John might be home when I know he is not. I have argued that these sentences are actually false. If the speaker knows that John is home, she cannot truly say that he might not be, and so the first conjunct of (390) is false, and so is the whole conjunction. Likewise, if the speaker knows that John is not at home, she cannot truly say that he might be, and so the first conjunct of (391) is false, and so is the whole conjunction. But let us accept the weaker claim that they are misleading. This claim is not based on the truth conditions but rather involves a scalar implicature. If I say the weaker statement, I suggest that I don't know the stronger statement.

Let me first bring up some objections to this account, before I assume – for the sake of argument – that it works. These objections were implicit in my earlier objections to a scalar implicature account. Why wouldn't the pragmatic suggestion of the first conjunct be cancelled by the utterance of the second conjunct? Uttering the first conjunct of (390) suggests I don't know that John is home, but uttering the second conjunct cancels this suggestion. Uttering the first conjunct of (391) suggests I don't know that John is not home, but uttering the second conjunct cancels this suggestion. This cancellation can be seen in sentences such as the following.

(392) Mary worked for eight hours. In fact, she worked for ten.

(393) John has three children. In fact, he has four.

Perhaps the cancellation is assisted by the sentence break and the discourse marker *in fact*.

Let us see what happens to (390) and (391) if these devices are used.

(394) John might not be home. In fact, he is home.

(395) John might be home. In fact, he is not.

I have refrained from putting question marks before these sentences in order not to prejudice the judgments. I don't think either discourse is acceptable, however, without involving a shift in the epistemic context for the speaker. This point was argued earlier.

However, this last paragraph was just to bring forth some points implicit in my earlier position. For now I want to accept that there is a pragmatic violation in (390) and (391) and see if this doesn't carry over to the problematic sentences in (388) and (389). The hinge for such an account is that the speaker knows whether or not John is home, in (390) and (391). This knowledge is what makes for a pragmatic violation. For (388) and (389), this would mean the speaker knows the future outcome of the horse-race. If the speaker does not know the future outcome of Lucky Stars winning the race, the explanation of the unacceptability of the sentences does not go through. I should be able to say (388) if I don't know the future outcome of the race, and if it turns out that Lucky Stars does not win, I will have spoken truly. Equally, I should be able to say (389) if I don't know the future outcome, and if it turns out that Lucky Stars does win, I will have spoken truly. But it is simply not the case that (388) or (389) are ever true.

Okay, the objectors might say, but if you don't know the future outcome of the race, you cannot make the prediction. Making the prediction suggests that you know, and you can't know the outcome of a race. It is misleading to say something you don't know to be true. In fact, there are Gricean maxims (Quality) against saying what you don't have evidence for or

don't believe. Since future events of a certain kind cannot be known, there is a Gricean restriction against making future predictions about these kinds of events.

But this is a misapplication of the Gricean theory. People say things all the time that they don't have evidence for or don't believe. The Gricean maxims are not rules preventing people from saying false things. The maxims are used, according to Grice's theory, to warrant inferences from what people say to what they mean. But even with the misapplication, the suggestion is testable. Since the outcome of a horse-race is never certain, it should be pragmatic violation to predict the outcome of a horse-race. By contrast, we know that all horses die, so it shouldn't involve a pragmatic violation to predict the death of a horse. There is no sense, however, in which one of the following sentences is pragmatically bad and the other is good.

(396) Lucky Stars will win the race tomorrow.

(397) Lucky Stars will die someday.

This pair of sentences underscores the difficulty of the determinists or actualists position. Why do we take (397) to be certain, knowable, but (396) to be uncertain, unknowable? Neither sentence is like their past counterparts, given next.

(398) Lucky Stars won the race yesterday.

(399) Lucky Stars finally died.

These sentences are knowable by direct acquaintance with the events. There is no possibility of direct acquaintance with the events that would make (396) or (397) knowable. We can only believe these latter sentences on the basis more general laws or regularities that we believe. That means there is an ordering source involved in the interpretation of these sentences, an ordering source that tells us to pick certain worlds over others.

Let's review the remarks here. The antactualist pointed to sentences like (388) and (389) that seem to be contradictions and therefore to count against the determinist/actualist. Their response is to say, these are pragmatic violations. But such an argument relies on the knowability of future statements about events such as horse races. If sentences like (388) or (389) are said in ignorance of future outcomes, they should be okay. The determinist/actualist is forced to say, you can't say them if you are ignorant of future outcomes. But that claim is based on the idea that you can't say things you are ignorant of, and we do all the time, without pragmatic violations. Further, the prediction is that you can't make future statements about uncertain events. But you can, and they don't show pragmatic inappropriateness, they just seem to be reckless. This brings us back to the question, why are some future statements certain, and some uncertain? Not because we have acquaintance with some future facts, and lack acquaintance with other future facts. We have acquaintance with no future facts. Some future statements are certain and others are not because of regularities we believe in or not. But that means an ordering source is involved in the interpretation of future sentences after all.

I turn to the next objection against the antactualist view of *will* as a quantifier over possible worlds. This objection was based on sentences such as (400).

(400) Either it will rain tomorrow or it won't.

This sentence appears to be a tautology – there is no way it could be false. But if we take the syntactic structure at face value, we have a disjunction of two modal sentences. That is, the disjunction appears to have scope over the modals. Each disjunct contains the modal *will*, which we have assumed is a quantifier over possible worlds. The first disjunct is true just in case it rains tomorrow in all relevant worlds. The second disjunct contains negation, and I

have shown that this negation is under the modal. The second disjunct is therefore true just in case it rains tomorrow in none of the relevant worlds. The truth of the disjunction depends on the truth of either disjunct. But each disjunct is contingent, so the disjunction itself should be contingent, and not a tautology. The theory conflicts with our intuitions about what the sentence means.

However, there are good reasons for not taking the syntax at face value. We see this by looking at the next modal over, *must*. This modal is uncontroversially a universal quantifier over possible worlds. But when it appears with a disjunction, the modal does not necessarily take scope under the disjunction. Consider the following sentence.

(401) Either John must take out the recycling, or Mary must take out the recycling.

This sentence is appropriate in the following context. Suppose tomorrow the recycling is to be collected, the rules of the apartment are that some tenant must take out the recycling, and John and Mary are the only tenants. But if (401) is appropriate here, it must have a reading in which the modal has scope over the disjunction. That is, each relevant world is either a world in which John takes out the recycling or Mary takes out the recycling. This is the same scopal relation needed to read (400) as a tautology. In each relevant world, it either rains tomorrow, or it doesn't rain tomorrow. That cannot fail to be the case. So whatever theory explains the modal over disjunction reading for (401), a reading the sentence clearly has, will give the tautology reading for (400) at no extra cost.

What about the narrow scope reading for the modal? (401) has such a reading, even though the context is a little harder to construct. Suppose that between John and Mary, it has been fixed that John must take out the recycling. Suppose I know it has been fixed, I know that it is either John or Mary but not both, but I don't remember whose task it is. I can

express what I know as (401). But if (401) has a disjunction over modal reading, why doesn't (400)? The answer is that it does. To see this, take a sentence that does not have a tautologous reading, such as the following.

(402) Either the US will invade Iraq on the 21st or it will on the 31st.

Even if the modal has scope over the disjunction, this sentence is not a tautology. There are other days for the US to invade, and it is even open that the US doesn't invade. But suppose I was at the war planners meeting where the date was decided. They were passing around the Schnapps at the meeting, so the next morning I can't remember if the date was the 21st or the 31st, I just know there was a *first* in it. In this case, I can utter (402). The desired reading is immediately apparent if the expression *but I don't remember which* is amended to the sentence. The modal-under-disjunction reading for this sentence would be appropriate if the planners had narrowed down the starting date to one day or another.

We see that readings of both scope are available for both sentences (401) and (402), with perhaps extra effort required to see the disjunction over modal reading. (400) surely has such a reading too, although it is hard to think of a context when that reading would make any sense: *either it will rain tomorrow or it won't, I don't remember which*. This reading is disfavored because rain is not something to be planned for. What we do see is that the tautologous reading of (400) is only a problem for the *will* as modal theory under certain assumptions about the scope relations in this sentence, and these relations are not invariant, as sentences with *must* and disjunction show.

The final objection to the modal view of *will* considered involves retrospective futures. This argument gets off the ground with the following intuition. If it is now true that there is space travel, then it has always been true that there would be space travel. That

means that *will* is just a future marker because surely if branching worlds were taken into account, there was never a guarantee that the human race would develop to the point where they could manage space travel. Any number of alternative scenarios, such as those involving self-destruction of the entire race, for example, were eminently more plausible. Yet we have the intuition, and that shows that *will* is not a quantifier over worlds or branching worlds.

Notice that this argument hinges on an intuition about *would* and the assumption that intuitions about *would* tell us about the semantics of *will*. That assumption would be less problematic, however, if it weren't for a mismatch between our intuitions about the *would* statement and our intuitions about the corresponding *will* statement. Consider the following sentences to see the mismatch.

(403) Since there is now space travel, there would always be space travel.

(404) Someday, there will be space travel.

I accept the intuition about (403), that it is a true statement, but matters are less clear for (404). The truth of this statement seems somewhat in doubt, especially as we consider it as uttered further and further back in time. If uttered in 1950, it quite likely would have been true. If uttered in 1895, it still might have been true, but you would have had to be H. G. Wells to recognize it as such. But if uttered in 1650, it does not seem that it was true at all, and even less so if uttered 1000 years before the birth of Buddha. We have something of a puzzle if we treat *would* as the past tense of *will*, since our intuitions about the truth of *would* statements in the present do not necessarily jibe with our intuitions about the corresponding *will* statement uttered at different times in the past. The intuition about the *would* statement in the present was given as an objection to the theory of *will* as a modal quantifier over worlds. However, treating *will* as a simple tense marker and *would* as the past form of *will*

does not explain the mismatch in intuitions. As it turns out, I believe that our theory of modals gives us the means in one fell swoop to explain the intuitions about the *would* statements in the present and to explain the differing intuitions about the corresponding *will* statements uttered in the past.

Let's begin with the following sentences.

(405) The following day, a storm would bring down the hundred-year-old elm.

(406) Tomorrow, a storm will bring down the hundred-year-old elm.

On May 31, 2002, a storm brought down a large elm tree near the CMU campus in Pittsburgh. The storm was in the form of a down-draft, an unusually powerful weather system in which a large mass of air is driven straight down towards the earth and having nowhere to do, travels sideways at great velocity and causing destruction in some ways analogous to a tornado but with the damage happening along straight lines and not in vortex patterns. The key point is that the conditions for down-drafts are rare, and are by no means determined in advance. A down-draft is a random event, if ever there was one, let alone the event of a tree being toppled by a down-draft on a particular occasion. Suppose it is June 1, 2002 – after the storm – and we are talking about the day before the storm, May 30, 2002. From our vantage point in the future, the sentence in (405) seems to be true, retrospectively. On May 30 it was true that the next day there would be a down-draft and the elm tree would come down. But suppose instead it is that day, May 30, 2002 – before the storm. On this day, the truth of the sentence in (406) is much less clear. The weather conditions that are to produce the down-draft have not yet formed. Maybe a prediction can be made of some stormy weather, but not of the storm taking this particular form and having this particular effect. The uncertainty is not simply epistemic here. The event that latter was to happen is

not definitely in the cards.

By the theory I have given, (406), when uttered on Mary 30, 2002, is interpreted with respect to a broomstick branching from the speech time, and with respect to a stereotypical ordering source. The ordering source orders the worlds in terms of likelihood of different events. A down-draft is not the most likely event, still less is a down-draft that takes down the elm tree. It makes sense that (406) is not definitely true. The prediction in (407), on the other hand, certainly would have been true.

(407) Tomorrow, there's supposed to be a fierce storm. It could take the form of a tornado, or – who knows – it could even produce a down-draft. If it does, even this tree won't be out of harm's way.

But now consider (405). This sentence seems to be true after the fact, when our point of reference is the day before the storm. If we accept that *would* is the past tense of *will*, we have the *would* sentence interpreted with respect to the same set of branching worlds. Like *will*, *would* involves universal quantification over possible worlds. How could the sentences differ in meaning? They could, if they involved different ordering sources.

Suppose there is a principle in our selection of ordering sources: do the best you can. The day before the storm, the best you can do is a stereotypical ordering source. The day after the storm, you can do better. You can use a retrospective ordering source. A retrospective ordering source uses the course of events as they actually unfolded to order the worlds in the modal base. Any world in which the course of events was identical to the actual course of events up to the time of speech will do better by this ordering source, than any world in which there was deviation. Any world in which the course of events was identical to the actual course of events up to the time of speech is a proxy for the actual world at the time of

speech. We have the same modal base, but the worlds favored by the ordering source are all worlds containing all events that actually happened until now. That is a difference between *would* and *will*. *would* has the advantage of a retrospective ordering source. *would* can pinpoint subsequent events with complete accuracy, as long as they happened before the time of speech. In the case of (405), the down-draft and the destruction of the elm tree happened in the future with respect to the day before yesterday, but in the past with respect to the speech time. The day before yesterday gives a set of branching worlds as the modal base. The retrospective ordering source gives the subset of branching worlds that are all proxies for the actual world at the time of speech. With respect to larger set of worlds, the falling down of the tree is still a disparity fact. It doesn't happen in all of them. With respect to the smaller set of worlds, the falling down of the tree is a certainty. It really happened, so it happened in all adequately close worlds. Here we expect identity with the actual course of events, because our retrospective point of view has raised our standards.

The same explanation carries over to the space travel case. Of course it is true that in the most well-behaved worlds in any past branching, there is eventually space travel. Actual history provides the standard of comparison. But go back to that past branching without the benefit of hindsight. What will happen is anybody's guess, not fixed at all. It doesn't mean the metaphysical structure of the world has changed. It means we are using different words to describe it, and our words – depending on when they are uttered – take advantage of the most up-to-date facts. (403) is true, because of what has transpired. (404) in most cases was probably not true, because anything could still happen.

The original objection said that *would* statements made in the present are true, which is unexpected if *would* is past of *will* and *will* quantifies over possible worlds. The objection

itself couldn't explain why the equivalent *will* sentences didn't always used to be true. We have an explanation within the theory of modals, however, since that theory has three parts – a modal base, an ordering source, and the quantificational force of the modal. *will* and *would* may involve the same modal base and have the same force, but rely on a different ordering source. The ordering source is the best there is, given the vantage point of the speaker, but in general the most up-to-date one is the best.

Chapter 7. The temporal interpretation of conditionals

7.1 Introduction

In the account I have developed so far, I have proposed a theory to explain the temporal interpretation of modal sentences. The theory proposed seeks to account for the temporal interpretation of these sentences not as a result of tense marking but as due to the modality itself. The fundamental idea is that modal sentences are about possibilities, and possibilities are realized in time. Some possibilities can only be realized at future times. Epistemic modality is about possibilities already realized, consistent with what we know to be the case. In this final section, I want to explore how this theory might be extended to the temporal interpretation of conditional sentences. Conditional sentences are also about possibilities, so by the same logic, the temporal interpretation of these sentences should not be due to tense marking but should follow from their modal nature. I will examine two general types of conditionals, epistemics on the one hand, and modal sentences with a future interpretation on the other. The treatment of conditionals here only scratches the surface of the topic. My goal here is to make some preliminary suggestions of how the theory of the temporal interpretation of modals that I have begun to develop could be extended to explain the temporal interpretation of conditional sentences.

7.2 Kratzer's theory of conditionals

A semantics for conditionals is provided by Kratzer (1981a). Kratzer treats a conditional as a modal sentence interpreted with respect to a modified modal base. The modal base is modified by adding the antecedent proposition. If f is the modal base function antecedent, f^+ is the modal base function for the consequent, as defined in Kratzer (1981a).

(408) If f is the modal base and g the ordering source for the first part of the utterance, then f^+ is the modal base and g the ordering source for the second part of the utterance. f^+ is that function from possible worlds to sets of propositions, such that for any world w , $f^+(w) = f(w) \cup \{p\}$.³⁰

The first part of the utterance is the antecedent. The second part of the utterance is the consequent. Suppose that p is the proposition denoted by the antecedent clause. p is interpreted with respect to modal base f and ordering source g . Then p is added to the modal base and the proposition denoted by the consequent clause, q , is evaluated with respect to this modified modal base, $f(w) \cup \{p\}$.

The device of modifying the modal base is meant to capture the hypothetical nature of conditionals. The modal base gives the set of propositions taken as true. It is tentatively modified by adding an additional proposition, p , to it. A modal sentence answers the question, 'what follows from everything that we are treating as true, given a certain kind of well-behavedness of worlds?' The conditional answers the question, 'if p were true, in addition to everything else we are treating as true, what would follow, given a certain kind of well-behavedness of worlds?'

³⁰ Kratzer (1981a) p. 68.

My program is to make the temporal interpretation of modal sentences follow from their modal interpretation. By Kratzer's theory, modal sentences and conditional sentences are closely related. Therefore, the temporal interpretation of conditional sentences should also follow from their conditionalized modal interpretation.

I will look at two kinds of conditional sentences, epistemic conditionals and future conditionals. Epistemic modal sentences takes as their modal base the set of (non-modal) propositions known by the speaker. The interpretation of these sentences is non-future. The idea is that the only non-future facts are knowable, and the set of non-future facts a speaker can know is necessarily incomplete. By starting with one's own knowledge, therefore, one is forced to entertain various possibilities about the past and present. These past and present possibilities bring with them an even greater variety of future possibilities, but the requirement to make first distinctions first forces distinctions to be made between past and present possibilities, if these number more than one. This is much like a book-keeping principle: straighten out lower levels of disorder before moving on to higher levels.

7.3 Epistemic conditionals

I take up the idea that a conditional sentence is a special kind of modal sentence. To understand epistemic conditionals, we should begin by looking at epistemic modal sentences. Epistemic modal sentences are constrained to be about propositions that are not known to be true by the speaker and not known to be false. For example, for a felicitous utterance of (409), the speaker should not know that John is inside and should not know that John is not inside.

(409) John must be inside.

I have assumed that this constraint is the sign of a more general interpretive principle that is

also at work in modal sentences with a future interpretation, and is part of the reason that these sentences have a future interpretation. I called the general interpretive principle the *disparity principle*. The disparity principle makes it part of the truth conditions of the modal that the propositions that close-enough worlds are asserted to be part of must be propositions that are true in some but not all worlds of the modal base set associated with the modal of that occasion of use. If the modal base set is the set of worlds consistent with what a speaker knows, the disparity principle ensures that these propositions are not known by the speaker but also not ruled out by what the speaker knows either. An additional requirement was that these propositions make first distinctions first with respect to the modal base. In the case of a (present) epistemic, only the speech time results in a proposition that makes first distinctions first with respect to the modal base because only such a proposition distinguishes between t-broomsticks for t, the time of utterance.

Conditional sentences in English show the same alternation between epistemics and sentences with a future interpretation. This alternation can first be seen in the interpretation of antecedent clauses. The antecedent of a conditional is about a fact not definitely known to hold by the speaker (and not ruled out either), or it is about a fact future with respect to the time of utterance.

That the antecedent of a conditional cannot be about a fact known by the speaker has been mentioned in the literature. Kratzer (1979) observes that the utterance of a conditional *if p, then q* is felicitous in *w* only if both the antecedent and its negation are compatible with common knowledge in *w*.³¹

³¹ Kratzer 1979, p. 135.

Kratzer notes that Stalnaker (1975) gives a similar rule.

It is appropriate to make an indicative conditional statement or supposition only in a context which is compatible with the antecedent.³²

If the context is compatible with the antecedent, there is at least one world in the context contained in the proposition denoted by the antecedent clause. Stalnaker's rule is not quite as strong as we want. We want at least one world in the context to be contained in the antecedent proposition, but we don't want all of them to be.

John Bigelow (1976), also mentioned in Kratzer (1979), has the following rule.

We may stipulate that the sphere of resonance must always be chosen to be at least large enough to include some worlds in which the antecedent is false.³³

Presumably, the antecedent must also be true in some worlds in the sphere of resonance, i.e. the modal base set. That means the antecedent must be true in some worlds and false in others in the modal base set.

Let's turn to some details of the interpretation of an epistemic conditional. Consider the epistemic conditional in.

(410) If the porch light was on, John must have been awake.

The morphology of the antecedent suggests that under the complementiser *if* we have a full tense phrase. That is, we have both tense and agreement on the *be* auxiliary. (The same assumption may not be warranted for future conditionals, as we will see below.) Let's adopt the following syntactic analysis for this sentence.

³² Cited in Kratzer 1979, p. 135.

³³ Cited in Kratzer 1979, p. 135, from Bigelow, John (1976). *If-then Meets the Possible Worlds*. In, *Philosophia*, vol. 2.

(411) $[_{CP} [_{CP} \text{if}_1 [_{TP} \text{PAST} [_{VP} \text{the porch light be on}]]] [_{CP} \text{PRES} [_{MP} \text{must} [_{AspP} \text{have} [_{VP} \text{John be awake}]]]]]]]$

The *if*-clause is a CP adjoined to the matrix CP.

I will assume that different *if*-clauses are associated with different lexical items if_n .

In this case, the *if*-clause contains a full TP, so I assume that this *if* translates as an expression that denotes a function from propositions to functions from propositions to propositions. I will call this lexical item if_1 . The translation for if_1 is given below.

(412) $if_1 \Rightarrow \lambda P \lambda Q \lambda w_0 [if'(P, Q(w_0))]$ $\langle\langle s, t \rangle, \langle\langle s, t \rangle, \langle s, t \rangle \rangle\rangle$

A translation for the sentence is derived as follows.

(413) <u>translation</u>	<u>type</u>
1. $[_{VP} \text{John be awake}] \Rightarrow \lambda t_0 \lambda w_0 [\text{awake}'_{w_0, t_0}(j)]$	$\langle i, \langle s, t \rangle \rangle$
2. $\text{have} \Rightarrow \lambda Q \lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ Q(w_0)(t')]$	$\langle\langle i, \langle s, t \rangle \rangle, \langle i, \langle s, t \rangle \rangle\rangle$
3. $[_{AspP} \text{have} [_{VP} \text{John be awake}]] \Rightarrow \lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ \text{awake}'_{w_0, t_1}(j)]$	$\langle i, \langle s, t \rangle \rangle$
4. $\text{must} \Rightarrow \lambda Q \lambda t_0 \lambda w_0 [\text{must}'_{w_0, t_0}(Q)]$	$\langle\langle i, \langle s, t \rangle \rangle, \langle i, \langle s, t \rangle \rangle\rangle$
5. $[_{MP} \text{must} [_{AspP} \text{have} [_{VP} \text{John be awake}]]] \Rightarrow$ $\lambda t_0 \lambda w_0 [\text{must}'_{w_0, t_0}(\lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ \text{awake}'_{w_0, t_1}(j)])]$	$\langle i, \langle s, t \rangle \rangle$
6. $\text{PRES} \Rightarrow \lambda Q [Q(t_0)]$	$\langle\langle i, \langle s, t \rangle \rangle, \langle s, t \rangle \rangle$
7. $[_{CP} \text{PRES} [_{MP} \text{must} [_{AspP} \text{have} [_{VP} \text{John be awake}]]]] \Rightarrow$ $\lambda w_0 [\text{must}'_{w_0, t_0}(\lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ \text{awake}'_{w_0, t_1}(j)])]$	$\langle s, t \rangle$
8. $[_{VP} \text{the porch light be on}] \Rightarrow \lambda t_0 \lambda w_0 [\text{on}'_{w_0, t_0}(\text{the-porch-light}')]]$	$\langle i, \langle s, t \rangle \rangle$
9. $\text{PAST} \Rightarrow \lambda Q \lambda w_0 [t' < t_0 \ \& \ Q(w_0)(t')]$	$\langle\langle i, \langle s, t \rangle \rangle, \langle s, t \rangle \rangle$

10. $[_{TP} \text{PAST } [_{VP} \text{ the porch light be on }]] \Rightarrow$
 $\lambda w_0[t' < t_0 \ \& \ \text{on}'_{w_0,t'}(\text{the-porch-light}')] \quad \langle s,t \rangle$
11. $\text{if}_1 \Rightarrow \lambda P \lambda Q \lambda w_0[\text{if}'(P,Q(w_0))]$ $\langle \langle s,t \rangle, \langle \langle s,t \rangle, \langle s,t \rangle \rangle$
12. $[_{CP} \text{if}_1 [_{TP} \text{PAST } [_{VP} \text{ the porch light be on }]]] \Rightarrow$
 $\lambda Q \lambda w_0[\text{if}'(\lambda w_0[t' < t_0 \ \& \ \text{on}'_{w_0,t'}(\text{the-porch-light}')] , Q(w_0))]$ $\langle \langle s,t \rangle, \langle s,t \rangle \rangle$
13. $[_{CP} [_{CP} \text{if}_1 [_{TP} \text{PAST } [_{VP} \text{ the porch light be on }]]]] \Rightarrow$
 $[_{CP} \text{PRES } [_{MP} \text{must } [_{Aspp} \text{have } [_{VP} \text{John be awake}]]]]] \Rightarrow$
 $\lambda w_0[\text{if}'(\lambda w_0[t' < t_0 \ \& \ \text{on}'_{w_0,t'}(\text{the-porch-light}')] , \text{must}'_{w_0,t_0}(\lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ \text{awake}'_{w_0,t_1}(j)])]$ $\langle s,t \rangle$

The complete translation is as follows.

$$(414) \ \lambda w_0[\text{if}'(\lambda w_0[t' < t_0 \ \& \ \text{on}'_{w_0,t'}(\text{the-porch-light}')] , \text{must}'_{w_0,t_0}(\lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ \text{awake}'_{w_0,t_1}(j)])]$$

I want to make disparity part of the interpretation of the antecedent. That is reflected in the following truth conditions for (414).

$$(415) \ \text{Given an assignment function } g, \text{ a modal base function } f, \text{ and an ordering source function } f', \text{ for a world } w \text{ and a time } t, \llbracket \lambda w_0[\text{if}'(\lambda w_0[t' < t_0 \ \& \ \text{on}'_{w_0,t'}(\text{the-porch-light}')] , \text{must}'_{w_0,t_0}(\lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ \text{awake}'_{w_0,t_1}(j)])] \rrbracket_{g,f,f'}(w) = 1 \text{ iff}$$

$$\llbracket \lambda w_0[t' < t_0 \ \& \ \text{on}'_{w_0,t'}(\text{the-porch-light}')] \rrbracket_{g,f,f'}$$

is a disparity fact which makes first distinctions first with respect to $\cap f(w,t)$ and, where $f^+(w,t) = f(w,t) \cup \llbracket \lambda w_0[t' < t_0 \ \& \ \text{on}'_{w_0,t'}(\text{the-porch-light}')] \rrbracket_{g,f,f'}$ and $g^+ = g[w_0/w]$,

$$\llbracket \text{must}'_{w_0,t_0}(\lambda t_0 \lambda w_0 \exists t' [t' < t_0 \ \& \ \text{awake}'_{w_0,t_1}(j)]) \rrbracket_{g^+,f^+,f'} = 1.$$

The disparity principle as part of these truth conditions guarantees that the antecedent of this conditional is associated with a proposition not known by the speaker. The disparity principle

as part of the truth conditions of the modal guarantees that the consequent is associated with a proposition not known by the speaker.

7.4 Future conditionals

I propose that the disparity principle is at work in the interpretation of antecedent clauses of future conditionals as well as of epistemic conditionals. Given an epistemic modal base, the disparity principle ensures that an epistemic antecedent can only denote a proposition that is neither known to be true or false by the speaker. (I also assume that the epistemic antecedent must make first distinctions first with respect to the modal base set.) An antecedent associated with a totally realistic modal base can only denote a proposition that is a disparity fact with respect to a set of branching worlds, that is, a proposition future with respect to the time of branching.

The morphology of the *if*-clause for future conditionals suggests that these clauses do not contain a full tense phrase.

(416) If Mary leaves, John will go home.

On the other hand, we do have agreement, as we see by comparison with the following sentence.

(417) If you leave, John will go home.

I will assume that these *if*-clauses contain the lexical item if_2 which selects an agreement phrase that has no semantic contribution to make. The syntactic structure for (416) is as in (418).

(418) $[_{CP} [_{CP} if_2 [_{Agr} [_{VP} Mary leaves]]]] [_{CP} PRES [_{MP} will [_{VP} John go home]]]]$

I assume that if_2 translates into an expression that denotes a function from functions from times to propositions to functions from propositions to propositions. The translation for if_2

is as follows.

$$(419) \quad \text{if}_2 \Rightarrow \lambda P \lambda Q \lambda w_0 [\text{if}'(P, Q(w_0))] \quad \langle \langle i, \langle s, t \rangle \rangle, \langle \langle s, t \rangle, \langle s, t \rangle \rangle \rangle$$

Given this translation rule, a translation for (418) is derived as follows.

(420) <u>translation</u>	_____ <u>type</u>
1. $[_{VP} \text{John go home}] \Rightarrow \lambda t_0 \lambda w_0 [\text{go-home}'_{w_0, t_0}(j)]$	$\langle i, \langle s, t \rangle \rangle$
2. $\text{will} \Rightarrow \lambda Q \lambda t_0 \lambda w_0 [\text{will}'_{w_0, t_0}(Q)]$	$\langle \langle i, \langle s, t \rangle \rangle, \langle i, \langle s, t \rangle \rangle \rangle$
3. $[_{MP} \text{will } [_{VP} \text{John go home}]] \Rightarrow$ $\lambda t_0 \lambda w_0 [\text{will}'_{w_0, t_0}(\lambda t_0 \lambda w_0 [\text{go-home}'_{w_0, t_0}(j)])]$	$\langle i, \langle s, t \rangle \rangle$
4. $\text{PRES} \Rightarrow \lambda Q [Q(t_0)]$	$\langle \langle i, \langle s, t \rangle \rangle, \langle s, t \rangle \rangle$
5. $[_{CP} \text{PRES } [_{MP} \text{will } [_{VP} \text{John go home}]]] \Rightarrow$ $\lambda w_0 [\text{will}'_{w_0, t_0}(\lambda t_0 \lambda w_0 [\text{go-home}'_{w_0, t_0}(j)])]$	$\langle s, t \rangle$
6. $[_{Agr} [_{VP} \text{Mary leaves }]] \Rightarrow \lambda t_0 \lambda w_0 [\text{leave}'_{w_0, t_0}(m)]$	$\langle i, \langle s, t \rangle \rangle$
7. $\text{if}_2 \Rightarrow \lambda P \lambda Q \lambda w_0 [\text{if}'(P, Q(w_0))]$	$\langle \langle i, \langle s, t \rangle \rangle, \langle \langle s, t \rangle, \langle s, t \rangle \rangle \rangle$
8. $[_{CP} \text{if}_2 [_{Agr} [_{VP} \text{Mary leaves }]]] \Rightarrow$ $\lambda Q \lambda w_0 [\text{if}'(\lambda t_0 \lambda w_0 [\text{leave}'_{w_0, t_0}(m)], Q(w_0))]$	$\langle \langle s, t \rangle, \langle s, t \rangle \rangle$
9. $[_{CP} [_{CP} \text{if}_2 [_{Agr} [_{VP} \text{Mary leaves }]]] [_{CP} \text{PRES } [_{MP} \text{will } [_{VP} \text{John go home}]]]]$ $\Rightarrow \lambda w_0 [\text{if}'(\lambda t_0 \lambda w_0 [\text{leave}'_{w_0, t_0}(m)], \text{will}'_{w_0, t_0}(\lambda t_0 \lambda w_0 [\text{go-home}'_{w_0, t_0}(j)]))]$	$\langle s, t \rangle$

The disparity principle as it applies to the antecedent is incorporated into the following truth conditions.

(421) Given an assignment function g , a modal base function f , and an ordering source function f' , for a world w and a time t $\llbracket \lambda w_0 [\text{if}'(\lambda t_0 \lambda w_0 [\text{leave}'_{w_0, t_0}(m)], \text{will}'_{w_0, t_0}(\lambda t_0 \lambda w_0 [\text{go-home}'_{w_0, t_0}(j)])) \rrbracket_{g, f, f'}(w) = 1$ iff

for any time t' such that $\llbracket \lambda t_0 \lambda w_0 [\text{leave}'_{w_0, t_0}(m)] \rrbracket_{g, f, f'}(t')$ is a disparity fact with respect

to $\cap f(w,t)$ and, where $f^+(w,t) = f(w,t) \cup \llbracket \lambda t_0 \lambda w_0 [\text{leave}'_{w_0,t_0}(m)] \rrbracket_{g',f',f}(t')$ and $g' = g[w_0/w]$,

$\llbracket \text{will}'_{w_0,t_0}(\lambda t_0 \lambda w_0 [\text{go-home}'_{w_0,t_0}(j)]) \rrbracket_{g',f',f} = 1$.

The disparity principle as part of these truth conditions guarantees that the antecedent of this conditional gets a future interpretation. The disparity principle as part of the truth conditions for the modal guarantees that the consequent gets a future interpretation.

7.5 Reproducing Enç's truth conditions

I would like to consider truth conditions given in Enç (1996) to capture the temporal interpretation of certain future conditionals.

(422) Where S is the antecedent of the conditional and S' is the consequent, $\text{MODAL}[S,S']$ is true at $\langle w,i \rangle$ iff for every w' such that w' is accessible to w and there is an interval $i' > i$ such that S is true at $\langle w',i' \rangle$, there is an $i'' > i'$ and S' is true at $\langle w',i'' \rangle$.

The following would be an example of such a conditional.

(423) If Mary moves in next door, John will sell the house.

The antecedent of this sentence is future, and the consequent is future to that. That means that for any future time of Mary's moving in next door, there is an even later time at which John sells his house. This temporal interpretation is captured by the truth conditions in (422) because these truth conditions involve two times, i' and i'' , in addition to the time of speech, i , and specify that i' is later than i and i'' is later than i' . Truth conditions of the sort in (421) do not capture the temporal interpretation. In (421), the temporal interpretation is due to the disparity principle. The antecedent must be interpreted as a disparity fact with respect to the speech-time broomstick, and the consequent must also be interpreted as a disparity fact with respect to the same broomstick. This leaves the antecedent event and the consequent event

temporally unordered.

I have not discussed the problem of fixing the relative time of antecedent and consequent in future conditionals. (423) represents one pattern. (424) represents another.

(424) If John comes to the party, he'll be wearing a red hat.

According to this sentence, John's future coming to the party, if it happens, will be accompanied by John's wearing a red hat. The truth conditions in (421) allow for this reading, but they do not require it, and that's a shortcoming.

An important point about (423) and (424) is that the relative temporal ordering between antecedent event and consequent event is not free. There are conditionals where it is free, like the following.

(425) If Jane bought a lottery ticket, then Mary must have bought one too.

What is the temporal ordering here? That depends. Maybe Mary always does what Jane does. In that case, Mary's buying a ticket would follow Jane's buying one. But maybe Jane always does what Mary does. In that case, the order of events implied would be the opposite. The sentence allows for either interpretation.

The truth conditions of the sort in (421) need to be altered only slightly to be equivalent to those given by Enç in (422). Such altered truth conditions are given here for (416), repeated here.

(416) If Mary leaves, John will go home.

(426) Given an assignment function g , a modal base function f , and an ordering source function f' , for a world w and a time t , $\llbracket \lambda w_0 [\text{if}' (\lambda t_0 \lambda w_0 [\text{leave}'_{w_0, t_0} (m)], \text{will}'_{w_0, t_0} (\lambda t_0 \lambda w_0 [\text{go-home}'_{w_0, t_0} (j)]))]] \rrbracket_{g, f, f'} (w) = 1$ iff
for any time t' such that $\llbracket \lambda t_0 \lambda w_0 [\text{leave}'_{w_0, t_0} (m)] \rrbracket_{g, f, f'} (t')$ is a disparity fact with respect

to $\cap f(w,t)$ and, where $f^{++}(w,t) = f(k,t')$, for $k \in \cap f(w,t) \cap \llbracket \lambda t_0 \lambda w_0 [\text{leave}'_{w_0,t_0}(m)] \rrbracket_{g,f,f}(t')$

and $g' = g[w_0/w]$,

$\llbracket \text{will}'_{w_0,t_0}(\lambda t_0 \lambda w_0 [\text{go-home}'_{w_0,t_0}(j)]) \rrbracket_{g',f^{++},f} = 1$.

According to these truth conditions, the antecedent must be interpreted as a disparity fact with respect to the speech-time broomstick. After that, a second layer of speech-time broomsticks are considered, and the consequent is interpreted as a disparity fact relative to these broomsticks. As a consequence, the antecedent event is portrayed as happening at a future time and the consequent event at a time future to that.

What is the difference between these two interpretation strategies, and why would one be preferred over the other? Consider the following sentences.

(427) If the butler does it, he'll use an ice-pick.

(428) If the butler does it, he'll escape into Canada.

I would argue that it makes sense that (427) is interpreted with f^+ and (428) is interpreted with f^{++} . (427) is interested in the question of how the butler would do it. Therefore, the proposition that he does it is added to the modal base. Closest worlds from the adjusted modal base set are examined to find out how he does it. (428) is interested in what the consequences of the action are. Therefore, any world in which he does it is fed into the modal base, along with a possible time for his doing it. This gives a new broomstick. The closest worlds in the broomstick are examined, to find out what has happened as a result of the action.

I have not indicated how a particular interpretation strategy is decided on. For now, I don't see a clear way of deciding between them, so I think it should be left up to the interpreter of the sentence. This puts the interpreter of a future conditional in much the same

position as the interpreter of the following sentence.

(429) Mary was standing by the bank when...

Does *bank* mean the land beside a river, or a financial institution? If the sentence continues, *it gave way and fell into the river*, one interpretation is favored. If the sentence continues *a masked man came rushing out*, the other interpretation is favored.

An objection can be raised to this appeal to a second layer of broomsticks in the interpretation. Why not just appeal to discourse interpretation principles? Consider the following portion of a narrative.

(430) Mary left. John went home.

It is natural to interpret this as meaning that first Mary left, and subsequently, John went home. (416) could be interpreted in the same way.

(416) If Mary leaves, John will go home.

The consequent follows the antecedent in time, and this leads to the understanding that the event mentioned in the consequent follows the event mentioned in the antecedent in time.

I cannot definitely rule out this account of the relative temporal ordering implied in the conditional. However, it seems to me that there are several reasons to resist it. First, the conditional can be reversed, with no change in temporal ordering.

(431) John will go home if Mary leaves.

This sentence also entails that John's going home would follow Mary's leaving. If the discourse sentences are reversed, the suggested ordering doesn't hold.

(432) John went home. Mary left.

Another question for the discourse ordering account is why we don't find the ordering with epistemic conditionals.

(433) If Mary left, John must have gone home.

As mentioned above in relation to a similar example, this sentence neither implies that Mary left first, nor that John went home first.

A final reason against this kind of account is to say that it is good to have two distinct interpretation strategies for a future conditional. Consider the following two sentences.

(434) If the butler does it, he'll most likely use an ice-pick.

(435) If the butler does it, he'll most likely escape into Canada.

Suppose it is most likely that the butler would use an ice-pick to commit the crime, but it is not out of the question that he might use a garden hoe. (434) is therefore true. Let's say that (435) is also true. However, I don't think we want to say that (435) means that the butler will most likely escape to Canada if he uses an ice-pick. To see that, consider the following sentence.

(436) However, if he uses a garden-hoe, he'll escape down the Ohio instead.

(436) would be very odd, in the context of (434) and (435). It seems to contradict (435).

The theory as given helps explain why. (436) apparently contradicts (435) in the context just given. Suppose (435) is interpreted with the adjusted modal base function f^* . The sentence is then true just in case in all the most likely worlds where the butler commits the murder, he escapes down the Ohio River. All these most likely worlds, as we know from (434), are worlds in which he uses the ice-pick to commit the murder. Therefore, in the context of (434), (435) would mean that in all the worlds where the butler commits the crime, he uses an ice-pick and escapes to Canada. It should still be open to say that if he uses the second most likely murder weapon, the garden hoe, he will escape to down the Ohio River. But this continuation is not appropriate.

Now suppose we interpret (435) using f^{++} . We choose any world k in which the butler commits the crime. We don't care, that is, if he uses an ice-pick, a garden hoe, or any other weapon. All we are saying is that he will most likely escape up into Canada. Given that meaning for (435), (436) is predicted to be a contradiction, and that is what it seems to be.

The general truth conditions for future conditionals are as follows, for M a universal modal.

(437) f^+ conditionals:

For a condition ϕ of the form $\lambda w_0[\text{if } \psi M_{w_0,t_0} \delta]$

Given an assignment function g , a modal base function f , and an ordering source

function f' , for a world w and a time t , $\llbracket \phi \rrbracket_{g,f,f'}(w) = 1$ iff

for any time t' such that $\llbracket \psi \rrbracket_{g,f,f'}(t')$ is a disparity fact with respect to $\bigcap f(w,t)$ and,

where $f^+(w,t) = f(w,t) \cup \llbracket \psi \rrbracket_{g,f,f'}(t')$ and $g' = g[w_0/w]$,

$\llbracket M_{w_0,t_0} \delta \rrbracket_{g',f^+,f'} = 1$.

(438) f^{++} conditionals:

For a condition ϕ of the form $\lambda w_0[\text{if } \psi M_{w_0,t_0} \delta]$

Given an assignment function g , a modal base function f , and an ordering source

function f' , for a world w and a time t , $\llbracket \phi \rrbracket_{g,f,f'}(w) = 1$ iff

for any time t' such that $\llbracket \psi \rrbracket_{g,f,f'}(t')$ is a disparity fact with respect to $\bigcap f(w,t)$ and,

where $f^{++}(w,t) = f(k,t')$, for $k \in \bigcap f(w,t) \cap \llbracket \psi \rrbracket_{g,f,f'}(t')$ and $g' = g[w_0/w]$,

$\llbracket M_{w_0,t_0} \delta \rrbracket_{g',f^{++},f'} = 1$.

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