A Multi-Model Modal Theory of I-Semantics
Part I: Modals[1]

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Dedicated to the memory of Keiko Yoshida

Abstract: This paper provides a semantic analysis of restrictions on quantification into doxastic modals uncovered by von Fintel and Iatridou (2003). The restrictions are made to follow from the architecture of a new theory of semantic interpretation, deriving from an asymmetry in the introduction of doxastic and non-doxastic modal bases. The analysis can be seen as a concrete extension of Kratzer (1991) that adds just enough structure to the semantics to be able to give a principled account of the restrictions on quantifying into doxastic modal statements.

1 Epistemic = {Doxastic, Metaphysical}

Modal auxiliaries in English are typically associated with a multiplicity of readings. The modal *must*, for example, could indicate certainty, as in the prominent reading of (1a), or requirement, as in the prominent reading of (1b), while *may* can indicate possibility as in the prominent reading of (1c), or permission as in the prominent reading of (1d).

(1) a. That must be Jones
     b. Jones must leave
     c. That may be Jones
     d. Jones may leave

That these are indeed separate readings is uncontroversial, the interpretations of (1a,c) typically referred to as epistemic or doxastic and those of (1b,d) as deontic, circumstantial, or simply non-epistemic (Lyons 1977, Kratzer 1991, von Fintel and Iatridou 2003, Papafragou forthcoming, among many others). The focus of this paper is on the scopal interaction

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between the former class of modals and quantifiers.

Lyons (1977) proposed that epistemic modals come in two different types – subjective and objective.   I will argue below that the subjective use is more properly labeled doxastic, sensitive only to belief and not knowledge.   The objective use clearly differs in this respect, involving reasoning from accepted facts rather than simple belief.   Since the label *epistemic* has been used by different authors for both of these categories, the subjective and the objective, and since they have distinct behaviors, I will simply avoid using that label as much as possible, referring to Lyons' objective epistemic modality as metaphysical modality, as in Iatridou (1990).   Since the doxastic / metaphysical distinction is an important one and failing to make it can lead to confusion, it is worth taking a moment to differentiate the two interpretations.

One of the most frustrating aspects of the subjective interpretation is that there is no clear diagnostic for it, or at least none known to me.   The English modal adverbs "perhaps" and "probably" (as well as their Japanese counterparts "moshikashitara" and "tabun") strongly prefer a subjective use, though like all other subjectively interpretable modals this is no more than a preference.   One can invoke a subjective interpretation more generally by prefixing a modalized statement with *subjectively (speaking)*, or adding *for all I know, as far as I know* or *as far as I'm concerned*, though even these will not ensure that the modal itself is to be taken subjectively.   It could as well be the case that the sentence as a whole is to be taken as a subjective statement about an objective modality, something that occurs regularly with (the far more colloquial) *in my opinion*.   What differentiates a subjective modal statement from others is that it is one that cares only about the speaker's subjective belief state.   All other modals involve something additional.   An objective, metaphysical, modal statement for example is based on speaker-external facts.   This type of modality can be much more reliably induced.   Prefixing a statement with *objectively (speaking)* forces this reading, as does addition of an evidential adverb like *apparently, clearly, allegedly* and *reportedly.*

To see the difference between the subjective and objective uses, consider first the simple case of (1c) uttered by a speaker in isolation upon hearing a knock at the door.   In such a situation, one could as easily utter *That's perhaps Jones* without any awkwardness, and in both cases the preferred way of taking the utterance is as simply saying something about the speaker's beliefs, namely that it's compatible with her beliefs that the person at the door is Jones.   Prefixing the utterance with *Subjectively (speaking)*, though stylistically awkward, can help to reinforce the desired reading.   In contrast to the subjective reading, consider the same sentence again following a knock at the door, but this time uttered to a hearer in the following context.

(2)   Jones said he would come to this party, so if he isn't here yet it follows that (1c).

Here the speaker is not simply commenting on her belief state.   She is rather making a statement of general fact, namely that the evidence mentioned (perhaps together with unstated background assumptions) leads to the following conclusion: that it is compatible with all known (relevant) facts that the person at the door is Jones.   She is not claiming that her

belief state follows from the evidence. In fact, she cannot be said to be claiming that anybody's state of mind follows from the evidence. The most she can be said to be claiming is that a rational person who understood and accepted the claim would be led to be in a belief state compatible with the person at the door being Jones.[2] The objective reading can be brought out even more unambiguously by prefixing the modal statement in (2) with *objectively (speaking)*.

I claimed above without argument that the subjective modality involved in the one interpretation of (1c) was based on belief and hence doxastic, not epistemic, i.e. not based on knowledge. To see that this is so, consider the case of a speaker – Alice – who knows that Jones was invited to the party and also knows that he has not yet arrived. Suppose that Alice incorrectly believes that Jones is out of the country and so cannot possibly make it to the party. In such a situation, (1c) would be an inappropriate thing for Alice to utter in a context where only her own state of mind is at issue. If the modality were subjective epistemic, however, i.e. based solely on her knowledge and not on her other beliefs, we would have to contend that it might well be not only true but appropriate as well, since Alice's knowledge is compatible with the person at the door being Jones. The fact that (1c) is false[3] in the envisioned situation is strong evidence that there is no such thing as a subjective epistemic interpretation of the modal. The above argument presupposes, of course, that Alice can distinguish those of her beliefs that constitute knowledge from those that do not. However, challenging that assumption is of no use in trying to salvage the category of subjective epistemic modality. If Alice has no basis for making a distinction between those of her beliefs that constitute knowledge and those that do not, then she has no way of ever knowingly making a subjective epistemic modal statement at all based on her own epistemic state. This leads once again to the same conclusion, that there is no subjective epistemic interpretation. Instead, what has been referred to with this label is more appropriately called a subjective doxastic interpretation of the modal, sensitive to both those beliefs that constitute knowledge and those that do not.

Based in part on the above considerations, I will eschew Lyons' term *subjective epistemic modality* and favor instead the term *doxastic modality*. Though this goes against what I take to be standard usage in the linguistic literature, continued use of an imprecisely or ambiguously defined term only adds to the confusion that such usage has already created.

2   Doxastic Modals and Quantifiers
The interaction between doxastic modals and quantifiers was observed in von Fintel and

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[2] The fact that the conclusion in (2) does not involve any mental states suggests that the term *metaphysical modality* is perhaps to be preferred over *(objective) epistemic modality* as a label for the type of modality involved. This raises the question of whether there is anything that could be properly labeled epistemic modality, a question I will not attempt to answer here.

[3] I follow Papafragou (forthcoming) in assuming that all modal statements, subjective as well as objective, are formally either true or false. While intuitions are unclear on this issue, the arguments she gives are persuasive. For present purposes, however, the argument only requires that (1c) be found unacceptable in the context in question.

Iatridou (2003), who show that in a wide range of cases, when a doxastic modal and a quantifier occur in the same clause in English, the modal takes obligatory wide scope over the quantifier.[4]   They also note that this behavior is limited to doxastic modals, with deontic modals giving rise to clear scope ambiguities where their doxastic counterparts do not.   The absence of quantifiers scoping over doxastics in a simple clause can be illustrated with a wide range of quantifiers, and is at least as robust in Japanese as it is in English.   In (3) we give English examples and in (4) corresponding Japanese examples for which the quantificational expression cannot take scope over the modal when the modal is interpreted doxastically.[5]

(3) a. #(As far as I know) Every student is perhaps Jones
      b. #(As far as I know) Most students are perhaps Jones

(4) a. #Subete-no   gakusei-ga   moshikashitara Jones de aru
         Every-GEN   student-NOM perhaps   Jones COP
         Every student is perhaps Jones
      b. #Hotondo-no gakusei-ga moshikashitara Jones de aru
         Most-GEN   student-NOM perhaps   Jones COP
         Most students are perhaps Jones

To illustrate the unavailable readings, consider the situation of a teacher at the beginning of a new semester looking over a list of students enrolled in her class and matching up as many names as possible with faces.   If the teacher sees the name *Jones* occurring once on the class list but has no idea who any of the students are in her class, then for all she knows any one of the students in front of her might be Jones.   If a wide scope interpretation for the quantifiers in the (a) sentences were possible these sentences would be predicted to be true in this situation as a comment by the teacher (perhaps made only to herself) on her state of mind. However, the sentences are not true in this situation.   Indeed, the only doxastic interpretation available for them is the nonsensical one in which the teacher leaves open the possibility that all of her students are Jones.   Absence of a wide scope QP interpretation in the (b) sentences can be illustrated with a similar situation in which the teacher already recognizes just under half of the students, Jones not among them.   If a QP>doxastic modal scope were possible,

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[4] Von Fintel and Iatridou refer to the modals in question as epistemic.   They do not explicitly distinguish between subjective and objective epistemic modality as Lyons does, though the claims they make and the arguments they give only go through for subjective modality. Based on this observation plus the fact that Iatridou (1990) explicitly equates Lyons' category of objective epistemic modality with metaphysical modality, I assume that their object of inquiry is Lyons'subjective epistemic modality, or what I refer to here as doxastic modality.

[5] The same effects can be demonstrated with modal auxiliary *may* and its Japanese counterpart *kamoshirenai*.   However, these modals allow a metaphysical interpretation as strongly as they allow a doxastic interpretation, making it necessary to tease the two interpretations apart. Since both *perhaps* and *moshikashitara* strongly prefer a doxastic interpretation in the first place, it is much easier to use these modals to illustrate the restriction on quantifying into doxastics.

then once again the sentences would be predicted to be true in this situation since for more than half of the students the teacher leaves open the possibility of their being Jones. And as with the (a) example, the only doxastic interpretation found is the nonsensical one in which the teacher leaves open the possibility that more than half of her students are Jones.

In section 1 we made a distinction between subjective, doxastic modals and objective, metaphysical modals. It is worth noting here that under the latter mode of interpretation sentences parallel to (3) and (4), with *objectively speaking* in place of *as far as I know* and the modal auxiliaries *may* and *kamoshirenai* employed in place of the modal adverbs *perhaps* and *moshikashitara* as in (5) and (6), are in fact acceptable with the quantifier taking wide scope.[6]

(5) a. (Objectively speaking,) Every student may be Jones
     b. (Objectively speaking,) Most students may be Jones

(6) a. (Kyakkanteki-ni mite)   Subete-no gakusei-ga   Jones de aru kamoshirenai
         Objectively   looking Every-GEN student-NOM Jones COP   may
         (Objectively speaking) Every student may be Jones
     b. (Kyakkanteki-ni mite)   Hotondo-no gakusei-ga   Jones de aru kamoshirenai
         Objectively   looking Most-GEN   student-NOM Jones COP   may
         (Objectively speaking) Most students may be Jones

To see this, consider once again the situation of a teacher in a classroom at the beginning of the semester, having a conversation with her TA about the students. They have heard about a certain Jones who is known to be exceptional, and they wonder who this Jones might be. They notice that his name is on the student list, but neither of them knows any of the students. The teacher concludes (5a)/(6a). The TA can then deny the teacher's claim, a denial that

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[6] The examples in (3) and (4) also have a wide scope QP interpretation that could plausibly be analyzed as involving a metaphysical interpretation of the modal adverbs. However, this interpretation is difficult to obtain, much more so than the corresponding interpretations of (5) and (6). Furthermore, this wide scope QP reading in (3) and (4) is sensitive to context in a way in which their modal auxiliary counterparts are not. In particular, the wide scope QP reading only readily surfaces in a context that contains previous use of *perhaps*, as in the following:
i: A: Who's that?
     B: That's perhaps Jones. But then again, EVERYONE is perhaps Jones (as far as I'm concerned, since I don't know a single person here).
I take this difference to indicate that the wide scope QP interpretation in these examples involves metalinguistic interpretation, akin to "For every person x, the sentence 'That is perhaps Jones' is true with *That* used to refer to x." I put this interpretation aside throughout the remainder of this paper. To exclude this interpretation it is useful to add an explicit context as in (ii) that does not contain mention or implication of *perhaps*.
ii: A: Which of these people is Jones?
     B: As far as I'm concerned, everyone is perhaps Jones (since I don't know a single person here).
In the remainder of this paper, I leave this task to the reader.

does not call into question the teacher's beliefs but rather the extent of her knowledge compared to the TA's. Imagine that before the teacher arrived, the TA heard a small group of the students talking about Jones, and it was clear from what he heard that Jones was not in the group. The TA can correct the teacher, saying (5b)/(6b), *but clearly not every student may be Jones.*[7] In both occurrences of the sentences in (5)/(6), the quantifier is very naturally taken as having wide scope over the modal. The modal, however, is no longer doxastic. It is forced, rather, to be metaphysical by the modifiers employed.

3   Prior Analysis

Iatridou and von Fintel (2003) account for the absence of a wide scope interpretation of the quantifiers in English sentences like those in (3) and (5) on their subjective, doxastic interpretation by stipulating a ban on quantification into doxastically modalized sentences, a ban they refer to as the Epistemic Containment Principle (ECP). The specific form of this principle that they favor is one that blocks a quantifier-trace chain from crossing a doxastic modal, as formalized in (7).

(7)   *The ECP revised as a condition on QR*
         At LF, a quantifier cannot bind its trace across [a doxastic] modal.
         $*Q_i$ . . . [[Doxastic] Modal (. . . t_i . . .)]

The ECP directly rules out the LF representations that are presumably required in order to generate a wide scope reading for the quantifiers, given in (8).

(8)   [Q student(s)]$_i$ may/must t_i be Jones

These LF representations consist of a quantified expression binding its trace across a doxastic modal, in direct violation of the ECP.

While the facts that von Fintel and Iatridou consider are striking, the analysis they give for them is far from convincing, for several reasons. First, in order for the analysis to accommodate metaphysical modals they will need to assume a syntactic difference between these and doxastic modals. There is little independent evidence, however, for such a syntactic distinction other than the quantifier scope facts that distinguish them, and there are good reasons for treating *may/must* and other similar modals as non-ambiguous (cf. in

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[7] This notion of objective interpretation is a curious one. Clearly if Jones's knowledge or just the fact of Jones's identity is also taken into account, then objectively exactly one person may be Jones, namely Jones himself. There is no requirement of taking either of these into consideration when claiming to make an objective statement, however. It is enough to take into consideration the relevant knowledge and beliefs of the discourse participants. This makes the word *objective* misleading in the present context. What the word appears to highlight is that a statement is made not based on belief-independent fact but rather based on what is perceived to be the common ground of the discourse participants, itself a belief-dependent construction.

particular Kratzer 1991).   The standard semantic analysis of modals in Kratzer (1991) distinguishes the various types of modality only by the identity of two types of conversational background – a modal base and an ordering source.   It is far from clear how this distinction could make its way into the syntax so that modals dependent on one set of conversational backgrounds would be syntactically distinct from those dependent on another set.   Even if these objections can be overcome, however, a more crippling objection to the analysis remains, namely that it amounts to no more than a restatement of the facts.   The ECP does potentially give an account of the unacceptability of quantification into a doxastically modalized statement, but the analysis makes no predictions about any phenomena other than the narrow one that they focus their attention on, and in particular fails to *explain* why doxastically interpreted modals and metaphysically interpreted modals (or deontic modals, for that matter) should exhibit such different behavior.

4   Background on Doxastic and Circumstantial modality

As noted above, the availability of a wide scope reading for a DP quantifier in English sentences like (5) depends on whether or not the modal is interpreted doxastically.   We have already seen the contrast of doxastic and metaphysical modality in section 2.   Under a deontic interpretation as well, where the sentences are taken as statements of permission or of restriction, each of these sentences easily allows the wide scope interpretation for the QP lacking with the doxastic interpretation of the modal, a fact already examined in detail by von Fintel and Iatridou and not reproduced here.[8]   If we adopt the standard semantics for modals proposed in Kratzer (1991), however, this observation cannot be given a principled explanation.

According to Kratzer, modalized sentences are interpreted with respect to a modal base and an ordering source.   Modals come in two main types: epistemic and circumstantial. The distinction between the two derives under her analysis from employing epistemic vs. circumstantial modal bases.   Here is what she has to say about the two:

> Epistemic and circumstantial modal bases are both *realistic modal bases*.   That is, both … assign to every possible world a set of propositions which are true in that world.   Yet circumstantial and epistemic conversational backgrounds involve different kinds of facts.   In using an epistemic modal, we are interested in what else may or must be the case in our world given all the evidence available.

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[8] The particular examples used in (5) are perhaps not the best for bringing this reading out, as they were chosen specifically to make the doxastic readings the most salient.   However, if interpreted as a statement of permission made to actors wishing to play the part of Jones in a play that is being performed many times, the wide scope reading of the quantifier in (5a) becomes readily available.   The narrow scope reading is also available, though pragmatically it will be dispreferred except in those rare circumstances in which multiple actors simultaneously all play (perhaps different aspects of) the same character in a single play. The Japanese modals in (6) lack a deontic interpretation, and so the scope variation found with deontic modals (in other Japanese examples as well as in English) cannot be seen in these examples.

Using a circumstantial modal, we are interested in the necessities implied by or the possibilities opened up by certain sorts of facts.

The modal base is taken to be determined by the conversational background, and is not lexically specified in a modal expression. Modal expressions themselves are given a uniform interpretation. In the case of *must* this interpretation will yield a necessity, and in the case of *may*, a possibility. These two most basic interpretations for a modalized proposition are given as follows:

(9) **Kratzer's Modal Semantics (excerpts)**

A proposition p is a **necessity** in a world w with respect to a modal base f and an ordering source g iff the following condition is satisfied:

For all $u \in \cap f(w)$ there is a $v \in \cap f(w)$ such that

$v \leq_{g(w)} u$ and for all $z \in \cap f(w)$: if $z \leq_{g(w)} v$, then $z \in p$.

A proposition p is a **possibility** in a world w with respect to a modal base f and an ordering source g iff $-p$ is not a necessity in w with respect to f and g.

The modal base f and the ordering source g are both functions from worlds to sets of propositions, with propositions analyzed as sets of worlds. The choices for f and g determine the type of modal interpretation a proposition is given. An epistemic modal base f picks out the set of all propositions that constitute a speaker's evidence, while a circumstantial f picks out the set of propositions denoting a certain set of facts. This gives us our main distinction between epistemic and circumstantial modals.[9] Within each of these broad categories, the ordering source determines the fine interpretation, e.g. whether a circumstantial statement of necessity is taken to be required by custom, law, mother-in-law, etc.

The ordering source g(w) is a set of propositions in the world of evaluation w which determine a set of most ideal worlds, those worlds in which the propositions satisfied are at a local maximum. There may or may not be worlds in which every proposition picked out by the ordering source is satisfied. If there are, then the set of such worlds constitutes the sole ideal. If there are not, two cases can be distinguished. If the failure derives from a proposition in the ordering source being incompatible with a proposition in the modal base, there can still be a single set of most ideal worlds. If, on the other hand, failure derives (in part) from two propositions p and q picked out by the ordering source being mutually incompatible, then there will be at least two separate sets of most ideal worlds. In one of the sets in this case p will be satisfied, and in another one q will be satisfied. If all other

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[9] Note that for Kratzer, an epistemic modal base is realistic. That means that it would be a mistake to equate doxastic modality in our sense with epistemic modality in Kratzer's. This leaves open the question of how doxastic modality can be analyzed within Kratzer's account. I presume that the analysis consists of an epistemic modal base with the set of the speaker's beliefs as an ordering source. Note that Kratzer makes a connection between epistemic modality and evidence, not knowledge, though she says no more about how epistemic modal bases are identified.

propositions P picked out by the ordering source are compatible with p and with q, then there will be exactly two sets of most ideal worlds, those in which all the propositions in P are satisfied in addition to p, and those in which all the propositions in P are satisfied in addition to q. These are most ideal worlds with respect to the propositions picked out by the ordering source in the sense that no additional such propositions can be satisfied in these worlds.

The ordering source g(w) lines worlds up depending on how close they come to approaching one of the sets of most ideal worlds. A world v is closer to such an ideal than another world u if the propositions in g(w) that are true in v form a superset of those true in u. Note that the absolute number of propositions satisfied in u and v is not directly relevant since the actual propositions satisfied could well form non-embedding sets. The definition of necessity, then, says that a proposition p is a necessity if for every world u compatible with the modal base there is another world v that is at least as close to the ideal determined by the ordering source such that p is true in every world z that is at least as close to the ideal as v. This determines that given a possibly inconsistent ordering source g that determines a set of sets of most ideal worlds $\{I_1, I_2, ..., I_n\}$ within the modal base, p is a necessity iff it is true in every world in I_i for every value of i from 1 to n.

What is most important for our purposes in these definitions is that they provide no basis for distinguishing between modals that can be quantified over within a simple clause and those that cannot. This is because epistemic and circumstantial modal bases are formally the same in kind, as are doxastic and deontic ordering sources. Indeed, all four are functions from worlds to sets of propositions. The modal bases differ from one another only in their identity, as do the ordering sources, but within Kratzer's theory this difference has no scopal consequences. As we have seen already, however, the scopal possibilities observed in section 2 for a QP vis-à-vis a modal depend on whether the modal is analyzed as doxastic or not. With a doxastic modal it is not possible for a quantifier to take scope over the modal, while with all other modals it is. Since Kratzer neither gives the semantics of lexical modal items nor shows how to derive the desired interpretations in (9) compositionally, this observation does not argue against her theory. However, it does show that her theory does not by itself explain the phenomenon that we are interested in. The best that could be achieved within her theory would be to tack an *ad hoc* explanation of the ECP effects onto it, which is in essence what von Fintel and Iatridou's ECP does. A more principled account would be one in which the ECP effects follow from the theory of modality itself, but that is a goal that cannot be attained without making major modifications.

To account for the ECP effects that von Fintel and Iatridou uncovered, I propose to introduce an asymmetry in the introduction of modal bases that makes it possible to derive the ECP effects as a consequence of the architecture of the theory. In particular, I argue that a doxastic modal base must be available prior to a circumstantial modal base (and to an epistemic modal base if there is such a thing), in a sense to be made precise below. This minimal addition to the theory makes it possible to maintain all of the main insights from Kratzer's analysis while also giving a principled account of the uniqueness of doxastic modality.

5   Multi-Model Theory

The central proposal of this paper that will make possible an account of the desired kind is that model theoretic semantics is a theory of the semantic component of an I-language in the sense of Chomsky (1986).   Since I-languages differ from individual to individual, it follows that in order to interpret other people it is necessary to be able to translate among I-languages. For semantics, I take this to require introduction of separate models for separate speakers together with a way of translating among them.[10]   Significantly, this means that interpretation of others requires relating a model of one's own beliefs to a model of another speaker's beliefs, and hence that each individual speaker needs to be able to manipulate multiple models.   This view differs from the standard model-theoretic semantic view in which a single model used for all interpretation is assumed to be given from the start.   On the present view, no designated model is given prior to interpretation of an utterance.   If we take models to be speaker relative, this makes it most natural to assume that models are introduced through utterances.   More specifically, I will assume that every utterance by a speaker comes with a claim that there is a model compatible with the speaker's beliefs within which the content of the utterance is true.

To formalize these ideas, I distinguish between interpretation of an utterance and interpretation of what was uttered.   The former involves attribution of a model of beliefs to the utterer, while the latter employs this model to calculate truth conditions.   To distinguish between these two very different aspects of interpretation, I employ triple brackets for the first and the standard double brackets for the second.   Since the identity of the utterer is essential in determining the model to be used for interpretation, I take the utterer to be identified through a parameter on the utterance.   For utterance U_S of a sentence S by a speaker a in world w, the beginning of the interpretation will go as follows:

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[10] An argument justifying this view can be made from the semantics of propositional attitude attribution, where the need arises to have distinct domains of individuals accessible at different points in the interpretation.   The foundation of this argument is the fact that *de re* and *de dicto* interpretations of names cannot be adequately represented in a single model if names are taken to be rigid designators and the speaker and attitude holder have irreconcilable differences in their ontology of individuals (real and/or imaginary).   A multi-model analysis that takes attitude attribution to always involve a translation between two models has no problem handling this kind of situation without having to abandon the rigid designator analysis of names within a model.   The full analysis of such cases requires introducing the notion of the counterpart of a world across models, since two worlds with different ontologies can never be strictly speaking identical.   The full analysis covering propositional attitude predicates involves a synthesis of a Lewis-style appeal to counterparts, needed to relate individuals and worlds across models, and a Kripke-style appeal to rigid designation within a model (cf. Lewis 1968 and Kripke 1980).

The analysis of modality does not involve reasoning with respect to alternative ontologies.   However, different types of modality do make reference to distinct sets of worlds, which can easily be modeled by taking changes in the relevant set of worlds to derive from a change in models.   While the analysis of modals by themselves does not force this approach upon us, appeal to multiple models does vastly simplify the semantic analysis of the ECP effects that are the main focus of this paper, constituting support for such an analysis.

(10) $[[U_S]]^{a,w}$ is true iff $\exists M$ M is compatible with the beliefs of a in w and $[[S]]^{M,a} = 1$

Of relevance here, the model M will contain a set of worlds W_M compatible with the speaker's beliefs and hence equivalent to the doxastic modal base of the speaker.[11] I propose that doxastic interpretation consists simply of a modal interpreted using this W_M as a modal base.

By taking all utterances to introduce a model compatible with the speaker's beliefs, a doxastic modal base has a privileged position in the theory that sets it apart from any other modal bases introduced later. This introduces the asymmetry into the theory needed to account for the differential behavior of doxastics and other modals. The particular asymmetry I will capitalize on is the absence of a world parameter in (10) with respect to which S is interpreted. The world parameter in (10), present in interpreting the utterance U_S, only serves to identify the utterer's beliefs, and is not added as a parameter used to interpret the sentence S that was uttered. This reflects the fact that although we make statements within the actual world, and it is this world that determines what our beliefs are, our beliefs do not themselves suffice to isolate this world and may well in fact be incompatible with it. It is the absence of this world parameter that gives us our account of ECP effects. Quantifiers are world sensitive. Under standard interpretations, this means that they need to be interpreted with respect to a world parameter in order to determine the extension of their restriction. The quantified expression *every detective*, for example, will range over a very different set of individuals within the context of a Columbo show, a Sherlock Holmes novel and a real-world crime investigation. If quantifiers are not given a world parameter for this purpose, their interpretation becomes undefined. With respect to (10), since S is interpreted only with respect to a model and not with respect to a world, it follows that S cannot have the form [QP S']: the QP would be undefined if it did. I take this to be the essence of ECP effects. Quantification is only possible at all with respect to a previously introduced world parameter,

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[11] Strictly speaking this statement is false under Kratzer's analysis in two ways. First, Kratzer takes the modal base to be a function applying to a world argument, while the set of worlds W_M implicitly contained in the model M in (10) is a mere set of worlds. This is a harmless difference since we have already incorporated the relativity to worlds in the fact that the utterance was made in world w, and that w helped to fix the beliefs of the speaker and hence the possible values of M. Second, for Kratzer a modal base applied to a world yields a set of propositions, and this set of propositions is not recoverable from the set of worlds W_M in which those propositions are true. This would be problematic if Kratzer ever made essential use of these propositions. However, in her analysis these propositions play no ineliminable role. Only the intersection of that set of propositions, i.e. the set of all worlds compatible with each of the propositions, is made use of in defining the various degrees of necessity and possibility. In this respect, modal bases and ordering sources differ. With ordering sources, the propositions themselves need to remain accessible since ordering between two worlds is dependent on the sets of propositions satisfied in those worlds. I will use the term *modal base* loosely in this respect. Since modal bases are not introduced in the present theory as primitives, the term itself becomes no more than a useful mnemonic for one of the ways in which the set of worlds specified in a model are put to use.

but doxastic interpretation occurs at a level prior to their introduction.

On the analysis sketched above, doxastic modal statements do not require introduction of any further models. They represent the simplest possible case in this respect. The modal expression simply quantifies over the set of worlds W_M contained in the model M. Since doxastic interpretation does not come in different flavors depending on ordering sources the way deontic interpretation does, we will need to prevent modification of a doxastic modal with an ordering source. However, since ordering sources within Kratzer's framework are functions from worlds to propositions, we can exclude the possibility of doxastics modals combining with ordering sources by analyzing the latter as a function of the former. Under such an analysis, the absence of an ordering source for doxastics can be given the exact same explanation as the absence of quantification into doxastics – there is no accessible world parameter at a point where one is needed to avoid undefinedness. This analysis will be spelled out in more explicit detail below after introducing ordering sources formally.

The analysis of doxastic modality just presented takes the set of worlds of the current model to act as the modal base that the modal expression quantifies over. In order to avoid unnecessary ambiguity, I propose to generalize this analysis of modals to all cases: **modals uniformly quantify over the worlds of the local model**. I give two examples in (11) of such modals, where W_M represents the set of worlds in the model M.

(11) $[\![must]\!]^M = \lambda c \lambda p.[\forall u: u \in W_M \,\&\, c(u)] \,(p(u))$
       $[\![may]\!]^M = \lambda c \lambda p.[\exists u: u \in W_M \,\&\, c(u)] \,(p(u))$

The inclusion of an additional proposition in the restrictive clause serves two purposes. The first is to allow *if*-clauses to serve as restrictors on modals, something that occurs with all types of modals but won't be examined here. The second is to facilitate incorporation of an ordering source in non-doxastic modals. In cases containing neither an overt *if*-clause nor a covert ordering source, I assume that the first argument applies to a default *if*-clause denoting a proposition true of all worlds in the model. This makes it possible for these modal expressions to be used directly without any ordering source, applying to a proposition in their scope, which is just what is wanted in the doxastic case.

We are now ready to deal with non-doxastic modals. Consider first the case of a non-doxastic modal embedded under a doxastic modal. Given that modals in the present framework quantify over the worlds W_M of the local model M, a change in modal base requires a change in models. A means of introducing a new model is thus required, together with rules for relating the new model to the current one. There are many potential operators that can do this, including most prominently those associated with propositional attitude predicates. For our purposes the most important such operator is the circumstantial operator that introduces a model M' whose worlds $W_{M'}$ are all those consistent with some salient set of facts. I assume that this operator incorporates the domain of individuals from the model of interpretation directly into the newly introduced model unchanged. Furthermore, if we follow Kratzer in taking a circumstantial modal base to be realistic, the set of worlds $W_{M'}$ that it introduces must contain the parameterized world w with respect to which the operator is

interpreted.   The semantics for the circumstantial operator is given in (12), where the relation R minimally requires the domains of M and M' to be identical.

(12) $[[Op_{circ}]]^{M,w} = \lambda p.$ circumstantial(M',w) & $w \in W_{M'}$ & R(M,M') & $[[p]]^{M',w} = 1$

A model M' is circumstantial with respect to a world w just in case all of the worlds in $W_{M'}$ are compatible with a (contextually supplied) set of relevant circumstances.   Note that the circumstantial operator is a metalinguistic operator that applies to expressions, not to their interpretations.   In positing such an operator I am implicitly following Potts (2005) and Sudo (2006) in taking all expressions to have a dual semantic type, one a normal semantic type and the other the type of expressions.

We can now incorporate ordering sources into our compositional treatment of modality. Following Kratzer, I assume that an ordering source is a function from worlds to propositions. The world I take to come from a parameter of the interpretation function $[[\ ]]$ specified together with a model.   The only difference is that whereas Kratzer takes all modals to involve an ordering source, I assume that ordering sources are optional.   The difference is crucial since without it we would not be able to account for the irrelevance of ordering sources for doxastic modals.

To facilitate computation, I will assume that for any set of worlds W, any ordering source g and any world w, there will be a set of sets of worlds $\{Max(g(w))_1, …, Max(g(w))_n\}$ such that each set of worlds $Max(g(w))_i$ counts as maximally close to the ideal set up by g(w). In order to introduce an ordering source where wanted, I employ the operator Op_{os} in (13), employing a free variable g whose value is to be fixed pragmatically.

(13) $[[Op_{os}]]^{M,w} = \lambda \wp \lambda c. \wp (\lambda u. \exists i \ u \in Max(g(w))_i$ & c(u))

This operator applies directly to a lexical modal expression like the ones defined in (12). Combined with *most* as in (14a) this operator will yield an interpretation that directly generates a necessity, and combined with *may* as in (14b) one that generates a possibility.

(14) a. $[[Op_{os} \ must]]^{M,w} = \lambda c \lambda p.[\forall u: u \in W_M$ & $\exists i \ u \in Max(g(w))_i$ & c(u)] (u $\in$ p)
      b. $[[Op_{os} \ may]]^{M,w} = \lambda c \lambda p.[\exists u: u \in W_M$ & $\exists i \ u \in Max(g(w))_i$ & c(u)] (u $\in$ p)

These interpretations are equivalent to Kratzer's notions of necessity and possibility, as the reader can verify.   The fact that the ordering source operator is only defined when a world parameter is specified precludes applying the operator to a doxastically interpreted modal as desired.

Before the analysis can count as a full-fledged account of the behavior of modals vis-à-vis quantifiers, one thing is still required: to specify how world parameters get introduced in cases in which there is no doxastic modal, so that quantification becomes possible quite generally.   I will follow von Fintel and Heim (2005) in taking worlds to be introduced generally through application of an intensional version of functional application.   The

definition I give below deviates somewhat from theirs since I do not assume that a world parameter is always present.

(15)   Intensional Functional Application (IFA)
If α is a branching node and $\{\beta,\gamma\}$ the set of its daughters, then, for any interpretation parameters π: if $[\![\beta]\!]^{\pi}$ is a function whose domain contains $\lambda w.[\![\gamma]\!]^{\pi,w}$, then $[\![\alpha]\!]^{\pi} = [\![\beta]\!]^{\pi} (\lambda w.[\![\gamma]\!]^{\pi,w})$.

Since both bare modals and Op_{os}-modal combinations require an intensional argument of type $\langle s,t \rangle$, IFA will require this argument to be raised to the appropriate intensional type prior to combination with the modal, introducing the world parameter needed for interpretation of quantified expressions in the scope of a modal.   In order to make quantification possible in cases lacking a wide scope modal operator, I assume a default evidential operator that like *must* quantifies universally though unlike *must* restricts the domain of quantification to those worlds in which the utterer has evidence for what she claims, an operator I will call Op_{ev}.[12]

(16) $[\![Op_{ev}]\!]^{M,a} = \lambda p.[\forall u: u \in W_M \text{ \& } a \text{ has evidence in } u \text{ for } a\text{'s claims in } u] (p(u))$

This will introduce the necessary world parameter for all non-doxastic interpretation, making possible not only quantification but also introduction of an ordering source.

6   Doxastic, Metaphysical and Deontic Modality Revisited

With our analysis in place, we are now ready to consider how to model the distinctions described earlier between doxastic modality, metaphysical modality and deontic modality. The first we have already adequately examined: a doxastic modal statement is one in which the modal quantifies over the worlds of a model that models the belief state of a speaker. Metaphysical modality we can now define as modality involving quantification over a set of worlds introduced by a circumstantial operator.   Pure metaphysical modality does not involve identification of an ideal in any sense, and so does not involve an ordering source either.   It only involves quantification over a modal base, and in this respect is similar to doxastic modals.   The most important difference between doxastic modals and metaphysical modals lies in the identity of the modal base: all worlds compatible with a speaker's beliefs

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[12] See Faller (2002) for an in-depth analysis of evidentials.   Note that the analysis given makes for a principled distinction between overt modal statements such as *That must be John* and simple declarative statements like *That's John*.   The former involves quantification over worlds in some of which the speaker has no evidence for what she claims, while the latter does not.   Since the set of worlds in which everything the speaker believes is true constitutes a subset of the worlds in which every thing the speaker believes and takes herself to have evidence for is true, *That's John* logically entails *That must be John* when both are taken to be uttered by the same speaker.   This gives us an explanation of the oft-noted observation that the non-modal claim, the one made based on evidence, is stronger than the modal claim, the one based on a combination of evidence and possibly unfounded belief.

for the former and all worlds compatible with a given set of facts in the latter.[13]   Finally, deontic modality as well as all remaining cases of circumstantial modality can be characterized as involving quantification over a set of worlds introduced by a circumstantial operator in combination with an ordering source.   Since our analysis is fully compositional, these distinctions reduce to the following syntactic representations for necessity.[14]

(17)   doxastic   [must p]
        metaphysical $[Op_{ev} [Op_{circ} [must\ p]]]$
        deontic $[Op_{ev} [Op_{circ} [Op_{os}\ must]\ p]]]$

7   Quantifier - Modal Interactions

We are at last ready to show how the analysis laid out above accounts for the scope interactions between modals and quantifiers discussed at the beginning of this paper.   There it was observed that quantifiers cannot scope over pure doxastic modals, but that they can scope over metaphysical and deontic modals.   These facts now follow from the framework without need of further stipulation.   The absence of quantification over doxastics follows from the fact that a doxastically interpreted modal is interpreted with respect to a set of parameters that does not include a specified world, as we have already seen.   QPs require access to a world parameter for their interpretation, and so it follows that they cannot be interpreted at the same point at which doxastic modals are interpreted.   Doxastic modals, however, as well as the default evidential operator Op_{ev}, introduce a world parameter (through IFA) into the interpretation, which will provide the necessary world parameter for interpretation of a quantifier in metaphysical and deontic modal statements as well as in declarative statements.   Crucially, the introduction of the world parameter logically precedes quantification over worlds by a modal expression in these latter types of modality, making it possible for a standard QP to be interpreted above the modal and hence to take scope over the modal.   The particular positions semantically allowed for a quantifier are illustrated in (18).

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[13] Note that a circumstantial modal base will in general include worlds not present in the doxastic modal base of the utterer.   That is, the set of worlds introduced in a circumstantial model need not be a subset of the worlds of the model within which the circumstantial operator is interpreted.   Allowing for this distinction requires having access to the set of all possible worlds at the point at which a circumstantial modal is introduced.   I do not explicitly introduce this set of worlds, though it could easily be added as a constant parameter of interpretation.

[14] The introduction of the evidential operator Op_{ev} brings with it the possibility of using it alone to introduce a modal base, without any accompanying circumstantial operator.   This gives rise to a third potential type of modal statement, an evidential modal.   This possibility could perhaps form the basis of an account of the various parallels and partial overlap between evidentials and modality argued for in the literature (cf. in particular Faller (2002) and sources cited therein).   It could also be seen as an alternative formalization of Kratzer's epistemic modal base.   Since adequate discussion of evidentiality would take me too far from the main focus of this paper, however, I leave for future research a detailed investigation into the questions this possibility opens up.

(18)   doxastic   [must [**\<QP\>** p]]

metaphysical   [Op_{ev} [**\<QP\>** [Op_{circ} [**\<QP\>** [must [**\<QP\>** p]]]]]]]

deontic   [Op_{ev} [**\<QP\>** [Op_{circ} [**\<QP\>** [Op_{os} must] [**\<QP\>** p]]]]]]

This gives us just the range of quantifier scopes that we observed to be possible.

8   Further Predictions of the Analysis:

The analysis presented in the preceding section makes a clear prediction regarding embedability of modals. Since circumstantially interpreted modals all involve quantification over a circumstantial modal base and a circumstantial base is introduced by an (intensional) operator, it should be possible for a circumstantially interpreted modal to be within the scope of any other modal. While we cannot demonstrate this possibility with multiple modal auxiliaries, which presumably all must be tensed in English, we can show this with the interaction of modal auxiliaries with modal adverbs and modal verbs like *have to*. As we can see in (19) below, the prediction is borne out straightforwardly for deontic modals.

(19) a. John has to$_{deon}$ go to prison

     b. i: John may$_{dox}$ (for all I know) have to$_{deon}$ go to prison

         ii: John perhaps$_{dox}$ has to$_{deon}$ go to prison

     c. Objectively speaking, John may$_{meta}$ have to$_{deon}$ go to prison

     d. (To build a safe society,) criminals must$_{deon}$ have to$_{deon}$ go to prison

For metaphysical modals the intuition is more subtle, though the following examples show that metaphysical modals as well can occur within the scope of any other modal.[15,16]

(20) a. John, (objectively speaking,) has to$_{meta}$ be guilty

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[15] In an earlier version of this paper I made no distinction between doxastic and metaphysical modals, implicitly taking epistemic modality to be what I am here calling doxastic modality. I claimed there that epistemic modals cannot occur in the immediate scope of another modal. An anonymous reviewer raised an example parallel to (20d) as an objection to this claim. (The actual example given was *The state must have to be right*). The reviewer suggested such a sentence might be used to describe a totalitarian society where thoughts are controlled. While I agree that a reading something like the one the reviewer pointed out is possible, I take this to involve a metaphysical interpretation of the modal and not a doxastic one. Whether this analysis is adequate or not, making a clear distinction between metaphysical and doxastic modals and abandoning the term *epistemic modal* should at the very least help to clarify the question of what interpretations are possible and to avoid the unintended confusion that invariably accompanies use of a single term that has multiple and conflicting standard uses.

[16] As noted in footnote 14, the evidential operator introduces a new model that should in principle provide a modal base for interpretation of a modal. The simplest way of dealing with this new class of modality is to assimilate it to Kratzer's epistemic modality. I note here that all modals in the scope of an evidential operator should be able to occur in the scope of any other modal as well as in the scope of any quantifier, and will hence pattern like metaphysical modals rather than like doxastic modals.

b. i: John may$_{dox}$ (as far as I know) (objectively speaking) have to$_{meta}$ be guilty

        ii: John perhaps$_{dox}$ has to$_{meta}$ (objectively speaking) be guilty

    c. (Objectively speaking,) John may$_{meta}$, (objectively speaking,) have to$_{meta}$ be guilty

    d. (By law,) criminals must$_{deon}$ (objectively speaking) have to$_{meta}$ be guilty.

In contrast, since doxastic modals are interpreted above all other modals it follows that doxastically interpreted modals cannot be embedded under any other non-doxastic modal: any such embedding would require access by the intended doxastic modal to a model that is no longer an active parameter of semantic interpretation.   Once again, the prediction is borne out, as seen in (21c,d).

(21) a. John is (for all I know) perhaps$_{dox}$ guilty.

     b. #John must$_{dox}$ be (for all I know) perhaps$_{dox}$ guilty.

     c. #(To build a good society,) criminals must$_{deon}$ (for all I know) perhaps$_{dox}$ be guilty.

     d. #(Objectively speaking,) John must$_{meta}$ (subjectively speaking) perhaps$_{dox}$ be guilty.

While the sentences in (21) are interpretable, it is not possible for the occurrences of *perhaps* contained therein to be given a doxastic, i.e. purely subjective, narrow scope interpretation.[17] The one case of blocked embedding that doesn't follow from the architecture of the theory is that of (21b), i.e. embedding of a doxastic modal under another doxastic modal.   Since both modals in (21b) involve quantification over the same modal base, there should be no problem with accessing the required modal base as there was for the case of doxastics embedded under circumstantials.[18]   If the present analysis is correct, it follows that the unacceptability of (21b) must be given a separate explanation.   The explanation I will adopt here is that multiple quantification over the same modal base without any ordering source is redundant. (21b) comes out as saying that some world consistent with the speaker's beliefs is such that in every world consistent with the speaker's beliefs John is guilty.   Clearly the first quantification adds nothing to the truth conditions here.

    The analysis of English modal auxiliaries given above represents the least restricted case, that in which a single modal expression can be interpreted with respect to any modal base. The compositional analysis of this range of possible interpretations, however, is not a necessity in the analysis of modals.   Indeed, one would expect to find variation in the range of interpretations available in a language depending on how many of the restrictions induced

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[17] For reasons that are not entirely clear to me, it does appear possible to give *perhaps* a wide scope doxastic interpretation in all of these sentences, making the sentences interpretable. On such an interpretation of (21b), however, *must* will have to be interpreted metaphysically, not doxastically.   This reading is irrelevant to the present discussion.

[18] A technical way out of this problem would be to analyze lexical modal expressions as including in their interpretation something equivalent to a circumstantial operator.   This would make (21b) entirely parallel to (21c,d).   While such an analysis gets the facts to come out right, however, it does so by stipulation rather than as a consequence of general properties of the theory of modality and is so to be dispreferred.

by operators are lexically encoded in a language's basic modal expressions. Incorporating ordering sources directly into the lexical semantics of a modal should make that modal deontic on the present analysis. If a language (e.g. one with such lexicalized deontics) lacked an independent deontic operator, it would furthermore be predicted to have modals having doxastic and metaphysical interpretations but lacking a deontic interpretation. As we will see below, Japanese is just such a language. A language that lexicalized the circumstantial operator but retained an optional ordering source operator should have modals that can be given either metaphysical or deontic interpretations but not doxastic interpretations. Finally, there should be no language with modals that are ambiguous between doxastic interpretations and deontic interpretations but which lack a metaphysical interpretation since there is no pattern of lexicalization of operators that could have this effect. These latter two predictions I have not yet explored, though they constitute a testable prediction of the theory presented. Whether these predictions are upheld across the various types of modal expressions across the worlds languages is a question only time will tell.

9   Extending the Analysis to Japanese

The technical analysis developed in the main section of this paper was worked out for the case of English modal verbs, where a single modal verb form can be given either a doxastic, a metaphysical or a deontic interpretation. Modal predicates in Japanese, however, generally do not exhibit this same three-way ambiguity. *Kamoshirenai* (may) in the examples in (6) as well as *ni-chigainai* (must) can be doxastic or metaphysical, while *-te ii* (may, for permission) and *-beki da* (should, of requirement) have only a deontic interpretation. The analysis we have given for English can be naturally extended to account for the Japanese facts as well. The only difference that needs to be introduced is to treat ordering sources as introduced only within the lexical specification of a sub-class of modal expressions in Japanese, and not available as a separate lexical item directly accessible by the syntax. This will leave all of the observed properties of the modals intact. Under this approach, the semantics of Japanese doxastic / metaphysical modal predicates would be modeled after (22a), and that of other modal predicates after (22b).

(22) a. $[[\text{kamoshirenai}]]^M = \lambda c \lambda p.[\exists u: u \in W_M \& c(u)] (p(u))$
b. $[[\text{-te ii}]]^{M,w} = \lambda c \lambda p.[\exists u: u \in W_M \& \exists i\ u \in \text{Max}(g(w))_i \& c(u)] (u \in p)$

The definitions given above preserve the world-dependence of deontic modals and the world-independence of doxastic and metaphysical modals. They furthermore instantiate one of the patterns of lexicalization that is predicted to be available as a universal possibility. The rest of the machinery for introducing models can remain unchanged and will have the same effect in Japanese as in English. Since the same quantifier scope contrasts found in English held for Japanese as well, this is a desirable consequence of the interpretations given.

The analysis of Japanese modals further leads to the same prediction as the English analysis regarding embeddability: non-doxastics should embed under other modals, while doxastics should not. The reason is again the same: doxastic interpretation requires access

to a model of the speaker's beliefs, but that model becomes unavailable once a circumstantial model is introduced, and in multiple doxastics one of the modals is always redundant. Indeed, to the extent that the architecture of interpretation is universal, these same facts are predicted to hold in all languages. That this prediction is upheld for Japanese can be seen in the Japanese counterparts to (19) – (21) given respectively in (23) – (25) below.

(23) Deontic modals can be embedded under other modals
   a. John-wa   iku-beki$_{deont}$-da
      John-TOP go-should-copula
      John should go
   b. John-wa   iku-beki$_{deont}$-kamoshirenai$_{meta(/dox)}$
      John-TOP go-should-may
      John may have to go (*may > have to*)
   c. John-wa   moshikashitara$_{dox}$ iku-beki$_{deont}$-da
      John-TOP perhaps   go-should-COP
      John perhaps should go (*perhaps > should*)
   d. John-wa   iku-beki$_{deont}$-dearu-beki$_{deont}$-da
      John-TOP go-should-copula-should-copula
      John should have to go

(24) Metaphysical modals can be embedded under other modals
   a. Sagashite-iru   hito-wa   John-ni-chigainai$_{meta(/dox)}$
      Looking for   person-TOP   John-must.be
      The person you are looking for must be John
   b. Sagashite-iru   hito-wa   John-ni-chigainai$_{meta}$ kamoshirenai$_{meta(/dox)}$
      Looking for   person-TOP   John-must   may
      The person you are looking for may have to be John (*may > have to*)
   c. ?Sagashite-iru hito-wa   moshikashitara$_{dox}$ John-ni-chigainai$_{meta}$
      Looking for   person-TOP   perhaps   John-must should-copula
      The person you are looking for perhaps must be John (*perhaps > must*)
   d. ?Shuujin-wa   yuuzai-ni-chigaina$_{meta}$-kereba-naranai$_{deont}$
      Prisoners-TOP   guilty-must-must
      Prisoners must have to be guilty (*must > have to*)

(25) Doxastic modals cannot be embedded under other modals
   a. Kono hito-wa   moshikashitara$_{dox}$ John-da
      This   person-TOP perhaps   John-COP
      This person is perhaps John
   b. #Kono hito-wa   moshikashitara$_{dox}$ John-ni chigainai$_{meta(/dox)}$
      This   person-TOP perhaps   John-must
      This person must perhaps be John (*must > perhaps*)
   c. ?#Kono hito-wa   tabun$_{dox}$ moshikashitara$_{dox}$ John-da

This   person-TOP probably   perhaps   John-TOP

This person is probably perhaps John (*probably > perhaps*)

d. #Sagashite-iru hito-wa   moshikashitara$_{dox}$ John-de-aru beki-da$_{deont}$

Looking.for   person-TOP perhaps   John-COP   should

The person you are looking for should be perhaps John (*should > perhaps*)

10   Scopal Preferences for D-linked Quantifiers

I have so far been accepting that ECP effects surface with all quantifiers, blocking them from taking wide scope over a doxastic modal, and I have formulated the analysis of modality to account for that fact.   D-linked quantifiers (cf. Pesetsky 1987), however, at first sight appear to counterexemplify the generalization upon which the ECP is established, as in the following examples.

(26) a.   Each student may be Jones
     b.   Either student may be Jones
     c.   Which students may be Jones?

(27) a.   Kaku   gakusei-ga   Jones de aru   kamoshirenai
        Each-GEN   student-NOM   Jones COP   may
        Each student may be Jones
     b.   Dochira-no   gakusei-demo Jones de aru kamoshirenai
        Which (of 2)-GEN   student-ever   Jones COP   may
        Either student may be Jones
     c.   Dono gakusei-ga   Jones de aru kamoshirenai no?
        Which student-NOM   Jones COP   may   Q
        Which student(s) may be Jones?

The quantifiers *each* and *either* and wh-expressions headed by *which* all clearly prefer a wide scope interpretation in the above examples.   The wide scope readings for (26a,b) can be seen in a situation in which a teacher faces a class full of unknown faces (a) or two unknown students (b) when she has reason to believe that Jones is among them.   In such a situation, the teacher need not countenance the possibility that *each student is Jones* or that *either student is Jones* for the sentences to be true.

While the examples presented clearly prefer for the quantifier to have wide scope over the modal, I maintain that this wide scope reading involves a metaphysical interpretation of the modal.   Establishing the possibility of a metaphysical interpretation is straightforward – add the phrase *objectively speaking* and notice that the scope facts remain unchanged.   More difficult is showing that a doxastic reading of the modal is impossible in the scope of a D-linked quantifier.   The result of substituting *perhaps* for *may* and *tabun* for *kamoshirenai*, however, goes a good way toward establishing that a doxastic modal cannot occur under the scope of a quantifier.   Recall that *perhaps* and *tabun* strongly prefer a doxastic interpretation. The examples in (28) and (29) in which these modals occur with a D-linked quantifier are

decidedly awkward, clearly much more so than their counterparts in (26) and (27). This is especially true with context provided to eliminate the possibility of a metalinguistic use of the quantifier (see footnote 6).

(28) a. #Each student is perhaps Jones
      b. #Either student is perhaps Jones
      c. #Which students are perhaps Jones?

(29) a. #Kaku   gakusei-ga   moshikashitara Jones de aru
           Each   student-NOM perhaps   Jones COP
           Each student is perhaps Jones
      b. #Dochira-no   gakusei-demo moshikashitara Jones de aru
           Which (of 2)-GEN   student-ever   perhaps   Jones COP
           Either student is perhaps Jones
      c. #Dono gakusei-ga   moshikashitara Jones de aru no?
           Which student-NOM   perhaps   Jones COP   Q
           Which student(s) is/are perhaps Jones?

The narrow scope reading of the quantifier is of course available, but in the declarative examples and the plural questions this scope gives rise to an absurdity. The wide scope reading of the quantifiers simply appears to be missing here.

     The above observations taken by themselves might suggest that the wide scope readings derive from a lexical property of a quantifier giving them preferential scope over all circumstantial modals, and that these scope preferences are independent of D-linking. However, sentence (30) shows that this is not the case.

(30) That may be two (of my) friends

In a situation in which (30) is uttered directly after hearing the doorbell, in the absence of any additional context the by far most natural reading is one in which the modal takes scope over the quantifier. The interpretation in that case is equivalent to *the following is possible: that that is two (of my) friends*. The opposite scope – there are two x among my friends such that it is possible that that is x – is comparatively much more difficult.[19] However, things change when context is added. Suppose that (30) is uttered in the following context:

(31) (Context for (30))
      5 of my friends visit me regularly. The doorbell just rang, and my daughter tells me

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[19] As von Fintel and Iatridou (2003) point out, a wide scope reading for the numeral quantifier is conceivable if this expression is given a non-distributed group interpretation. However, they do not establish the existence of such an interpretation, but merely show that it would be compatible with the interpretation observed.

that there is one person at the door, and that he has a moustache.   To me, that means that (30).

In this context, it becomes fairly easy to interpret (30) with *two (of my) friends* taking wide scope *provided that the two friends are understood to be among the 5 mentioned in the context*.   If the two friends in mind are taken to be identified independently of the five already mentioned, then the wide scope reading of the quantifier disappears.   The partitive version of (30) is somewhat more natural than the non-partitive version, though by facilitating an anaphoric interpretation of the non-partitive version by placing emphasis on *two* and deaccenting *friends* the relevant reading is marginally available in this case as well. Changing the quantifier to *two of them*, where the anaphoric connection to the previously mentioned friends is made explicit, makes the wide scope QP reading impeccable.   Note, incidentally, that replacing *may* with *perhaps* once again makes a wide scope quantifier reading much more difficult.

The above considerations suggest that D-linking facilitates wide scope over metaphysical modals but that contrary to first appearances it does not give us a way of quantifying into doxastics.   Unexplained here is why D-linking makes quantification into metaphysical modals so much easier than using non-D-linked quantifiers.   I can only speculate at this point that D-linking may be connected to the notion of evidence used to introduce a world parameter for non-doxastic modality, and requiring interpretation within an evidential domain and deriving the preferred wide scope for a D-linked quantifier.   While the proper analysis of D-linking is an interesting question, for reasons of time and space I have to leave the question here.

11   Remaining Problem

The framework developed above is very successful at accounting for a range of properties of modals.   There remains one important problem, however, whose solution does not follow from the theory developed, the problem of selective modality.   We have made a lot of use of the fact that *perhaps* strongly prefers a doxastic interpretation and lacks a metaphysical interpretation.   This fact itself, however, is not easily formalized in the semantics developed. Modals are assumed to be interpreted with respect to the worlds specified in the current model. There is no indication within the model, however, of where these worlds came from, i.e. whether they represent a doxastic modal base, any of a number of possible circumstantial modal bases or some other modal base.   Furthermore, for doxastic modals in particular it is difficult to see how to circumvent this problem.   Doxastic interpretation is differentiated from all other types of interpretation in not having a world parameter specified.   However, absence of a parameter is not generally the kind of thing that can be selected for.   The best that can be done for pure doxastic modals is to incorporate selection for an evidential operator in their lexical semantics.   However, there is no principled reason why an evidential operator needs to be restricted to a doxastic context, and unless such a reason can be found any such account would remain nothing more than an ad hoc stipulation.   At present, I do not see a way of giving a principled explanation for the existence of selective doxastic operators like

perhaps.   I note that the modals I know of that have a strong preference for doxastic interpretation are all adverbial, suggesting that a theory of adverb scope could potentially help to solve this problem.   For reasons of time, however, I have to leave this question for future research.

11   Conclusion

In this paper I have argued that the ECP effects uncovered by von Fintel and Iatridou (2003) are properly analyzed as involving doxastic modals and not metaphysical modals, i.e. that quantification into doxastics in a matrix context is impossible while quantification into metaphysical modals is allowed.   I showed that Kratzer's (1991) analysis of modal interpretation fails to predict this distinction because it treats all types of modality in a parallel fashion.   I then showed that a revision to the analysis that treats doxastic modality as interpretively prior to all other types of modality can account for the ECP effects without giving up the advantages of Kratzer's analysis.   The revision proposed is based on the notion that models are used to represent several different things in the course of semantic interpretation, speaker's beliefs, presumed objective circumstances and other speakers' beliefs among them.   This innovation makes it possible to use the worlds of a model as a modal base for modal interpretation, and also readily provides the asymmetry between doxastic modals and all other modals needed to account for ECP effects.   From a broader perspective, the proposed multi-model theory can readily serve as a basis for investigating the semantic properties of I-language, or what I call I-semantics, something that a semantic theory based on a single model is ill equipped to do.

Under the framework of modal interpretation proposed, ECP effects fall out as a consequence of doxastic interpretation not involving specification of a world parameter.   On the assumption that all quantification is world relative, this absence of a world parameter makes it impossible for a quantifier to be interpreted at the same level as a doxastic modal.   I showed that the fact that doxastic modals do not come in different flavors the way deontics do also follows from this absence of a world parameter at the relevant stage of interpretation. In this way, the analysis of ECP effects proposed goes farther than that of von Fintel and Iatridou in that it has broader and testable effects on other phenomena as well as accounting for the ECP effects themselves.

In making fundamental changes to the framework of semantic interpretation, the analysis proposed is certain to have far-reaching consequences not foreseen at this stage.   I hope I have at least made a plausible case that these consequences are worth pursuing.

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