The semantic roots of positive polarity: epistemic modal verbs and adverbs in Greek and Italian

Anastasia Giannakidou and Alda Mari
University of Chicago and Institut Jean Nicod CNRS/ENS/EHESS/PSL

October 2017

Abstract

In this paper, we started with the common observation that epistemic modal verbs and adverbs are PPIs. We study their behavior by examining modal spread— a phenomenon which, like all spread or concord phenomena in language, can be considered redundant or even anomalous, since it involves two apparent modal operators being interpreted as a single modality. We propose an analysis in which the modal and the adverb make two different contributions. In our theory modals feature a modal base that is partitioned between Ideal and non-Ideal words, according to stereotypicality. In our account stereotypicality does not trigger ordering, and ranking is provided by an upper layer of meta-evaluation that can be spelled out by the adverbs. MUST and MIGHT differ in that the first codes a lexical preference for higher ranking of stereotypical worlds. This preference is nonetheless negotiable and languages vary in the malleability of this parameter.

1 Modal verbs and adverbs: negation, modal spread

The interaction of modal verbs with negation has been the object of much recent study (among others, Iatridou and Zeijlstra 2013, Rubinstein, 2014, Homer 2015, Zeijstra to appear). A core observation is that universal *must* scopes above negation, but existential modals scope below:

(1) Ariadne must not be a doctor (= MUST (Ariadne not be a doctor)).

(2) Ariadne must not eat meat (Ariadne is a vegetarian).

(3) a. Ariadne cannot be a doctor.
b. Ariadne cannot talk to Dean.

(4) a. Ariadne doesn't have to be a doctor (to apply for this job).
b. Ariadne doesn't need to spend a lot of money (for Jason't birthday gift).

The English modal *must*, in both epistemic and deontic use, is interpreted with scope above negation. *Can*, on the other hand, receives scope inside negation, on a par with modals such as *have to, need* in (4). It did not escape attention that these scope constraints are reminiscent of polarity, and van der Wouden (1994) proposed indeed that *need* is a negative polarity item (NPI), identifying similar NPI modals in Dutch (*hoeven*) and German (*brauchen*). If the necessity *need* is an NPI, then its counterpart *must* must be a *positive* polarity item (PPI), since it escapes the scope of negation.

This basic polarity contrast of English has been reproduced in a number of languages, and though the data are not always exactly parallel (in part depending on what the actual modal verb system is in each language), the general tendency is that a necessity modal which is not an NPI will tend to scope above negation. In this paper, we will focus on the epistemic variants — which have generally received less attention than the deontic ones.

Our main focus will be the realization of epistemic necessity in Greek and Italian. We show below that Italian and Greek equivalents of *must* are also PPIs:

(5) a. Gianni deve essere malato.
John must.PRES.3SG be ill.
'John must be ill.'

b. Gianni non deve essere malato. MUST > NEG
John not must.PRES.3SG be ill.
'John must not be ill.'

(6) a. I Ariadne dhen prepi na einai eggyos. MUST > NEG
the Ariadne not must.PRES.3SG subj be pregnant
'Ariadne must not be pregnant (based on what I know).'

b. I Ariadne dhen xreiazete na ine eggyos. NEG > MUST
the Ariadne not need.3sg subj. be ill.
'Ariadne need not be pregnant (to be eligible for this leave).'

Giannakidou 1997 characterizes *xreiazete* 'need' in (6b) an NPI; like *need* it tends to have deontic reading (see also Iatridou and Zeijlstra 2013 for more discussion). Greek and Italian employ the modal verbs *dovere, prepi* as equivalents to *must*, and lack single word equivalents of the English words *should, ought, have to* and the like. (Italian uses the modal *dovere* in the conditional for *should*, or uses *essere tenuto* for *have to*.). Such lexicalizations tend to be employed for *priority* modality (Portner 2009, Rubinstein 2014, Portner and Rubinstein 2016), i.e. a wide range type of modality that is not epistemic, but sets up a contrast of priority between options or goals. Deontic modality can be understood as a kind of priority modality (Portner 2009). For now, simply note that Greek and Italian align with many of the world's languages that lexicalize in the modal verb system only the basic distinction between a universal modal (*prepi, dovere*), and an existential (*bori, potere*) (see further Staraki 2013 for more discussion on Greek modals; Narogg 2012 for cross linguistic discussion.)

Given the data above, we can generalize that the universal epistemic modals *must, dovere, prepi*— which can jointly be referred to as MUST[1]— are indeed PPIs, and we will ask the question: what makes MUST a PPI? The literature thus far emphasizes the syntactic aspects of the phenomenon, and a popular approach appeals to feature checking (Iatridou and Zeijstra 2013, Zeijstra to appear; and, partly Huitink 2012). We find the feature checking approach unsatisfactory for reasons to be made clear soon, and pursue a semantic explanation (see also e.g. Rubinstein 2014, Homer 2015). Our analysis crucially and newly rests on the behavior of MUST verbs and their co-occurrence with modal adverbs, which have also been characterized as PPIs (Nilsen 2004, Ernst 2009, Liu 2009).

Modal adverbs co-exist, crucially, with modal verbs in what we call *modal spread*. Modal spread is not typically discussed in the context of positive polarity, but we will argue that it is, in fact, instrumental in revealing additional structure in the modality that plays a key role in semantics and in producing the polarity effect. As an illustration of modal spread, consider the examples below:

[1]We use upper case as a cover term for related words in multiple languages; italics designate the linguistic expressions in specific languages.

(7) a. John must probably/certainly be sleeping.
b. John may possibly be a doctor.

Here we see *must* and *may* co-occurring with *probably/certainly* and *possibly*, respectively. Nilsen 2004 and Ernst 2009 observed the PPI behavior of modal adverbs in their discussion of speaker oriented adverbs. Focussing on modal spread, Lyons 1977 talks about 'harmony' in (7), (8)— the idea being that there is a concord running through the clause which results in the double realization of a single modality (Lyons, 1977: 808; see also Willer 2013), on a par with other cases of concord such as negative concord, person or gender agreement. This observation, namely that there is one modality in these cases, is stable in most of the analyses of the phenomenon (Geurts and Huitink 2006, Huitink 2012,2014, Grosz 2010, *a contrario* Anand and Brasoveanu, 2010). Syntactically, if we admit one modality in these cases, we are essentially saying that there is no embedding of one modal operator to the other. The two work together to produce a single modal structure. This situation is clearly distinct from true embeddings such as below:

(8) It may turn out that Ariadne must give her speech this afternoon.

This is a genuine case of *must* embedded under *may*; notice also the clause boundary (*that*). (Embedding can also happen within one clause, of course, as in *Ariadne may have to give her speech this afternoon*). In sentences (7) and (8) we have a single clause: the modal verb and adverb belong to the same syntactic domain.

If the modal verb is the modal operator, what is the semantic contribution of the adverb? In more philosophical works it has been claimed that "iterating epistemic possibility operators adds no value in the semantics" (Yalcin 2007: 994), or "embedding an epistemic modal under another epistemic modal does not in general have any interesting semantic effects" (Willer 2013: 12). Though these statements were mostly made mostly for embeddings, they reveal a concord perspective where some of multiple exponents of modality are semantically vacuous (just like, e.g., multiple exponents of negation in negative concord). Huitink 2012 and Moss 2015, on the other hand, argue that the multiple exponents of modality have a semantic role— and Huitink in particular argues that the adverb presents the ordering source of the modal. This can be thought of as a 'contentful' perspective to modal spread, and our own account and the novel data to be presented in this paper agree with this perspective.

In understanding modal spread, we must also acknowledge that we are not always dealing with concord, and this fact by itself serves as an argument that the use of the adverb is contentful. Modal verbs and adverbs with apparently opposing forces can co-occur with a single modality reading, as (9) shows for Italian *dovere* co-occurring with *forse* 'maybe':[2]

(9) Le luci sono accese. Gianni deve forse essere a casa. (non-harmonic use)
The lights are switch-on. Gianni must maybe be at home.
'The lights are on. John must (#maybe) be at home.'

Below is an attested example (see also Cui 2015 for a corpus study of modal concord). The discussion is about an archeological reconstruction of the town Castel Nuovo, near Naples.

(10) Il vaso, che costituisce uno dei premi guadagnati dagli atleti negli agoni panatenaici di

[2]Although very marginally, we also find some attested examples of the combination of epistemic *must* with *maybe* in English (see discussion in Lassiter 2014).

(i) So there must maybe be some glitch somewhere along the line or something that makes this happen. I am sure is a cache or technical glitchup[3]

Atene, **deve forse** fare parte del corredo di una sepoltura ubicata non lontano dall'area di Castel Nuovo.
'The jar, which constitutes one of the prizes earned by the athletes in the pan-athenians olympics of Athens, must maybe belong to the kid of a burial located not far from the area of Castel Nuovo.[4]'

Sentences like these are, to our knowledge, not discussed in the literature, and every theory of modal concord would claim that they do not have a single modality reading. We will argue here, however, that they do, and this is why we use the neutral term 'modal spread' instead of 'concord' (or 'harmony'). Huitink 2012 states that conditions on the adverbs "really can only be decided on a case to case basis" (Huitink 2012:30), but we aspire to show that there are some general principles that delimit the set of possible interactions.

Apparent harmonic uses seem to be pervasive in Greek and Italian:

(11) a. Prepi malon/oposdhipote na ine giatros.
Must probably/definitely subj be.3SG doctor
'He must probably/definitely be a doctor.'
b. Deve probabilmente/sicuramente essere un dottore.
Must.3SG.PRES probably/certainly be a doctor.
'He must probably/definitely be a doctor.'

(12) a. Prepi malon/oposhipote na efije noris.
must probably/definitely subj left.3SG early.
b. Deve probabilmente/sicuramente essere partito presto.
Must.3SG.PRES probably/certainly be left early.
'He must have probably/definitely left early.'

We see here the modal adverbs *malon/probabilmente* (*probably*), *oposdhopote/certamente* (*definitely*), etc. co-occur with the necessity modals *prepi/dovere/must*. In Greek and Italian, modal spread is very common and unmarked. We offered combinations with present and past tenses, to illustrate that the phenomenon is tense independent. We find the co-occurrence also with the future, see (13) (Bertinetto 1979, Mari 2009b, Giannakidou 2012, Giannakidou and Mari 2012a,2013):

(13) a. Arriverà certamente/probabilmente alle 4.
Arrive.3SG.FUT certainly/probably at 4.
'John will definitely/probably arrive at 4.'
b. O Janis tha erthi sigoura/malon stis 4.
the John FUT come.3SG certainly/probably at 4 pm.
'John will definitely/probably arrive at 4.'

Crucially, in Greek strong adverbs cannot co-occur with possibility *bori/may/might* (14-a)-(15-a). In Italian and English, on the other hand, weak modals can co-occur with strong adverbs (14-b)-(15-b)-(16), just as strong modals can co-occur with weak adverbs.[5]

[4]Source: `http://www.comune.napoli.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/1425/UT/systemPrint`

[5]An anonymous reviewer suggests that *probably* is an existential adverb. We disagree, and here is why. First, the data here indicate that *probably* combines with universal modals. Secondly, consider that the adverb *necessarily*, which would be the uncontested universal, tends to not be used epistemically in languages. Its closest equivalent, *obligatorily*, has deontic flavor. This leaves *probably* in the context of MUST and *should* as the universal adverb, and we are not aware of any analysis that argues otherwise.

(14) a. #Bori malon/opsdhipote na efije noris.
May probably/definitely subj left.3SG early.
b. Può probabilmente essere partito presto.
Can.3SG.PRES probably/certainly be left early.
'#He may have probably/definitely left early.'

(15) a. #Bori malon na ine giatros.
May probably subj be.3SG doctor.
b. Può probabilmente essere un dottore.
May.3SG.PRES probably/certainly be a doctor.
'#He may probably be a doctor.'

(16) In some cases, however, the psychosis might definitely be due to anxieties and conflicts associated with the pregnancy.[6]

In Italian, the co-occurence of existential modality with a strong adverb is extremely rare, although it is not impossible to find a few occurrences. In (17), we can be certain that the existential modal is epistemic insofar as it embeds a stative which cannot be coerced into an eventive giving rise to the abilitative or circumstantial interpretation of *potere* (*might*). We also see in the second sentence ('no matter how the facts were settled') that the truth is not established and that the first sentence is described as expressing a conjecture. In this attested example, *potere* combines with *probabilmente (probably)*.

(17) ... e a questa circostanza **può probabilmente** essere dovuto il fatto che egli fosse arrivato al nono compleanno. Comunque stessero le cose, in ogni modo, era il suo nono compleanno.
'and the fact that he reached his ninth birthday might probably be due to these circumstances. No matter how the facts where settled, in any case, it was his ninth birthday.[7]

On the other hand, the possibility adverb is grammatical only with possibility modals in Greek, Italian and English.

(18) a. Bori isos na efije noris.
may maybe subj left.3SG early
b. Può forse essere partito presto.
Can.3sg.pres maybe be left early.
'He may have possibly left early.'

(19) a. Bori isos na ine giatros.
may maybe subj be.3SG doctor
b. Può forse essere un dottore.
Can.3SG.PRES maybe be a doctor.
'He may possibly be a doctor.'

We can summarize the facts above in the following three generalizations:

1. Modal matching appears to be the general case, attested in all three languages (Greek,

[6]Source: https://books.google.com/books?id=c6JPyfOBZYIC&pg=PA74&lpg=PA74&dq=\%22might+definitely\%22&source=bl&ots=LXLgsQVXTj&sig=S5u9MCjN4HwRHnfYTs_yQOSbL9Y&hl=fr&sa=X&ved=0ahUKEwjp-4Xm36XVAhUJh1QKHWPFCVA4ChDoAQg5MAQ#v=onepage&q=\%22might\%20definitely\%22&f=false

[7]Source: https://books.google.fr/books?isbn=8804536829

Italian, English), as well as Dutch (Geurts and Huitink 2006, Huitink 2012,2014), and German (Grosz 2012).

2. Modal spread also allows non-matching. It appears to be a more restricted option, a fact that needs to be explained.

3. Languages are subject to variation with respect to whether they allow non-matching (Italian does, but Greek and English don't).

Importantly, the modal adverbs that participate in modal spread tend to be positive: *probably, definitely, maybe*. Negative incarnations of possibly epistemic adverbs, like *improbably* and *unlikely* are not used in modal spread:

(20) #Ariadne must/may unlikely/improbably be a doctor.

The reluctance of negative modal adverbs to participate in modal spread is to our knowledge unnoticed in the literature – but we will argue that the fact is consistent with our idea that modals cannot express negative bias. We discuss this issue further in section 6 in the context of interaction with negation.

To see the effect of the adverb and modal verb with negation, observe what happens when we have both:[8]

(21) a. #Dhen prepi profanos/malon na ine giatros.
Not must obviously/probably subj be.3SG doctor
b. #Non deve probabilmente/sicuramente essere un dottore.
#Not must.3SG.PRES probably/certainly/forse be a doctor.
'He must not obviously/probably/maybe be a doctor.'

The addition of the modal adverb yields a bad result, as it would without the verb *#Ariadne isn't probably a doctor*. Thus, the limited scope of MUST above negation, and the ill-formedness of the adverb inside the scope of negation both manifest the PPI-property, and the following puzzles need to be addressed:

1. What is the underlying cause for positive polarity with necessity epistemic modal verbs such as *prepei/dovere/must*?

2. What is the underlying cause for positive polarity with modal adverbs?

3. What is the proper analysis of modal spread such that it can account both for the (non)matching generalizations observed (recall examples (10)- (17)) , and the positive polarity property of both the adverb and modal verb?

Our discussion proceeds as follows. In section 2, we start with the positive polarity analysis of modal adverbs, and offer some more clarifications about the modal verb and adverb combinations that illustrate that modal adverbs need to be in the syntactic domain of the modal verb and disprefer higher positions when a modal is present (e.g. the sentence peripheral position). This will be taken as evidence that we are not dealing with embedding, but with composition

[8]In addition, universal epistemic modal verbs and adverbs cannot appear in questions or if clauses: *#Prepi (profanos/malon) na ine giatros? #Must it (probably, obviously) be the case that he is a doctor?* For a recent description of the English facts, see Hacquard and Wellwood 2012. Our judgment above reflects these results. The Greek and Italian facts don't appear to be different. The exclusion from questions support the characterization of universal epistemic modal verbs and adverbs as PPIs (see Ernst 2009 for more discussion).

of the modal verb with the adverb. Relying on Ernst 2009, we show that the modal adverbs that we are dealing with here behave differently from the evaluative adverbs. In section 3, we present the core ingredients of the modality theory we are assuming, which include: (a) the nonveridical axiom (Giannakidou 1999, Giannakidou and Mari 2016b,2017a), (b) an Ideal set and (c) a meta-evaluation ordering source $\mathcal{O}$ — the realization of which, we ill propose, is the adverb. Our account dissects the notion of Best of Kratzer, 1991 and Portner 1998,2009 into stereotypicality and meta-evaluation, only the latter acting as an ordering source and being introduced by a (possibly silent) adverb. Our analysis bears similarities to Rubinstein, 2014 and Portner and Rubinstein 2016, though these authors use secondary ordering sources. Our three postulates help us build the basic analysis of the MUST epistemic modal as a weak necessity and 'positively biased' modal. Section 5 addresses possibility modality. We discuss the implications and predictions of our analysis in section 6, where we derive PPI-hood, and discuss cross-linguistic variation. We conclude in section 7. To our knowledge, none of the existing accounts can afford the wide coverage we offer in bridging two seemingly unrelated phenomena, PPI-hood and modal spread.

2 Speaker-orientated adverbs and modal adverbs

2.1 Evaluative adverbs and modal adverbs: similarities and differences

The positive polarity property of English modal adverbs is discussed in Nilsen 2004 and Ernst 2009, where modal adverbs are framed in the context of speaker-oriented adverbs (SOAs) including purely evaluative adverbs. Ernst presents the most updated treatment, we will therefore take his theory as the point of departure. The observation is that SOAs are ill-formed in the scope of a local negation:

(22) a. Unfortunately, John disappeared.
b. Frankly, John is an idiot.

(23) a. Unfortunately, John didn't disappear.
b. #John didn't unfortunately disappear.

(24) a. Frankly, John is not an idiot.
b. #John isn't frankly an idiot.

This observation holds for a number of languages, including French and Catalan (Bonami and Godard 2008, Mayol and Castroviejo 2013). Crucially, as PPIs, SOAs resist being in the direct scope of other nonveridical operators (*if*-clauses and questions), as illustrated in (25) (Ernst also offers similar examples with *luckily, happily)*.

(25) a. #Has he unfortunately disappeared?
b. #If he has unfortunately disappeared...
c. #Has he surprisingly disappeared?

Modal adverbs are odd in these positions:

(26) a. #If he has probably disappeared...
b. #Has he probably disappeared?
c. #He has not probably disappeared.

PPIs exhibit limited interpretation, but are not subject to grammaticality conditions unlike NPIs (Giannakidou 2011). Consequently, a failed PPI is only infelicitous, as indicated by # above. Metalinguistic denial (Horn 2001) can often rectify PPIs (see Ernst 2009 for discussion): *John hasn't UNFORTUNATELY disappeared; I am thrilled he did!*. Using # reflects the judgement that the PPI failure is weaker than ungrammaticality— and this is an important observation about most PPIs that matters when it comes to the type of explanation needed.

Modal adverbs pattern with evaluative adverbs when it comes to the PPI property. However, there are also differences between modal adverbs and evaluative SOAs, recognized by Ernst. He distinguished between 'strong PPIs' which are blocked in all nonveridical contexts, including negation, questions and if-clauses, and 'weak' PPIs, which have a somewhat freer distribution and can be occasionally admitted in these contexts. We will only study the interaction with negation in the present paper, and will not elaborate further on the distribution. Crucially, Ernst treats modal adverbs as weak PPIs, but places evaluatives in the strong class.

A second difference concerns the syntactic positions of adverbs. Evaluative adverbs tend to appear in the peripheral position, either on the left or the right edge of the sentence.

(27) a. Unfortunately, John disappeared.
b. Unfortunately, John didn't disappear.
c. John didn't disappear, unfortunately.

When this happens, as we see, the negation is fine, a fact that proves the PPI property since now the adverb is outside the scope of negation. In the literature on polarity, PPI-hood is analyzed as the need to escape syntactically the offensive negation, and it typically translates into an anti-scope syntactic condition (Giannakidou 1998, Szabolcsi 2004; see also Progovac 1994). Evaluative adverbs tend to appear precisely in the peripheral position in a number of languages including French (Bonami and Godard 2008), and in Spanish (Mayol and Castroviejo 2013) where the high scoping is understood as contributing force and expressive meaning in the sense of Potts (2007). The preference for left peripheral position is taken as evidence that the evaluative adverbs are 'appended' in the clause, and that there is a different mode of composition (conventional implicature and expressive meaning; Mayol and Castroviejo 2013).

Modal adverbs, on the other hand, are typically odd in the peripheral position, and become worse if we add a modal verb. This appears to be the case in all three languages we are studying (we thank our native informants). Unless *mallon, probabilmente, probably* and the verbs are coerced to present the judgement of different individuals, the construals below are unacceptable:

(28) a. ?Probably, John disappeared.
b. ?Probably, John didn't disappear.

(29) a. #Probably, John must be the murderer.
b. #Probably, John might be the murderer.

Occasionally, they may improve depending on whether the speaker can assign to them a more evaluative flavor; but as mere modal adverbs they are not admissible.

Compare the respective versions with evaluative adverbs:

(30) a. Sadly, John must be the murderer.
b. Frankly, John might be the murderer.

The facts are parallel in Italian and Greek:

(31) a. #Probabilmente, Gianni deve essere l'assassino.
Probably, John must.3SG.PRES be the murderer.
'#Probably, John must be the murderer.'

b. #Forse, Gianni può essere l'assassino.
Maybe, John can.3SG.PRES be the murderer.
'#Maybe, John might be the murderer.'

(32) a. #Mallon, o Giannis prepei na ine o dholofonos.
probably, the John must subj. be.3SG the murderer.
'#Probably, John must be the murderer.'

b. #Isos, o Giannis bori na ine o dholofonos.
maybe, the John might subj. be.3SG the murderer.
'#Maybe, John might be the murderer.

In the peripheral position, with a break as indicated with the comma, the adverbs are simply odd. Instead, the modal adverbs prefer to be in the syntactic domain of the modal verb:

(33) a. Gianni deve probabilmente essere l'assassino.
Gianni must.3SG.PRES probably be the murderer.
'John must probably be the murderer.'

b. Gianni può forse essere l'assassino.
Gianni must.3SG.PRES probably be the murderer.
'John might maybe be the murderer.'

(34) a. O Giannis prepei mallon na ine o dholofonos.
the John must probably subj. be.3sg the murderer.
'John must probably be the murderer.'

b. o Giannis bori isos na ine o dholofonos.
the John might maybe subj. be.3SG the murderer.
'John might perhaps be the murderer.

A reviewer points out that there may be more nuanced cross-linguistic variation, for instance, if in some languages the post-modal position isn't available. Language specific syntax may indeed pose additional constraints. What we want to show here is that if we assume that modal adverbs are simply evaluative adverbs, we won't be able to explain why there tends to be difference in the sentence peripheral position. And since the evaluative class has been treated compositionally at non-assertion level, we think it is worth pointing out this difference at the beginning so as to know what available analyses make sense. As we point out in section 4, modal adverbs can be embedded, and we take this to further evidence that they contribute to the sentential level and no special compositional rule is needed.

Ernst does make a distinction between modal and evaluative adverbs in terms of distribution, characterizing the modals weak PPIs. It is thus plausible to assume that though evaluative and modal adverbs both want to avoid the scope of negation and are PPIs, they do not necessarily have to have the same syntactic analysis. A related difference between the two classes, noted in section 1, is that the evaluative adverbs can be positive or negative (*unfortunately, fortunately)*; but negative epistemic modal adverbs are rare (if existent at all: **un-probably, *un-maybe, *un-possibly, *un-necessarily* etc.). And when possible, they can't be used with modals; recall *Ariadne must improbably be a doctor*.

As with every polarity item paradigm, one must ask the question of what makes it polarity sensitive (the 'sensitivity question', see Israel 1996, Giannakidou 2011 for an overview). Ernst offers an inspiring idea, namely that SOAs become PPIs because they are *subjective*. Subjec-

tivity says that the adverbial sentence is true in all worlds in the speaker's epistemic state M:

(35) Subjectivity (for speaker orientation) (Ernst 2009: (62))
Where a speaker asserts Q= ADV(p),
(a) ADV is subjective iff all the worlds by which Q is evaluated are consistent with respect to the speakers epistemic state M(s) at the time of utterance; otherwise ADV is objective.
(b) Consistency: a set of worlds (q-worlds) is consistent with a belief state M if the proposition q is true both in q-worlds and in all the worlds in M.

Ernst formulates subjectivity and consistency specifically for 'speaker orientation'. Thus formulated, evaluative adverbs become subjectively veridical since all worlds support Q (more discussion coming next). Ernst's intent here is to indicate that the speaker is committed to the truth of the proposition when using the speaker oriented adverb. In Ernst's words: "Subjective SOAs must be true for the speaker's entire belief set - the speaker brooks no possibility of the proposition ADV(p) being false. This is how strong SOAs work, their strong emotion underlying this certitude. In contrast, evidentials are (very) objective because they necessarily invoke publicly available evidence which in principle may be at odds with the speaker's belief set. Weak PPIs are somewhere in the middle between the extremes of strong evaluative SOAs and evidentials." (Ernst 2009: 516). Modal adverbs are claimed to be weaker PPIs, and would not necessarily express such a strong certitude.

Ernst's insight is that oddity in the scope of negation arises because negation breaks the homogeneity that *all* worlds are p-worlds. The important insight of this type of account is that the PPI adverb, by getting associated with universal quantification over a set of worlds, lexically encodes a positivity that renders it incompatible with the scope of negation. Homer 2015 offers a similar account of PPI-hood of certain epistemic attitudes and modal verbs, but he does not make the connection to Ernst's work. Like Ernst, however, Homer proposes that with epistemic PPIs the modal base is homogeneous, and suggests further that this is a presupposition. Our explanation for the PPI property will use this idea— but we will show that non-homogeneity alone cannot explain PPI-hood; NPI universals, after all, are fine in the scope of negation. We will propose that the role of the adverb is crucial in producing a conflict with PPI universals.

We move on now to address more closely the empirical question of embedding, in order to make clear that in the cases under discussion in this paper we are dealing with modal composition and not embedding.

2.2 Embedding?

We just saw that modal adverbs are not at home in the sentence peripheral position, and we took that to be evidence that they compose with the modal. In a recent study, Moss (2015) considers phenomena under the label 'nested epistemic vocabulary'. This term includes a variety of constructions involving multiple epistemic modal expressions, for which she provides a unified account. Nested epistemics include cases like (36) ((64) in Moss), with syntactic embedding.

(36) a. It is definitely the case that Bob might be the best candidate for the job.
b. It might be probable that Liem is wearing green.

Moss discusses cases of contradictory nested modals (where the modals have different forces) and non-contradictory ones (where the modals have the same force). In typical embedding as above *definitely* and *might* are of different forces, and likewise *probable* and *might*.

According to Moss, the role of the adverb is to appeal to different opinions:

(37) $[\![\textbf{probably}_i]\!]^c = [\lambda S.\{\bigcup\{p \in g_c(i) : m\,|_p \in S\} > .5\}]$ (Moss, 2015:31)

In Moss' shorthand: "find the union of everyone that accepts that S. If you give that proposition greater than .5 credence, then your credences are contained in the content of "probably S". Moss concludes that the sentence in (35) means that, according to all (because of *definitely*) credences it is possible that Bob is the best candidate for the job.

Moss' view, it seems to us, correctly acknowledges a semantic role for the adverbs, but we see no empirical motivation for additional assumptions such as the internal committee representing sets of worlds in which different credences hold. We will cast our analysis in the more widely used semantics of Kratzer and Portner, and will make additional assumptions only if they are motivated empirically within that system.

Moss' system can also not derive the contrast below:

(38) a. John must probably be the murderer (ok without comma intonation)
b. #John might probably be the murderer (out without comma intonation)

The account cannot distinguish between modal spread and true embedding: in (39b) there can be no embedding because we have one clause, and English only allows matching spread, hence the #. The account is not designed to address the adverbs in connection to their polarity properties, and does not discuss the interaction with negation at all. A theory is needed that derives the difference between modal spread and embedding, while tolerating a certain degree of flexibility for the observed co-occurrences of differing forces with modal spread in Italian noted earlier.

To conclude this section, we think that modal embedding is real, and it is to be distinguished from modal spread. The study of nested modals, to use Moss' term, only recently attracted attention; it is therefore progress to state that 'nesting' is in fact two phenomena: spread (which involves one modal operator) and embedding (which involves two or more).

It is also worth repeating that modal adverbs are not identical to the evaluative class. Evaluative analyses, therefore, do not seem to be applicable to modal adverbs (see also Wolf, 2013). Modal adverbs occur in embedded clauses, as we see below, where the adverb is interpreted within the scope of *credere*, a fact which would be unexpected if the adverb were an utterance modifier (as in Potts' 2005 analysis):

(39) Credo che Maria deve forse/certamente essere a casa.
believe.1SG.PRES that Maria must maybe/certainly be at home.
I believe that Maria must maybe/certainly be at home.

We must therefore conclude that an evaluative analysis is not possible for modal adverbs. We retain Ernst's idea of positivity as universal quantification in a set of worlds, and create a system that is similar to using multiple ordering sources (Rubinstein, 2014). Before we move on to our account, let us lay out the foundation, the theory of modality we will rely on.

3 Epistemic necessity, (non)veridicality, and truth

We assume a Kratzer/Portner semantics for modality, where modals take modal bases and ordering sources. Following Giannakidou 1998, 1999, 2013b, Mari 2015,2017 and Giannakidou and Mari 2012a,b, 2013, 2016b, we add the 'Nonveridicality Axiom' that all modal bases are nonveridical, i.e. they are non-homegenous spaces containing p and $\neg p$ worlds. Beaver and Frazee 2016 adopt nonveridicality as a defining property of modality, and the Nonverdicality axiom

appear also in work by Condoravdi 2002 as a 'diversity' condition for modal bases. Nonveridicality derives a semantics of universal modals as 'weak', i.e., not entailing knowledge of the prejacent p, in the tradition of the 'mantra' (label by von Fintel and Gillies 2010). We propose that necessity modals express additionally 'positive bias' towards p, which means that p worlds are better possibilities than $\neg p$ worlds. Positive bias is responsible for positive polarity.

3.1 Subjective (non)veridicality: truth assessment relying on knowledge

In objective terms, we talk about sentences being true or false in the world. This may be adequate for textbook purposes, but the truth judgement is more complex: it is done relative to the speaker and hearer, who assess whether a sentence is true or not given what they know or what they believe (Giannakidou 1994, 1998, 1999, 2009, 2013b; Harris and Potts 2009; de Marneffe *et al.* 2012; Mari 2015c on perspectival generics). That such relativization is needed becomes particularly visible with propositional attitude verbs (*know, believe, imagine*, etc) and their complements (Farkas 1985, Giannakidou 1994, 1998, Mari 2016b, Giannakidou and Mari 2016a); but the role of the individual in assessing truth is apparent even in unembedded sentences, as expressed lucidly in Harris and Potts (2009) assertion that 'all' sentences are perspectival.

When a speaker asserts a positive unmodalized sentence in the present or past, unless she is lying, she asserts p because she knows or believes that p is true;[9] but when a speaker uses a modal verb, she may think that p is possible or even likely, she may have evidence supporting that p is true, but she doesn't know *for sure* that p is true. When speakers make assertions or assess assertions of others, they make *veridicality judgments* about the truth of the sentence— and the veridicality judgement is more complex than truth assignment because it depends on what speakers know and how they extract information from context (see especially Giannakidou 1998, 2013a, Mari 2003,2005, Giannakidou and Mari 2016b; de Marneffe *et al.* 2012 confirm this complexity with corpus data).

It makes sense, then, to talk about **objective** and **relative** veridicality for all sentences. Objective veridicality depends, naturally, on what is the case or not in the world, i.e. actual truth; but in relative veridicality, an individual is making the judgement— which we will call the *individual anchor* (Farkas 1992, Giannakidou 1994, 1998, et sequ.)— and the judgment relies on what the anchor knows or believes to be the case.[10] For unembedded sentences, the individual anchor is the speaker. For an unmodalized assertion of p, p is assertable if the speaker knows or at least believes p to be true. Another way to phrase this is to say that the speaker is epistemically committed to p. If the speaker doesn't know or believe p, she is said to not be epistemically committed to p (see also Smirnova 2013). Moore paradoxical sentences *#p and I do not believe that* p are infelicitous because the assertion of p requires that the speaker knows or believes p to be true (for more recent discussion, see Lauer, 2013; Mari, 2017b).

Giannakidou (1994, 1997) was among the first to propose a generalization of the veridicality judgement relative to individual anchors and their epistemic states. In main clauses the anchor is by default the speaker.[11] 'Models of evaluation' are defined to describe the information states of anchors (see Giannakidou 2013a for updated discussion). These models are sets of worlds,

[9]The relation between assertion and belief is a complex one that is now under close scrutiny in the linguistic literature, see Lauer 2013; Krifka 2015; Mari 2017b. We do not enter in this complex debate here, and focus on modality rather than belief.

[10]With sentences containing predicates of personal taste (Lasersohn 2005; Stephenson 2007) truth is determined not by knowledge but by taste or experience, and the individual anchor is called the *judge*.

[11]Individual anchoring of truth should be seen on a par with other kinds of anchoring of propositional content, i.e. temporal anchoring, or event anchoring (e.g. Hacquard 2006, 2010).

relative to i, corresponding to what i believes or knows.[12] Following Giannakidou 1999: (45), we call these models epistemic states in our definition below:

(40) *Epistemic state of an individual anchor i*
An epistemic state M(i) is a set of worlds associated with an individual i representing worlds compatible with what i knows or believes.

Given M(i), we now identify (non)veridicality *subjectively* in terms of inference to i knowing or believing p:

(41) *Subjective veridicality* (for functions)
A function F that takes a proposition p as its argument is subjectively veridical with respect to an individual anchor i and an epistemic state M(i) iff Fp entails that i knows or believes p: iff $\forall w'[w' \in \text{M}(i) \rightarrow p(w')]$.

Subjective veridicality reflects knowledge or belief of i that p is true, as in the classical treatment of Hintikka (1962), and imposes 'homogeneity' of the entire M(i).

Veridical functions require that the individual anchor is in an epistemic state that supports p, regardless of whether p is actually (i.e. objectively) true. For instance, *Nicholas believes that Ariadne is a doctor* reflects a veridical epistemic state, but the sentence *Ariadne is a doctor* can be objectively false.

(42) $[\![$Nicholas believes that $p]\!]$ is true in w with respect to M$(Nicholas)$ iff:
$\forall w'[w' \in \text{M}(Nicholas) \rightarrow p(w')]$

The truth condition of *believe* does not entail actual truth, but the verb *believe* is subjectively veridical, because the whole M$(Nicholas)$ supports p, that it is to say, M$(Nicholas)$ entails p.

When all worlds in M(i) are p worlds, p is entailed in M(i). This is a state of full epistemic commitment to p, a homogenous p-space. The verb *know* prototypically reflects such a homogenous veridical epistemic state. Other verbs denoting private epistemic spaces such as *dream, imagine*[13] are subjectively veridical like *believe*: they fully support p, but unlike *know* they do not entail actual truth (Giannakidou 1994, 1998, 1999; Giannakidou and Mari 2016a,b).

For unembedded sentences, subjective veridicality is a condition[14] on the assertability of the sentence:

(43) *Flavio is a doctor* is subjectively veridical with respect to a speaker i (the individual anchor) iff $\forall w'[w' \in \text{M}(i) \rightarrow doctor(Flavio)(w')]$.

An unmodalized unembedded sentence expresses the speaker's belief or knowledge of p. A negative sentence, in a parallel manner, expresses the speaker's belief or knowledge that $not\ p$:

(44) *Flavio is not a doctor* is true wrt the speaker i iff $\forall w'[w' \in \text{M}(i) \rightarrow \neg doctor(Flavio)(w')]$.

Again we have a universal condition, this time that all worlds in M(i) be $\neg p$ worlds. We can

[12]The difference between knowledge and belief is not important for our purposes here, and in many other cases, e.g. for mood choice, it doesn't matter either—- as verbs of knowledge and belief both select the indicative in many languages. Mari 2016 however refines the typology of non-epistemic and fictional attitudes and shows that there is a systematic ambiguity between *expressive-belief* (the classical Hintikkean belief) and *inquisitive-belief* (the subjunctive trigger for languages in which mood is parametric to the status of p in the common ground). Here we only focus on the Hintikkean interpretation of belief.

[13]See footnote 8 and Mari, 2016,2017 for a refinement of the meaning of fictional attitudes.

[14]It is still unclear whether necessary and/or sufficient, see discussion in Mari, 2017b.

therefore say that unmodalized sentences, positive or negative, are epistemically settled in the modal space M(i), where i is the speaker:

(45) *Epistemic settledness* in M(i)
M(i) is epistemically settled about p iff $(\forall w' \in \mathrm{M}(i) p(w')) \vee (\forall w' \in \mathrm{M}(i) \neg p(w'))$

The notion of epistemic settledness is useful as a characterization of homogeneity, and it includes both veridicality (all worlds are p worlds, the epistemic state is positively settled) and antiveridicality (all worlds are $\neg p$ worlds, the epistemic state is negatively settled). We can now define veridicality as a property of epistemic states as follows:

(46) *Veridicality of epistemic states*
a. An epistemic state M(i) is veridical about p iff it is positively settled: i.e $\forall w' \in \mathrm{M}(i) : p(w')$
b. An epistemic state M(i) is antiveridical about p iff it is negatively settled: i.e $\forall w' \in \mathrm{M}(i) : \neg p(w')$

Nonveridicality, on the other hand, is a property of a function that does not entail that i knows or believes p to be true.

(47) *Subjective nonveridicality* (for functions)
A function F that takes a proposition p as its argument is subjectively nonveridical with respect to an individual anchor i and an epistemic state M(i) iff Fp does not entail that i knows or believes p: iff $\neg \forall w' [w' \in \mathrm{M}(i) \rightarrow p(w')]$.

In terms of spaces, we define what follows.

(48) *Nonveridical epistemic state*
An epistemic state M(i) is nonveridical about p iff M(i) is partitioned into p and non-p worlds.

Nonveridical epistemic states M(i) are non-homogenous, containing p and $\neg p$ worlds, they are thus weaker than veridical states of knowledge and belief. Inquisitive spaces such as questions are, according to Giannakidou 1997, 1998, 2013, prototypical nonveridical epistemic states. Statements with possibility modals and modals generally are also nonveridical (labelled 'inquisitive assertions' by Giannakidou 2013), and epistemically weaker (Giannakidou and Mari 2016b) than unmodalized assertions: *It is raining* and *I believe that it is raining* are stronger epistemically than *It must be raining* because they are not partitioned.

Modalization reveals a nonveridical epistemic state partitioned into p and $\neg p$ worlds. This explains why it is odd to use the modals *It must be raining* when looking outside the window at the rain falling (see section 3 for extended discussion). Knowledge is an undisputedly strong, veridical state. By uttering *It must be raining* when the speaker sees the rain, the speaker either appears to question her own knowledge or is saying something weaker than what is actually the case – in both cases an odd result. The alleged evidential component of MUST is simply a reflection of its nonveridicality, i.e. of the fact that MUST p is incompatible with *knowing p* (see Giannakidou and Mari 2016b, a discussion that we follow up in the next section).

Following Giannakidou and Mari 2016b, we formulate nonveridicality as a precondition on modalities in the form of the axiom below:

(49) *Nonveridicality Axiom of modals*
MODAL (M) (p) can be defined only if the modal base M is nonveridical, i.e. only if

M contains p and non-p worlds.

The nonveridicality axiom requires that the modal base M be partitioned into worlds where p is true, and worlds where p is not true. This idea, as we said earlier, was also present in Condoravdi's 2002 diversity condition. Non-aleithic modals (possibility and necessity, epistemic, deontic, bouletic, etc) obey this principle, and therefore come with partitioned modal bases; consequently, epistemic modals do not entail p or knowledge of the speaker that p.[15]

To summarize, we end up with the following typology of modal spaces (sets of worlds):

(50) *Veridical and nonveridical modal spaces, homogeneity*

a. A modal space M is *veridical* with respect to a proposition p iff it is positively homogenous: $\forall w'(w' \in M \rightarrow p(w'))$

b. A modal space M is *nonveridical* with respect to a proposition p iff it is non-homogenous: $\exists w', w'' \in M(w' \neq w'' \wedge (p(w') \wedge \neg p(w''))$

c. A modal space M is *antiveridical* with respect to a proposition p iff it is negatively homogenous: $M \cap p = \emptyset$.

There are all sorts of modal spaces corresponding to all sorts of modalities and propositional attitudes, and the above definitions are general enough to be used in all kinds of cases. In the rest of the paper we focus on epistemic modals.

3.2 Epistemic MUST: nonveridicality and weak necessity

3.2.1 Partition in the modal base

Giannakidou and Mari (2016b,2017a) adopt the analysis of *must* by Kratzer 1991 (also Giorgi and Pianesi 1997, Portner 2009). MUST (and specifically Italian *dovere* and Greek *prepi*), associates with an epistemic modal base M(i) which is the set of propositions known by the speaker i at t_u (the utterance time). w_0 is the world of evaluation:

(51) M(i) (t_u) = $\lambda w'(w'$ is compatible with what is known by the speaker i in w_0 at t_u)[16]

The epistemic modality is by default 'subjective' (Lyons 1977), and knowledge changes with time. Epistemic modality is therefore parametric to knowledge at t_u, as is often acknowledged in the literature (see Portner 2009, Hacquard 2006,2010, Giannakidou and Mari 2016b).

Given what the speaker knows, the modal base of epistemic MUST is nonveridical and contains both p and $\neg p$ worlds. To derive this, MUST uses a set of propositions $\mathcal{S}$ which describe shared stereotypical/normalcy conditions. Such conditions have most notably been discussed in relation to genericity (see Asher and Morreau 1995) and progressives (Dowty 1979; Landman 1992; Portner 1998), but appear also as inertia (Dowty, *ibid.*), stereotypicality (Portner, 2009), and reasonability (Landman *ibid.*, Portner 1998; Mari 2014; see also discussion in Mari, Beyssade and Del Prete, 2012).

[15]There are two exceptions to Nonveridicality, and both result in trivialization of modality. The first case is the actuality entailment of ability modals, in which case the modal is trivialized (see Mari 2017). The second case is aleithic modality, as in *1 + 1 must equal 2*. Giannakidou and Mari (2016b) distinguish this deductive use of $must$ from the epistemic use — thus maintaining nonveridicality and so-called 'weakness' of epistemic MUST (Karttunen (1972). With both aleithic modality and actuality entailment, the distinction between modal and non modal statement is lost.

[16]It should be clear that our notation M(i) corresponds to the Kratzerian notation using set intersection $\cap f_{epistemic}(w_0, i)$, where this returns the set of worlds compatible with what it is known in w_0 by i.

The Kratzer/Portner semantics posits an ordering source Best which ranks worlds according to how close they are to the sterotypical ideal. Our account encodes that the modal base is partitioned into stereotypical and non-stereotypical worlds, but we dissociate stereotypicality from ranking. This allows us to capture possibility modals as undergoing the intial partition between stereotypical and non-stereotypical worlds without necessary ordering. Ranking in our system is expressed via a meta-evaluation which ranks the two sets of worlds produced by the initial partition. The adverb is the manifestation of the ranking.

Given an epistemic modal base M(i)(t_u), we define Ideal$_{\mathcal{S}}$ as a function over M(i)(t_u), still in the spirit of Portner 2009. The output Ideal$_{\mathcal{S}}$ is a subset of M(i).

(52) Ideal$_{\mathcal{S}}$ (M(i)(t_u)) = $\{w' \in \text{M}(i)(t_u) : \forall q \in \mathcal{S}(w' \in q)\}$

So defined, Ideal$_{\mathcal{S}}$ delivers the worlds in the epistemic modal base in which all the propositions in $\mathcal{S}$ are true. $\mathcal{S}$ is a set of propositions that corresponds to common ground norms. [17] The set Ideal$_{\mathcal{S}}$ is also parametric to time. Unless otherwise stated, we consider that Ideal$_{\mathcal{S}}$ is determined at the utterance time (this will be indeed always the case in the reminder of the paper). As we can see, there is no ranking. The modal base M(i) is now partitioned into p and $\neg p$ worlds (Nonveridicality Axiom), and MUST does not entail p or that the speaker knows or believes p (pace von Fintel and Gillies 2010). MUST is thus weak (see Giannakidou and Mari 2016b and Lassiter 2016 for recent discussions and many examples).

Let us consider the weakness of MUST a bit further. For von Fintel and Gillies, like for Karttunen 1972 before them, *must* requires the evidence for p to be indirect. To us, the issue is not about directness or indirectness, but of knowledge. To understand this, consider visual and auditory evidence. Von Fintel and Gillies predict both to be incompatible with MUST because they are both direct, but we predict a difference between seeing and hearing the rain. Consider seeing first, which is the well known case we alluded to earlier. MUST is infelicitous when I see, therefore I know, that it is raining.

(53) Context: I am in my office, looking at the rain through the window.
#It must be raining.

For von Fintel and Gillies (2010) this example is odd because the evidence is not indirect. But there is a simpler reason: the sentence is odd because if I see the rain I know it is raining. To see that this is a better explanation, consider what happens if I only hear the rain. In this context, contrary to seeing the rain, MUST is fine:

(54) Context: I am in a room, no windows; I hear sounds of what could be rain on the roof.

a. It must be raining.
b. Prepi na vrexi.
must subjunctive raining.
c. Pioverà.
rain-FUT.3sg.
d. Tha prepi na vrexi.
FUT must subjunctive rain.

I do not see the rain, therefore I do not know that it is raining, I only have sound that supports inferencing that it is raining, and MUST becomes good. Crucially, hearing is as direct as seeing (wee Willett 1988 upon whom von Fintel and Gilles 2010 rely), the contrast above is

[17] Since only those worlds are considered in which *all* the propositions in $\mathcal{S}$ are true, the function Ideal$_{\mathcal{S}}$ determines a cut-off point.

thus not predicted by von Fintel and Gillies who expect MUST to be infelicitous with hearing too. Therefore, Giannakidou and Mari 2016b conclude, Inferencing with MUST requires epistemic gaps— a conclusion supported consisntently by the data (in all three languages we are discussing). Consider also the following scenario:

(55) Context: I see a wet umbrella.
It must be raining.

If I only see a person coming in with a wet umbrella, I do not know that it is raining, but I can infer that it must be. MUST is felicitous in this inferential context, because seeing a wet umbrella alone does not imply that I *know* that it is raining. There is an epistemic gap that allows me to infer, but not know for sure, that that it is raining.

Consider further the observation that MUST statements can be continued by 'but I am not entirely sure', in Italian and Greek, as first noted in Bertinetto 1979; Mari 2009a,b, Giannakidou and Mari 2012b (see extended discussion in Giannakidou and Mari 2016b where the following example is drawn from):

(56) Deve essere a casa, ma non sono totalmente sicuro.
Must.3SG.PRES be at home, but not be.1SG.PRES entirely sure.
'He must be home, but I am not entirely sure.'

In this respect, MUST differs from *know* or the bare positive assertion which are veridical, and do not accept such continuation:

(57) a. #He is at home but I am not entirely sure.
b. #I know he is at home but I am not entirely sure.

Lassiter offers 2016 numerous attested English examples where *must* is compatible with 'I don't know for sure', and similar expression directly challenging knowledge of p:

(58) This is a very early, very correct Mustang that has been in a private collection for a long time. ... The speedo[meter] shows 38,000 miles and *it must be 138,000, but I don't know for sure*.

(59) *I don't know for sure*, sweetie, but she *must have been* very depressed. A person doesn't do something like that lightly.

(60) It must have been a Tuesday *(but I don't know for sure)*, I can't remember"

(61) I have an injected TB42 turbo and don't like the current setup. There is an extra injected located in the piping from the throttle body... *Must be an old DTS diesel setup but I'm not certain*. Why would they have added this extra injector?

There is nothing about indirectness here; the examples support the nonveridicality of MUST, i.e. that it cannot entail knowledge of p; if it did, the above examples should have been contradictions like the veridical assertions. MUST, rather, is inferential— signaling inference to p based on a number of premises and potential gaps.

Consider now deductive contexts:

(62) The ball is either in A, B or C. It is neither in A nor in B. It must be in C.

In this case, MUST indeed entails p and that the speaker knows p. But does this show that MUST is strong, as von Fintel Gillies would have it? Giannakidou and Mari 2016b argue that MUST in this case is not epistemic but aleithic, and note that deductive MUST is marked: it

bears focus on MUST, unlike epistemic inferential MUST which is unmarked. Consider, for instance, how odd it is in the inferential context to focus *must*:

(63) Context: I see a wet umbrella.
It MUST be raining.
PREPI na vrexi.

(64) The ball is either in A, B or C.
a. The ball is neither in A nor in B. It MUST be in C.
b. Dhen ine sto A oute sto B, ara PREPI na ine sto C. (Greek)
c. La palla è in A o in B. Non è né in A, né in B. DEVE essere in C. (Italian)

It is therefore reasonable to be cautious about the deductive use of MUST, and not confuse it with epistemic MUST which obeys the nonveridicality axiom and relies on inference and partial knowledge (Giannakidou and Mari, 2016b). MUST, therefore is weak in that its modal base in nonveridical, but at the same time 'strong', in performing universal quantification over the subset of M(i) that is Ideal$_{\mathcal{S}}$.

Epistemic MUST has the following basic truth condition; note that the tense comes from below (a semantic present and past; see Giannakidou and Mari, 2017b for discussion of tense):

(65) (to be completed)
$[\![$prepi/devere/must (PAST (p))$]\!]^{M,i,\mathcal{S},t_u}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![$prepi/*tha/futuro*/MUST (PAST (p))$]\!]^{M,i,\mathcal{S},t_u}$ = 1 iff $\forall w' \in$ Ideal$_{\mathcal{S}}$: $\exists t' \prec t_u \wedge p(w', t')$

(66) (to be completed)
$[\![$prepi/devere/must (PRES (p))$]\!]^{M,i,\mathcal{S},t_u}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![$prepi/*tha/futuro*/MUST (PRES (p))$]\!]^{M,i,\mathcal{S},t_u}$ = 1 iff $\forall w' \in$ Ideal$_{\mathcal{S}}$: $p(w', t_u)$

Echoing Giannakidou and Mari 2016b (and Szabo and Knobe 2013 before them), we can think of Ideal$_{\mathcal{S}}$ as the 'inner' domain of MUST, and M(i) as the 'outer' domain. The outer domain is a nonveridical space, but Ideal$_{\mathcal{S}}$ is veridical. This accounts for the illusion of strength. And there exists an additional component, that we proceed to study next, which is responsible for *bias* and positive polarity.

3.2.2 Positive bias and meta-evaluating ordering source

We will now postulate that Ideal$_{\mathcal{S}}$ and non-Ideal$_{\mathcal{S}}$ worlds are ranked according to an ordering source $\mathcal{O}$. It is common to assume secondary ordering sources in recent literature (Rubinstein 2014, Protner and Rubinstein 2016); but given that our initial partitioning into Ideal$_{\mathcal{S}}$ and non-Ideal$_{\mathcal{S}}$ worlds does not depend on ranking, $\mathcal{O}$ is not a secondary ordering. It is the primary ordering source, a 'meta-evaluation' that compares Ideal$_{\mathcal{S}}$ to its complement in M(i) (we thank Paul Portner for suggesting this term).

In everyday life, we constantly evaluate whether the actual world follows stereotypical rules.What counts as normal or reasonable outcome depends on one's knowledge and experience, and, as expected, human agents make use of it when they reason. Normalcy and reasonability manifest themselves as domain restriction with quantifiers, or ignoring exceptions with generic statements, to mention just two well known examples. Of course, actual outcomes do not always conform to what is expected under normalcy conditions, and expectation of not conforming to what it is 'normal' determines often our uncertainty (besides not having complete

knowledge). We propose the meta-evaluation $\mathcal{O}$ as a way to capture the speaker's confidence in normalcy effects. $\mathcal{O}$ contains those propositions that allow i to evaluate the relative ranking of Ideal$_{\mathcal{S}}$ and non-Ideal$_{\mathcal{S}}$.

Consider the case of John who is invited to a party. He is leaving from Place de la Sorbonne and needs to reach the Louvre. We know that he takes the metro. We also know that usually the metro works well in Paris. Ideal$_{\mathcal{S}}$ creates a partition is M(i) in which John arrives on time (these are worlds in which the metro worked well) and worlds in which he does not arrive on time (these are worlds in which the metro breaks down). Now, how likely are the worlds in which John arrives on time in comparison with those in which he does not? Usually, we believe, they are very likely, one of the propositions in $\mathcal{O}$ being 'I trust the metro system more than the car.' Stated otherwise, stereotypicality triggers high confidence in one's conclusion, and this seems to be something basic about the way humans draw conclusions. One will have a tendency to rank the stereotypical worlds as higher than the non-stereotypical ones. In this case one would probably utter something like (67-a) or even (67-b).

(67) a. John must be at the Louvre.
b. John must definitely be at the Louvre.

As we explained, higher ranking of stereotypical worlds is a common practice across individual anchors, who evaluate stereotypical worlds higher over non-stereotypical ones. Some anchors, however, can evaluate the situation in a different manner. Based on their pessimistic personal inclinations, or convinced that public transportation is not as unreliable as expected, one can draw a different conclusion. $\mathcal{O}$ will be different in this case, including 'I do not trust the metro system'. In this case, in a language like Italian, one would probably utter something like the following sentence, where the MUST combines with a possibility modal:

(68) Deve forse essere al Louvre.
Must maybe be at the Louvre.

A few comments. First, as we have noted, there is a pragmatic dependency between stereotypicality and the ordering source $\mathcal{O}$, revealing trust in the normalcy conditions. This dependency can be fragile because $\mathcal{O}$ is subjective, and does not rely on shared rules like the initial Ideal$_{\mathcal{S}}$ partition. $\mathcal{O}$ is a negotiable (Rubinstein, 2014, Portner and Rubinstein 2016) meta-evaluation of how confident i is about Ideal$_{\mathcal{S}}$ being a better possibility than non-Ideal$_{\mathcal{S}}$. In this sense, $\mathcal{O}$ can change as more arguments are added in the conversation.

Second, languages differ in the strength of the meta-evaluation. Languages like Greek maintain a dependence between stereotypicality and confidence, that it is to say, $\mathcal{O}$ will always rank the Ideal$_{\mathcal{S}}$ worlds as higher. Recall that there is no Greek counterpart of (68).[18] In other languages, the pragmatic connection between stereotypicality and $\mathcal{O}$ is more fragile, and $\mathcal{O}$ can reveal a low confidence, as we explain in section 6.2.

Third, and most importantly, lexical items encode whether $\mathcal{O}$ is empty or not, that it is to say, whether stereotypicality triggers ordering or not. MUST, we claim, lexically encodes a default preference for a non-empty $\mathcal{O}$, but epistemic possibility MIGHT encodes the preference for an empty one. Note that, both MUST and MIGHT have a non-empty $\mathcal{S}$. As we shall see in section 6.2 these preferences can be overwritten and languages differ in the extent to which they allow overwriting.

In the semantics we gave, MUST quantifies universally over the Ideal$_{\mathcal{S}}$ worlds. $\mathcal{O}$ in addition

[18]Recall that English is more ambiguous and that we can find some attested examples of the combination MUST + MIGHT, see footnote 2.

determines that Ideal$_{\mathcal{S}}$ is a better possibility than ¬ Ideal$_{\mathcal{S}}$. This creates positive bias:

(69) Positive bias of epistemic necessity modals.
Ideal$_{\mathcal{S}}$ is a weak necessity relative to M(i) and $\mathcal{O}$.

According to (69), there is no ¬Ideal$_{\mathcal{S}}$ world in M(i) which is not outranked by an Ideal$_{\mathcal{S}}$ world. Hence, the meta-evaluation is crucial in privileging the Ideal$_{\mathcal{S}}$ over its negative complement set in M(i), and in doing so it creates positive bias in epistemic necessity. As we noted earlier, authors have generally acknowledged a need to 'discriminate' between the two options in the modal base with necessity modals (e.g. Rubinstein 2014, Portner and Rubinstein 2016). Our own implementation proceeds in two steps, determining a partition based on stereotypicality and then evaluating the relative ranking of the two subsets. And recall again that the preference for p relies on a (potentially fragile) connection between stereotypicality and confidence that the actual world behaves in a stereotypical way.

Existential modals are generally taken to not have ordering sources (although there is variation across types of existential modals, see discussion in Portner, 2009). We will assume following most of the literature that epistemic possibility modals come with an empty $\mathcal{O}$, and we will call this, following Giannakidou 2013, Giannakidou and Mari 2016b, 2017 *nonveridical equilibrium*(more in section 5). In section 6.2, we see that the default preference for non-empty ordering sources can be overwritten.

We can now define a general concept of bias:

(70) Biased modals.
A modal verb is biased iff it has a non-empty $\mathcal{O}$.

It is important to note that the difference between bias in (70) and the positive bias in (69) we defined for universal epistemic modals. Focusing on (69), when $\mathcal{S}$ is non-empty, the bias will be necessarily positive. This, as we shall see in section 6.2 will play an important role in explaining the limited flexibility of modal verbs (necessity as well as possibility). The reader can already anticipate, that, in virtue of using $\mathcal{S}$, the necessity modal will not be able to express negative bias. We return to this in detail in section 6.2. Moreover, as we explain at length in section 5, by default, existential modals have a non-empty $\mathcal{S}$ and an empty $\mathcal{O}$. However, note that, by parametrizing existential modals to $\mathcal{O}$, we leave the possibility open that there may be existential modal lexicalizations with non-empty $\mathcal{O}$.

In sum, we have proposed here that the modal structure involves three ingredients: (i) a nonveridical modal base M(i), (ii) a secondary modal base $\mathcal{S}$ that partitions M(i) into Ideal$_{\mathcal{S}}$ and a ¬Ideal$_{\mathcal{S}}$ subsets and that relies on stereotypical assumptions, and (iii) a meta-evaluation $\mathcal{O}$ triggered by stereotypicality that ranks Ideal$_{\mathcal{S}}$ as a better possibility than ¬Ideal$_{\mathcal{S}}$. The preference for higher ranking of Ideal$_{\mathcal{S}}$ is lexically specified, and MUST and MIGHT differ in their lexical preferences (both use $\mathcal{S}$, but higher ranking of Ideal$_{\mathcal{S}}$ is only a feature of MUST). Next, we argue that the adverbs are overt realizations of the meta-evaluation $\mathcal{O}$.

4 Modal adverbs, modal spread, and positive bias

For universal modals, the role of the adverbs, we propose, is to reflect overtly the positive bias by supplying the meta-evaluation $\mathcal{O}$. They are thus responsible for the relative ranking of the Ideal$_{\mathcal{S}}$ as weak necessity, or necessity as we shall see. We call the former 'maintaining the default' – since this is the lexical default emerging from the high ranking of stereotypical worlds – and the later 'strengthening the default'. Some languages, as we discuss extensively

in section 6.2 also allow 'weakening of the default.'

Giannakidou and Mari (2013) noticed the connection between modal adverbs and 'speaker's perspective' and suggested a connection between positive bias and speaker confidence. They claim, for instance that with a necessity epistemic modal "the epistemic agent i has some degree of confidence that the actual world will be a reasonable one"— where reasonable is stereotypical — and that "when a modal adverb is present, the degree of confidence is determined by the adverb. It can be high when the adverb is strong (*certainly, definitely, probably*), in which case it is harmonic to the force of necessity modal; but it can also be medium (*50%*) or weak (*maybe, possibly*)." They continue that "with no modal adverbs, because of positive bias, the degree of confidence is high (i.e. akin to *probably/definitely*)." (Giannakidou and Mari 2013:121).

They also suggest to implement the confidence as a presupposition by using a measure function μ:

(71) Giannakidou and Mari 2013: confidence as a likelihood measure
Presupposition: there is a probability measure function $\mu_{likelihood}$ determined by i that measures the likelihood, according to i that the actual world is within the set of the best worlds. The default value of $\mu_{likelihood}$ is *probably*, above 80%.

That account contains the seeds of the analysis developed in the present paper; however, our analysis here will strive to maintain a strictly Kratzer/Portner semantics for modals.

Consider now that there are three nuances of strength for the adverbs. We do not claim that these are exhaustive, but they are faithful of the range of possibilities observed in the three languages we are considering.

(72) Effect of the adverbs with universal modals.
- a. DEFINITELY (It. *assolutamente*; Gk. *oposdhipote*; Eng. *definitely*): Strengthening the default.
- b. PROBABLY (It. *probabilmente*; Gk. *mallon*; Eng. *probably*): Maintaining the default.
- c. MAYBE (It. *forse*; Gk. *isos*; Eng. *maybe*): Weakening the default, indicates hesitation.

As we discuss in section 5, existential modality does not trigger bias, and does not use ordering sources (see Kratzer, 1991). MAYBE maintains the default lack of bias, and adding DEFINITELY or PROBABLY would introduce a bias.

(73) Effect of the adverbs with existential modals.
- a. DEFINITELY (It. *assolutamente*; Gk. *oposdhipote*; Eng. *definitely*): Introducing the bias.
- b. PROBABLY (It. *probabilmente*; Gk. *mallon*; Eng. *probably*): Introducing the bias.
- c. MAYBE (It. *forse*; Gk. *isos* Eng. *maybe*): Maintaining the default.

Not all the analytical possibilities are realized in each language — and while default and strengthening with universal modals are allowed in all, Italian (and English, see footnote 2 and the attested case repeated in (75-c)) differs from Greek in that weakening is realized for MUST. Likewise, English and Italian allows strengthening for possibility modals. These two analytical possibilities are absent in Greek. Recall the key examples from section 1:

(74) a. #Bori malon/opsdhipote na efije noris.
May probably/definitely subj left.3SG early

b. Può probabilmente essere partito presto.
Can.3SG.PRES probably/certainly be left early.
'#He may have probably/definitely left early.'

c. In some cases, however, the psychosis might definitely be due to anxieties and conflicts associated with the pregnancy.[19]

(75) a. Le luci sono accese. Gianni deve forse essere a casa.
The lights are switch-on. Gianni must.3SG.PRES maybe be at home.

b. Ta fora one anamena. O Janis prepei #isos na ine spiti.
The lights are on. The John must maybe be at home.
'The lights are on. John must maybe be at home.'

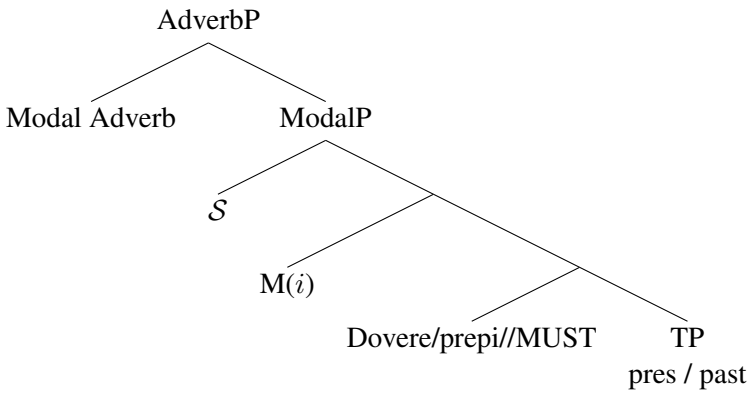
c. So there must maybe be some glitch somewhere along the line or something that makes this happen. I am sure is a cache or technical glitchup[20]

Now, for universal modals, we generalize and propose that without an overt adverb there is a silent adverb akin to *probably*. This covert adverb provides the baseline (default) bias of the universal modal.

4.1 Epistemic MUST and the effect of adverbs

The starting structure plus the adverb is as follows:

(76)



This is the structure of 'modal spread'. The adverb appears adjoined to the ModalP, a position consistent with its syntactic status of epistemic adverb (see Rizzi 1997, Hacquard 2010, and Portner 2009 for more discussion of the high scoping of epistemic adverbs). The adverb can appear following the verb too - generally the position is interchangeable as it became clear in the discussion in section 1. Regardless of position, the adverb is logically interpreted as an adjunct to ModalP as we propose here above. Within ModalP, we find the two arguments M(i) and $\mathcal{S}$, which are typically covert (unless there is an overt *if* clause to serve as the modal base). In our structure, the adverbs are expected to occupy the Modal Adverb slot. The following are thus equivalent semantically:

[19]Source: https://books.google.com/books?id=c6JPyfOBZYIC&pg=PA74&lpg=PA74&dq=\%22might+definitely\%22&source=bl&ots=LXLgsQVXTj&sig=S5u9MCjN4HwRHnfYTs_yQOSbL9Y&hl=fr&sa=X&ved=0ahUKEwjp-4Xm36XVAhUJh1QKHWPFCVA4ChDoAQg5MAQ#v=onepage&q=\%22might\%20definitely\%22&f=false

[20]Source: https://www.blackhatworld.com/seo/ogads-com-mobile-cpa-cpi-incent-network-mobil 704909/page-26. We thank Paul Portner for pointing this to us.

(77) a. John is probably sick.
b. John must probably be sick.
c. John must be sick.

If no overt adverb appears, there is a silent adverb, indicated as $\emptyset$. The lexical entry for this silent adverb triggered by MUST is as follows. For any proposition p and set $\text{Ideal}_{\mathcal{S}}$,

(78) $[\![\emptyset]\!]^{\mathcal{O}} = \lambda q.\text{Ideal}_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ & q

The $\emptyset$ adverb introduces lexically the weak necessity and the meta-evaluation $\mathcal{O}$. The higher position is motivated, as we said, by the nature of the epistemic modality— and no special composition rule is need, as one could argue e.g. for evaluative adverbs in a Potts-like framework (Mayol and Castroviejo 2013). Recall that, as we showed in section 2, modal adverbs generally disprefer being placed in the left periphery, contrary to purely evaluative adverbs. Some existent theories have defended a view in which the adverbs contribute ancillary commitments (Bonami and Godard, 2008), expressive content (Mayol and Castroviejo 2013, Giannakidou and Mari 2017b), or sincerity conditions (Nielsen 2004, Wolf 2013). In our view, the adverbs do none of these things; they can appear, for instance in embedded clauses:

(79) Credo che Maria è certamente/forse a casa.
believe.1SG.PRES that Maria is maybe/certainly at home.
I believe that Maria maybe/certainly is at home.

(80) Pistevo oti i Maria isos/sigoura ine sto spiti.
believe.1SG.PRES that the Maria maybe/certainly is at home.
I believe that Maria maybe/certainly is at home.

If adverbs were force operators, or contributed more at the speech act or Potts-style conventional implicature level, we wouldn't expect them to embed. Importantly, adverbs can't move above the attitude verb:

(81) #Forse/Certamente, credo che Maria e a casa.
Maybe/certainly believe that Maria is at home.
Maybe, certainly, I believe that Maria is at home.

(82) #Isos/sigoura, pistevo oti i Maria ine sto spiti.
Maybe/certainly, believe.1SG.PRES that Maria is at home.
Maybe, certainly, I believe that the Maria is at home.

In the embedded position the adverbs are interpreted within the local modal structures, we take it therefore that they contribute at the sentence level, as expected since they are epistemic.

Before proceeding with the semantics, let us also clarify that our structure differs from Huitink 2012 who argues that adverbs supply the ordering source of the modal. In that analysis, the adverb applies at a lower level. Huitink proposes the following trees (items (55) and (56) in Huitink 2012).

Huitink's modal "skeleton" renders the adverb a V-adjunction, but in our structure (76) the adverb is a VP adjunct applying after composition with the modal base and $\mathcal{S}$. Both analyses capture the dispreference for sentence initial position and the embedding data above. Our approach, renders the adverbs flexible with respect to where they will appear: they can be pre-modal or post modal (e.g., *must probably, probably must, mallon prepi, prepi mallon, probabilmente deve, deve probabilmente*), something expected since they are adverbs thus adjuncts. In the lower analysis, one expects a more rigid syntactic position.

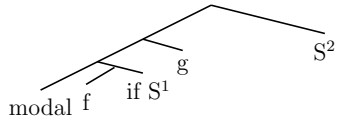


Figure 1: Modal skeleton - Huitink, 2012

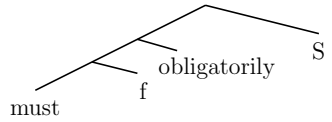


Figure 2: Adverbs provide the ordering source - Huitink, 2012

Crucially, our analysis, by placing the adverb higher than ModalP, allows for negation to intervene between ModalP and the adverb, and this will be used to explain why MUST cannot scope inside negation in section 6. If the adverb were a lower operator, we cannot see an explanation of the core positive polarity pattern.

We are now in position to provide the final truth conditions for MUST-sentences:

Consider first the case without an overt adverb (t_u still fixed at the time of utterance) but with the default silent one. We augment our earlier truth condition as follows. For any set Ideal$_{\mathcal{S}}$,

(83) $[\![\emptyset \text{ MUST (PRES } (p))]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if the modal base M(i) is nonveridical and it is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![\emptyset \text{ MUST (PRES } (p))]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff:
Ideal$_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ & $\forall w' \in$ Ideal$_{\mathcal{S}}$: $p(w', t_u)$

(84) $[\![\emptyset \text{ MUST (PAST } (p))]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![\emptyset \text{ MUST (PAST } (p))]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff
Ideal$_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ &$\forall w' \in$ Ideal$_{\mathcal{S}}$: $\exists t' \prec t_u \wedge p(w', t')$

The meta-evaluation of Ideal$_{\mathcal{S}}$ and non-Ideal$_{\mathcal{S}}$ worlds is conveyed by the adverb, the default force of which is *probably*. We now provide the lexical entries for the overt adverbs; q is the ModalP proposition (i.e. MODAL (PAST/PRES (p)). For any proposition p and set Ideal$_{\mathcal{S}}$,

(85) $[\![\text{Probably/mallon/probabilmente}]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ =
λq.Ideal$_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ & q

(86) $[\![\text{Definitely/oposdhipote/sicuramente}]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ =
λq.Ideal$_{\mathcal{S}}$ is a necessity relative to $\mathcal{O}$ & q

(87) $[\![\text{Maybe/Forse/Isos}]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = λq. $\mathcal{O}$ is empty & q

The input to the adverb is the modal proposition, and the adverb gives the (lack of) bias as part of the modal meaning. With PROBABLY the bias is maintained: PROBABLY has the same force as the default covert adverb, namely weak necessity. With a stronger adverb

(DEFINITELY), we have strengthening of the bias to necessity. This means that the adverb strengthens the default preference of MUST. A possibility adverb adds that $\mathcal{O}$ is empty. This means that there is no bias, no preference for the Ideal$_{\mathcal{S}}$ set over the not-Ideal$_{\mathcal{S}}$ set.

As we have already noted, bias strengthening is the only possible option supported in Greek (75-b). Italian and English allow bias weakening with MUST ((75-c) and (75-a)). We return in section 6.2 to the reasons according to which bias strengthening is quite a natural operation on the meaning of the modal.

In a syntactic configuration [Modal Adverb [MODAL p]], then, modal bias is determined by the Modal Adverb. Here are the complete truth conditions after the adverb bias is projected. For any proposition p, and set Ideal$_{\mathcal{S}}$.

(88) $[\![$PROBABLY MUST (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![$PROBABLY MUST (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff
Ideal$_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ & $\forall w' \in$ Ideal$_{\mathcal{S}}$: $\exists t' \prec t_u \wedge p(w', t')$

(89) $[\![$PROBABLY MUST (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![$PROBABLY MUST (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff
Ideal$_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ & $\forall w' \in$ Ideal$_{\mathcal{S}}$: $p(w', t_u)$

(90) $[\![$DEFINITELY MUST (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![$DEFINITELY MUST (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff
Ideal$_{\mathcal{S}}$ is a necessity relative to $\mathcal{O}$ & $\forall w' \in$ Ideal$_{\mathcal{S}}$: $\exists t' \prec t_u \wedge p(w', t')$

(91) $[\![$DEFINITELY MUST (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![$DEFINITELY MUST (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff
Ideal$_{\mathcal{S}}$ is a necessity relative to $\mathcal{O}$ & $\forall w' \in$ Ideal$_{\mathcal{S}}$: $p(w', t_u)$

Possibility adverbs would weaken the bias (see section 6.2 for discussion of this option).

Our analysis is relatively simple and stipulates nothing extraordinary in the semantics. It differs substantially from Moss 2015 (as discussed in section 2.2), but also from Huitink's (as discussed earlier). It also differs from Grosz (2010), who treats modal adverbs as operators over degrees mapping their prejacents into sets of degrees on a scale of necessity, where adverbs denote the *endpoints* of scales. Grosz also posits a matching requirement between the force of the modal and the adverb— argued to be a polarity presupposition on the modal degree modifier. In our account, weak necessity bias is hardwired in MUST by the covert adverb.

A binary distinction between universal and existential modality is explored by Anand and Brasoveanu (2010), who claim that the existential modal features a nonveridicality (existence of $\neg p$ worlds) implicature. In their view, universal modality does not give rise to nonveridical inference (it is thus, in our terms, veridical). But as we showed in our discussion of MUST earlier, this cannot be true. Importantly, universal modality is compatible with a range of adverbs (including possibility modals in Italian), a fact not predicted by Anand and Brasoveau.

As we conclude this part of the analysis, we must remind the reader that previous works mostly focus on deontic modality, for which the bias may be stronger (necessity, instead of weak necessity); if that is the case, then we expect less variation with deontic modals, it would thus be no surprise that previous theories cannot predict the more flexible patterns with epistemic modality identified here. Importantly, no rules of concord or feature checking were needed in

our discussion. Finally, consider that none of the previous accounts of modal concord establishes a correlation, as we do, between the modal and the adverb, and the PPI-hood of both. The similar PPI behavior of both modal verbs and adverbs is merely accidental in all accounts we have encountered, and the two phenomena are never connected.

5 Possibility modality

In agreement with the common analysis of epistemic possibility (Kratzer, 1991), we take it that epistemic possibility modals are existential quantifiers and that they lack ordering sources.[21] The absence of ordering sources with epistemic possiblity modals renders p and $\neg p$ equal possibilities revealing that the assessor is in a state of hesitation and true uncertainty. Following earlier work (Giannakidou 2013, Giannakidou and Mari 2016b,2017a), we call this *nonveridical equilibrium*. These works define nonveridical equilibrium as the absence of bias, which means, in our current terms, the following.

(92) Nonveridical equilibrium (updated)
A partitioned space M(i) is in nonveridical equilibrium if the ordering $\mathcal{O}$ is empty.

Nonveridical equilibrium implies that Ideal$_{\mathcal{S}}$ and Non-Ideal$_{\mathcal{S}}$ are not compared to one another; p and not p are equal possibilities, none is previlidged over the other. (In addition to possibility modals, neutral, information questions are also in nonveridical equilibrium, see Giannakidou 2013). We take equilibrium to be the default for epistemic possibility – hough it is conceivable that this may be subject to variation (see a brief discussion in Lassiter 2016 and discussion in section 6.2).

We assume, as before, that a silent adverb hosts the default preference for equilibrium of *bori/potere/might*. For any proposition p,

(93) $[\![\emptyset \text{ MIGHT (PAST } (p))]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![\emptyset \text{ MIGHT (PAST } (p))]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff $\mathcal{O}$ is empty & $\exists w' \in \mathrm{M}(i) \exists t' \prec t_u \wedge p(w', t')$

(94) $[\![\emptyset \text{ MIGHT (PRES } (p))]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![\emptyset \text{ MIGHT (PRES } (p))]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff $\mathcal{O}$ is empty & $\exists w' \in \mathrm{M}(i) p(w', t_u)$

Note that with the covert adverb, $\mathcal{O}$ is empty. Note also that the existential quantifier operates on the entire modal base M(i) and not on one of the subsets created by $\mathcal{S}$ (and Ideal$_{\mathcal{S}}$ in particular). This amounts to stating that the quantifier is blind to stereotypicality conditions in spite of the fact that these are always operational in the cognitive system of the anchors (note also that there might be p worlds which are not in the set Ideal$_{\mathcal{S}}$). Stereotypicality conditions, however, as we explain in section 6.2, can also trigger a non-empty $\mathcal{O}$ for MIGHT, in some languages.

Recall the entries of the adverbs in (85)-(86)-(87), which we repeat below. For any proposition p and set Ideal$_{\mathcal{S}}$,

(95) $[\![\text{Probably/mallon/probabilmente}]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ =
λq.Ideal$_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ & q

[21] Note that deontic possibility modals are claimed to use a circumstantial modal base and a deontic ordering source (see Portner, 2009).

(96) $[\![$Definitely/oposdhipote/sicuramente$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = λq.Ideal$_{\mathcal{S}}$ is a necessity relative to $\mathcal{O}$ & q

(97) $[\![$Maybe/Forse/Isos$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = λq. $\mathcal{O}$ is empty & q

Just as the presence of stereotypicality conditions with universal modals trigger positive bias (i.e. higher ranking of the Ideal$_{\mathcal{S}}$ over non-Ideal$_{\mathcal{S}}$), the absence of stereotypicality conditions with existential modal does not enhance any ranking.

In virtue of this, the most straightforward combination which we find in all languages is MAYBE + MIGHT. When we add MAYBE we obtain (98)-(99). The combination maintains the default, which now is nonveridical equilibrium. With possibility modals, MAYBE has no effect on the equilibrium, since it does not provide ranking. For any proposition p,

(98) $[\![$MAYBE MIGHT (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![$MAYBE MIGHT (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff $\mathcal{O}$ is empty & $\exists w' \in$M$(i)\exists t' \prec t_u \wedge p(w', t')$

(99) $[\![$MAYBE MIGHT (PRES (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![$MAYBE MIGHT (PRES (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff $\mathcal{O}$ is empty & $\exists w' \in$M$(i)p(w', t_u)$

As we note in section 6.2, languages may vary and the nonveridical equilibrium can be strengthened into bias if $\mathcal{O}$ is non-empty.

Possibility modals are not forced to scope above negation; the situation of equilibrium is compatible with both scopes. Empirically, possibility modals tend to scope below negation crosslinguistically. In *John cannot be at home*, the possibility is denied that John is at home. The reason for this preference, we want to suggest, seems to be that low scope with negation appears to be the general case with all kinds of existentials: *Ariadne didn't see any student/ a student/ one student* all scope below negation. If this is a general tendency of existential quantifiers, possibility modals simply follow this systemic pattern. (There do appear to be PPI existentials like *some— Ariadne didn't see SOME student—* but note that this use is marked; Giannakidou 2011)). It is an open question whether PPI possibility modals can be found in languages. Our analysis predicts, in any case, both scopes.

6 Back to the PPI property: why not negative bias?

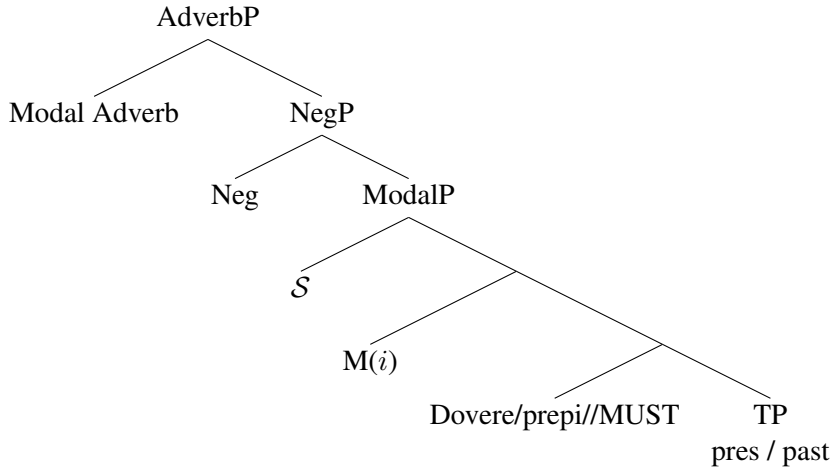
6.1 Negation and the higher adverb create a conflict

We are now ready to explain why epistemic MUST scopes above negation. Recall the truth conditions for MUST. For any p and set Ideal$_{\mathcal{S}}$,

(100) $[\![\emptyset$ MUST (PAST (p))$]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}}$ = 1 iff Ideal$_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ & $\forall w' \in$ Ideal$_{\mathcal{S}}$: $\exists t' \prec t_u \wedge p(w', t')$

MUST presupposes a non-homogenous modal base (we leave out here the nonveridicality condition for readability purposes); it universally quantifies over the Ideal$_{\mathcal{S}}$ worlds. Now, in Italian and Greek, the negation scopes, syntactically, above ModalP and below the Modal Adverb.

(101)



Negation typically takes TP as an argument, and in Greek and Italian appears directly preceding the verb (Zanuttini 1992, Giannakidou 1998). When a modal is used, negation will precede the modal: *dhen prepi*, *non deve* (lit. not must). The adverb appears above negation and can never intervene between negation and the modal:

(102) a. Malon dhen prepi.
Probably not MUST.
b. Probabilmente non deve.
Probably not must.

(103) a. *Dhen malon prepi.
Not probably must.
b. *Non probabilmente deve.
Not probably must.

We observe the same distributions for the existential.

(104) a. Isos dhen bori.
Maybe not can.
b. Forse non può.
Maybe not can.

(105) a. *Dhen isos bori.
Not maybe can.
b. *Non forse può.
Not maybe can.

Hence the adverb must be above the negation syntactically. Crucially, the adverb can never appear lower than negation, even in English:

(106) #Ariadne must not probably/definitely be at home.

Only a metalinguistic negation reading is acceptable here, which is irrelevant. In other words, scoping of modal adverbs under negation seems to be generally prohibited in languages.

As a result, the corresponding semantics would be as follows:

(107) $[\![\emptyset \text{ NOT MUST (PAST } (p))]\!]^{\mathcal{O},\mathrm{M},i,\mathcal{S}} = 1$ iff $\text{Ideal}_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ & $\neg\forall w' \in \text{Ideal}_{\mathcal{S}} : \exists t' \prec t_u \wedge p(w', t')$

The default adverb scoping high, it retains the content that Ideal$_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$, but Ideal$_{\mathcal{S}}$ now is targeted by negation and becomes non-homogenous. Ideal$_{\mathcal{S}}$ becomes now a nonveridical space, and this creates a conflict with positive bias: the Ideal$_{\mathcal{S}}$ worlds are required to be better possibilities than the $\neg p$ worlds, but not all Ideal$_{\mathcal{S}}$ worlds are p worlds. This is the kind of lexical conflict that must be avoided; negation being interpreted above MUST is the most obvious way to fix the problem. In other words, the positive polarity property of MUST is by-product of preventing or repairing a lexical inconsistency otherwise induced by the meta-evaluation function of the higher adverb, and the non-homogeneity of Ideal$_{\mathcal{S}}$ that results from application of negation. As we noted earlier, if the adverb were low (in Huitink 2012), it is unclear how low scoping can be avoided.

As regards NPI-universals like *need, hoeven, xreiazete*— which are typically deontic— we propose that the higher (adverb) content is neutralized. One way to make this precise in the context of our theory so far is to say that NPI necessity modals have an empty $\mathcal{O}$. That would be a lexical feature of them that, in contrast to epistemic PPI universals, renders them compatible with negation. The two necessity modals would thus differ not by stipulation but by lexical properties– a desirable result. Future research will show whether this is also a correct result.

As mentioned in section 2, our explanation is in line with Ernst (2009) and Homer (2015), with one major difference: we do not appeal to a clash between homogeneity and negation, but rather to a conflict between the default adverbial contribution ($\mathcal{O}$, positive bias towards p) and the non-homogeneity produced by negation. This has a variety of suitable consequences. Ernst and Homer assume subjectivity and 'opinionatedness' with a homogenous modal base— which, we argued, is not justified given that MUST p is incompatible with knowledge or belief of p. Here, we have shown that by using the modals the speaker is not opinionated; there is uncertainty in MUST because of the nonveridicality of the modal base which allows $\neg p$ worlds. And remember that, as we mentioned already, if non-homogeneity alone were responsible for PPI-hood then the contrast with NPI-universals cannot be explained since non-homogeneity doesn't cause a problem in that case.

6.2 Cross-linguistic variation: how much can $\mathcal{O}$ be negotiated?

We are now ready to explain cross-linguistic variation. Recall once again that Italian (and possibly English) are more tolerant and allow the combinations MUST + MAYBE.

(108) a. Le luci sono accese. Gianni deve forse essere a casa.
The lights are switch-on. Gianni must.3SG.PRES maybe be at home.

b. Ta fota one anamena. O Janis prepei #isos na ine spiti.
The lights are on. The John must maybe be at home.
'The lights are on. John must maybe be at home.'

c. So there must maybe be some glitch somewhere along the line or something that makes this happen. I am sure is a cache or technical glitchup[22]

We proposed an analysis of MUST triggering positive bias by using stereotypicality conditions. We also saw (i) that stereotypicality conditions per se do not introduce ordering and (ii) that the ordering is a meta-evaluation that in general Ideal$_{\mathcal{S}}$ worlds as higher. Given that ordering sources are easily negotiable (Rubinstein 2014, Portner and Rubinstein, 2016), the question is: how much? We expect some variation cross-linguistically, and here we make predictions that can be confirmed or challenged by further research on other languages.

[22]Source: `https://www.blackhatworld.com/seo/ogads-com-mobile-cpa-cpi-incent-network-mobil 704909/page-26`. We thank Paul Portner for pointing this to us.

Recall that bias can be strengthened, and DEFINITELY can be used with MUST. Bias strengthening is a possibility that exists across all languages under discussion (Greek, Italian and English). Strengthening does not contravene the default positive bias of MUST towards p, and appears to be a natural tendency.

Given the preference for positive bias of MUST, many languages including Greek ban the combination MUST + MAYBE, as MAYBE does not introduce ranking and is an indicator of equilibrium. However, occassionally, the observed preference is negotiated, and MUST can combine with MAYBE. In this combination bias weakens: $\mathcal{O}$ is now empty with MAYBE:

(109) $[\![\text{MAYBE MUST (PAST } (p))]\!]^{\mathcal{O},\text{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![\text{MAYBE MUST (PAST } (p))]\!]^{\mathcal{O},\text{M},i,\mathcal{S}}$ = 1 iff $\mathcal{O}$ is empty & $\forall w' \in$Ideal$_{\mathcal{S}} \exists t' \prec t_u \wedge p(w', t')$

This is an analytical option that some languages, like Italian (and to some extent English) realize. This analytical option can be realized, insofar as $\mathcal{O}$ is a parameter, and that it can either be empty or not. However, an empty ordering source combining with a modal that prefers a non-empty one overrules the lexical tendency of MUST, and is therefore a less common operation.

With possibility modals, $\mathcal{O}$ is empty, and we expect them to combine easily with adverbs that are similar. For this reason, in Greek, English and Italian possibility modals combine, unproblematically, with MAYBE. However, as we mentioned earlier, the combination between MAYBE + PROBABLY and even DEFINITELY, is not rare (it is in fact attested in English too, as we see in (110-c)).

(110) a. #Bori malon/opsdhipote na efije noris.
May probably/definitely subj left.3SG early
b. Può probabilmente essere partito presto.
Can.3SG.PRES probably/certainly be left early.
'#He may have probably/definitely left early.'
c. In some cases, however, the psychosis might definitely be due to anxieties and conflicts associated with the pregnancy.[23]

In Italian and English, we obtain what follows. Given the set Ideal$_{\mathcal{S}}$,

(111) $[\![\text{PROBABLY MIGHT (PAST } (p))]\!]^{\mathcal{O},\text{M},i,\mathcal{S}}$ is defined only if M(i) is nonveridical and is partitioned into Ideal$_{\mathcal{S}}$ and not-Ideal$_{\mathcal{S}}$ worlds. If defined,
$[\![\text{PROBABLY MIGHT (PAST } (p))]\!]^{\mathcal{O},\text{M},i,\mathcal{S}}$ = 1 iff
Ideal$_{\mathcal{S}}$ is a weak necessity relative to $\mathcal{O}$ & $\exists w' \in$ M(i)$\exists t' \prec t_u \wedge p(w', t')$

Again, this is an analytical possibility that some languages realize insofar as $\mathcal{O}$ is also a parameter of the existential modals that can, or cannot, be empty. Note that the resulting interpretation is not parallel to the bare MUST as the domain of quantification of the existential remains M(i) and the modal maintains its existential meaning.[24] However, while there is no contradiction in (111), the two conjuncts in the truth conditions create a cacophony that most of

[23]Source: https://books.google.com/books?id=c6JPyfOBZYIC&pg=PA74&lpg=PA74&dq=\%22might+definitely\%22&source=bl&ots=LXLgsQVXTj&sig=S5u9MCjN4HwRHnfYTs_yQOSbL9Y&hl=fr&sa=X&ved=0ahUKEwjp-4Xm36XVAhUJh1QKHWPFCVA4ChDoAQg5MAQ#v=onepage&q=\%22might\%20definitely\%22&f=false

[24]Unlike in St'aátimcets Matthewson et al. 2007 Greek, Italian and English distinguish modals according to force and the dimension that is manipulated is not force but ordering (i.e. bias).

the languages avoid. Greek does exactly that.

In sum, because combining a non-ordering possibility modal with an adverb that provides a non-empty ordering source goes against the natural inclination, the occurrence is more rare. But it is not excluded. We therefore conclude that, while keeping $\mathcal{O}$ empty with existential modals and non-empty with universal modals is the most reasonable option for both the modals and the meta-evaluation in line with an important portion of the data, it is not a logical necessity to have only harmonic combinations.

Finally, if $\mathcal{O}$ can be negotiated, then why don't we have *negative* bias? Our answer is the following: there is no parameter available for non-stereotypicality conditions, hence lower ranking of the domain of quantification of the modals is impossible. Our theory therefore predicts that, while it is possible to manipulate (upgrade or downgrade, as we saw) the default preferences of all modals— and to discard the preference of universal modals for positive bias and of the existential modal for lack of bias—, it is not possible to introduce a negative bias. The absence or, at best, extreme rarity of negative epistemic adverbs (**un-definitely, *un-maybe*) supports this fact, and recall that even the rare negative adverbs cannot be used in modal spread. One may find, for instance, *improbably* and *unlikely*, but neither one is used in modal spread:

(112) #Ariadne must/may unlikely/improbably be a doctor.

The reluctance of negative epistemic modal adverbs to participate in modal spread is, to our knowledge, unnoticed in the literature — but is evidence that the modals cannot express negative bias. Given what we said so far, none of the parameters of the existential and universal modals allow to encode preference for the $\neg p$ set. Recall that the ordering can be triggered by stereotypicality and that stereotypicality can cause the stereotypical set to be ranked higher and not lower. In other words, epistemic necessity and possibility are both 'positive' in virtue of the fact that stereotypicality conditions trigger bias towards the p-set. This seems to be a lexical property of all modals in language once sterotypicality is introduced. Crucially, there is no parameter available for non-stereotypicality conditions, therefore lower ranking of the domain of quantification of the modals is impossible.

7 Conclusions

In this paper, we started with the common observation that epistemic modal verbs and adverbs are PPIs. We decided to study their behavior by examining modal spread— a phenomenon which, like all spread or concord phenomena in language, can appear to be redundant or even anomalous, since it involves two apparent modal operators being interpreted as a single modality. We defended the following positions:

1. First, epistemic necessity modals are nonveridical, which means that they are incompatible with knowledge of p. Their nonveridical modal base includes a set of Ideal$_{\mathcal{S}}$ worlds that are p-worlds and a set of non-Ideal$_{\mathcal{S}}$ worlds. Ideal$_{\mathcal{S}}$ is ranked by a meta-evaluation $\mathcal{O}$ as a better possibility than the non-Ideal$_{\mathcal{S}}$ set, thus rendering epistemic universal modals inherently positively biased.

2. Second, the modal base of modals is either in nonveridical equilibrium (with existential, possibility modals), which means that $\mathcal{O}$ is empty, or there is positive bias, as is the case with epistemic necessity modals.

3. Third, the adverbs spell out the meta-evaluation $\mathcal{O}$. Generally, the tendency is for the adverbs to observe the inherent bias of the modal— given, we argued, by a null adverb—,

or to strengthen it. However, whether $\mathcal{O}$ is empty or non-empty maybe negotiable in some languages, and Italian and English allow the option of empty $\mathcal{O}$ with universal modal, and non-empty $\mathcal{O}$ with an existential. These options target the default specifications of the modals, and are therefore less common.

4. Fourth, though bias is negotiable, there is never negative bias because sterotypicality (manifested in $\mathcal{S}$) can only trigger an ordering source $\mathcal{O}$ that ranks the stereotypical set higher, and there is no modal parameter available for non-stereotypicality conditions. This means practically that MUST cannot combine with negative epistemic adverbs (which are indeed quite rare).

5. Universal epistemic modal verbs are PPIs because negation intervenes syntactically between the adverb and the verb, thus creating a conflict between the adverb positive bias that the $\text{Ideal}_{\mathcal{S}}$ set of p worlds be better possibilities, and the truth condition NOT MUST that not all $\text{Ideal}_{\mathcal{S}}$ worlds are p worlds. We have suggested that NPI-MUST contains an empty $\mathcal{O}$, therefore no problem arises and it can stay in the scope of negation.

In our analysis, modal spread emerges not as a redundancy, but as explicitly realizing the additional layer of $\mathcal{O}$, which can be empty (possibility) or non-empty (necessity). However, as we said, $\mathcal{O}$ is a parameter, and we may find possibility modals with nonempty $\mathcal{O}$, or necessity modals with an empty one (as we just claimed the NPI MUST might be). Our analysis makes the adverbs an integral component of modality; modal spread is the canonical structure of modality even if one piece (the adverb or the verb) is missing. We approached the puzzles differently from feature checking accounts (e.g. Zeijlstra to appear), and our theory is, we believe, better equipped to capture the nuanced data observed in this paper. Note, finally, that we relied on the standard premises of linguistic theories of modality (Kratzer 1991, Giannakidou 1998, 1999, Portner 2009, Mari, 2015, Portner and Rubinstein 2016, Giannakidou and Mari 2013, 2016b, 2017a), and we did not have to make any extraordinary assumptions.

References

Abusch, D. 2004. On the temporal composition of infinitives. In J. Guéron and J. Lecarme (eds.). *The Syntax of Time*, MIT Press, pp. 1-34.

Anand, P. and A. Brasoveanu (2010). Modal concord as modal modification. In *Proceedings of Sinn und Bedeutung 14*, pp. 19-36.

Anand, P. and Hacquard, V. 2013. Epistemics and Attitudes. *Semantics and Pragmatics 6*: 1-59.

Asher, N. and Morreau, M. 1995. What some generic sentences mean. In G. Carlson and F.J. Pelletier (eds.). *The Generic Book*. Chicago: CUP.

Bertinetto, P.M. 1979. Alcune ipotesi sul nostro futuro (con alcune osservazioni su potere e dovere), *Rivista di grammatica generativa 4*: 77-138.

Beaver, D. and Frazee, J. 2016. Semantics. In The Handbook of Computational Linguistics. Online Publication `DOI:10.1093/oxfordhb/9780199573691.013.29`

Bonami, O. and Godard, G. 2008. Lexical semantics and pragmatics of evaluative adverbs. In L. McNally and C. Kennedy (eds.). *Adverbs and adjectives: Syntax, semantics and discourse.* Oxford: Oxford University Press, pp. 274-304.

Condoravdi, C. 2002. Temporal interpretation of modals: modals for the present and for the past. In *The Construction of Meaning*, eds D. Beaver, Luis D. Cassillas Maritinez, Brady Z. Clark, S. Kaufmann.

Cui, Y. 2015. Modals in the scope of attitudes: a corpus study of attitude-modal combinations in Mandarin Chinese. PhD Georgetown University.

Dowty, D. 1979. Word Meaning and Montague Grammar. Dordrech: Kluwer.

Ernst, T. 2009. Speaker oriented adverbs. *Natural Language and Linguistic Theory* 27, 497-544.

Farkas, Donka. 1985. *Intensional Descriptions and the Romance Subjunctive*. New York: Garland.

von Fintel, K. and Gillies, A. 2010. Must...stay... strong ! *Nat. Language Semantics 18*: 351-383.

von Fintel, K. and Iatridou, S. 2008. How to Say Ought in Foreign: The Composition of Weak Necessity Modals. In J Guéron and J. Lacarme (eds.). Time and Modality. Dordrecht: Springer, pp. 115-141.

Giannakidou, A. 1997. *The Landscape of Polarity Items* . PhD thesis, University of Groningen. Amsterdam.

Giannakidou, A. 1998. *Polarity Sensitivity as (Non)veridical Dependency*. John Benjamins. Amsterdam.

Giannakidou, A. 1999. Affective dependencies. *Linguistics and Philosophy 22*: 367- 421.

Giannakidou, A. 2009. The dependency of the subjunctive revisited: temporal semantics and polarity. *Lingua 120:* 1883-1908.

Giannakidou, A. 2011. Positive polarity items and negative polarity items: variation, licensing, and compositionality. In Semantics: An International Handbook of Natural Language Meaning (Second edition; ed. by C. Maienborn, K. von Heusinger, and P. Portner). Berlin: Mouton de Gruyter.

Giannakidou, A. 2012. The Greek future as an epistemic modal. In the *Proceedings of ICGL 10*.

Giannakidou, A. 2013. Inquisitive assertions and nonveridicality. In The dynamic, inquisitive, and visionary life of ϕ, ?ϕ and possibly ϕ, A feestschrift for Jeroen Groenendijk, Martin Stokhof and Frank Veltman, ed. by Maria Aloni, Michael Franke, F. Roelofsen: 115-126.

Giannakidou, A. and Mari, A. 2012a. Italian and Greek futures as epistemic operators. *Proceedings of CLS 48*, pp. 247-262.

Giannakidou, A. and Mari, A. 2012b. The future of Greek and Italian: An epistemic analysis. Proceedings of *Sinn und Bedeutung 17*: 255-270. `http://semanticsarchive.net/Archive/Dk3NGEwY/GiannakidouMari.pdf`

Giannakidou, A. and Mari, A. 2013. A two dimensional analysis of the future: modal adverbs and speaker's bias. *Proceedings of the Amsterdam Colloquium 2013*, pp. 115-122.

Giannakidou, A. and Mari, A. 2016a. Emotive predicates and the subjunctive: a flexible mood OT account based on (non)veridicality. In *Proceedings of Sinn und Bedeutung 20*, pp. 288-305.

Giannakidou A. and Mari, A. 2016b. Epistemic future and epistemic MUST: nonveridicality, evidence, and partial knowledge. In Tense, Mood, and Modality : New Perspectives on Old Questions, ed. by Blaszack, J. et al., University of Chicago Press.

Giannakidou, A. and Mari, A. 2017a. A unified analysis of the future as epistemic modality: the view from Greek and Italian. *Natural Language and Linguistic theory*. `https://doi.org/10.1007/s11049-017-9366-z`

Giannakidou, A. and Mari, A. 2017b. La dimension épistemique du futur : le rôle des adverbes. In Baranzini and de Saussure (eds). *Le Futur dans les langues Romanes*. Peter Lang AG.

Giorgi, A. and Pianesi, F. 1997. *Tense and Aspect: Form Semantics to Morphosyntax*. Oxford: Oxford University Press.

Grosz, P. 2010. Grading modality: a new approach to modal concord and its relatives. In *Proceedings of Sinn und Bedeutung 14*, pp. 185-201. `http://www.univie.ac.at/sub14/http://www.univie.ac.at/sub14/`.

Geurts, B. and Huitink, J. 2006. Modal concord. In P. Dekker and H. Zeijlstra (eds.), *Concord and the syntax-semantics interface*. ESSLLI, Malaga, pp. 15-20.

Gunlogson, C. 2001. *True to Form: Rising and Falling Declaratives in English*, Ph.D. UCSC.

Hacquard, V. 2006. *Aspects of Modality*. PhD MIT.

Hacquard, V. 2010. On the Event Relativity of Modal Auxiliaries. *Natural Language Semantics 18(1)*: 79-114.

Hacquard, V. Wellwood, A. 2012. Embedding epistemic modals in English: A corpus-based study. *Semantics and Pragmatics, 5(4)*: 1-29.

Hamblin, C. 1970, *Fallacies*, London: Methuen.

Harris, J. A. and Potts, C. 2009. Perspective-shifting with appositives and expressives. *Linguistics and Philosophy 32(6)*: 523-552.

Homer, V. 2015. Neg-raising and positive polarity: The view from modals. *Semantics & Pragmatics 8*: 1-88.

Halliday, M. A. K. 1970. Functional diversity in language as seen from a consideration of modality and mood in English. *Foundations of Language 6*: 322-361.

Hintikka, J. 1962. *Knowledge and Belief.* Cornell: Cornell University Press.

Huitink, J. 2012. Modal concord. A case study in Dutch. *Journal of Semantics 29(3)*: 403-437.

Huitink, J. 2014. Modal concord. Submitted to The Blackwell Companion to Semantics, edited by Lisa Matthewson, Cécile Meier, Hotze Rullman and Thomas Ede Zimmermann.

Iatridou, S. and Zeijlstra, H. 2013. Negation, polarity and deontic modals. *Linguistic Inquiry* 44: 529-568.

Israel, M. 1996. Polarity sensitivity as lexical semantics. *Linguistics and Philosophy 19(6)*: 619-666.

Karttunen, L. 1971. Some observations on factivity. *Papers in Linguistics 4:1*: 55-69.

Karttunen, L. 1972. Possible and must. *Syntax and Semantics*: volume 1. J. Kimball. New York, Academic Press: 1-20.

Knobe, J. and Szabo, G.S. 2013. Modals with a taste of the deontic. *Semantics and Pragmatics 6*: 1-42.

Kratzer, A. 1981. The Notional Category of Modality. In *Words, Worlds, and Contexts. New Approaches in Word Semantics*, ed. By H. J. Eikmeyer & H. Rieser, 38? 74. Berlin: de Gruyter.

Kratzer, A. 1991. Modality. In Semantics: *An International Handbook of Contemporary Research*, ed. By A. von Stechow & D. Wunderlich, 639-650. Berlin: de Gruyter.

Krifka, M. 2015. Bias in Commitment Space Semantics: Declarative questions, negated questions, and question tags. *Proceedings of SALT 25*, 328-345.

Landman, F. 1992. The progressive. *Natural language semantics, 1(1)*: 1-32.

Lasersohn, P. 2005. Context dependence, disagreement, and predicates of personal taste. *Linguistics and Philosophy* 28: 643-686.

Lassiter, D. 2014. The weakness of must: In defense of a Mantra. *Proceedings of SALT 24*: 597-618.

Lassiter, D. 2016. Lassiter, Daniel. 2016. Must, knowledge, and (in)directness. *Natural Language Semantics* 24: 117-163.

Lauer, S. 2013. Towards a dynamic pragmatics. PhD Stanford.

Liu, M. 2009. Speaker-Oriented adverbs of the German *-weise* sort. *Proceedings of Sinn ind Bedeutung 2009*, 333-346.

Lyons, J. 1977. *Semantics*. Cambridge University Press, Cambridge

Mari, A. 2003. *Principes d'identification et de catégorisation du sens: le cas de 'avec' ou l'association par les canaux*. Paris: L'Harmattan.

Mari, A. 2005. Intensional and epistemic wholes. In E. Machery, M. Werning, and G. Schurz (eds.), *The compositionality of Meaning and Content*. Vol I Foundational issues. Frankfurt : Ontos Verlag.

Mari, A. 2009a. Disambiguating the Italian Future. In Proceedings of *Generative Lexicon*, 209-216.

Mari, A. 2009b. Future, judges and normalcy conditions. *Selected talk at Chronos 10*, Austin, Texas. `https://halshs.archives-ouvertes.fr/ijn_00354462/`

Mari, A. 2014. *Each Other*, asymmetry and reasonable futures. *Journal of Semantics, 31(2)*: 209-261.

Mari, A. 2015a. *Modalités et Temps*. Bern: Peter Lang AG.

Mari, A. 2015b. French future : Exploring the future ratification hypothesis. *Journal of French Language Studies*, doi :10.1017/S0959269515000289.

Mari, A. 2015c. Overt and covert modality in generic sentences. *Cahiers Chronos 27*: 265-288.

Mari, A. 2016. Assertability conditions of epistemic (and fictional) attitudes and mood variation. *Proceedings of SALT 26*: 61-81.

Mari, A. 2017a. Actuality entailments: when the modality is in the presupposition. In *Lecture Notes in Computer Science*, Dordrecht: Springer Verlag, pp. 191-210.

Mari, A. 2017b. Belief and assertion. Evidence from mood shift. Talk presented at QSA Konstanz, September 2017.

Mari, A., Beyssade, C. and Del Prete, F. 2012. Introduction. In A. Mari, C. Beyssade and F. Del Prete (eds.). *Genericity.* Oxfor: Oxford University Press, pp. 1-92.

de Marneffe, M., C. Manning, and C. Potts. 2012. Did it happen? The pragmatic complexity of the veridicality judgement. *Computational Linguistics* 38: 300-333.

Mayol, L. and Castroviejo, E. 2013. (Non)integrated evaluative adverbs in questions: A cross-Romance study. *Language 89(2)*: 195-230.

Montague, R. 1969. On the nature of certain philosophical entities. *The Monist* 53, 159-194.

Matthewson, L. Rullmann, H., and Davis, H. 2007. Evidentials as Epistemic Modals: Evidence from St'at'imcets. *The linguistic Variation Yearbook 7*, 201-254.

Moss, S. 2015. On the semantics and pragmatics of epistemic vocabulary. *Semantics and Pragmatics 8*: 1-81.

Narrog, H. 2012. *Modality, Subjectivity, and Semantic Change*. Oxford University Press.

Nielsen, Ø. 2004. Domains for adverbs. *Lingua, 114(6)*: 809-847.

Palmer, F.R. 1987. *Mood and Modality*. Cambridge UP.

Portner, P. 1998. The Progressive in Modal Semantics. *Language 74(4)*: 760-87.

Portner, P. 2009. *Modality*. Oxford University Press.

Portner, P. and Rubinstein, A. 2016. Extreme and non-extreme deontic modals. In N. Charlow and M. Chrisman (eds.), Deontic Modality. Oxford: OUP.

Potts, C. 2005. *The logic of conventional implicature*. Oxford: Oxford University Press.

Potts, C. 2007. The expressive dimension. *Theoretical Linguistics 33(2)*:165-197.

Progovac, L. 1994. Positive and Negative polarity: A binding approach. Cambridge: Cambridge University Press.

Rubinstein, A. 2014. On Necessity and Comparison. *Pacif Philosophical Quaterly* 95: 512-554.

Smirnova, A. 2013. Evidentiality in Bulgarian. *Journal of Semantics*: 1-74.

Stephenson, T. 2007. Judge dependence, epistemic modals, and predicates of personal taste. *Linguistics and Philosophy, 30(4)*: 487-525.

Szabolcsi, A. 2004. Positive polarity - Negative polarity. *Natural Language and Linguistic Theory 22*, 409-452.

Yalcin, S. 2007. Epistemic modals. *Mind 116*: 983-1026.

Tonhauser, J., Beaver, D., Roberts, C. and Simons, M. 2013. Toward a taxonomy of projective content. *Language 89(1)*: 66-109.

Willer, M. 2013. Dynamics of Epistemic Modality. *Philosophical Review* 122: 45-92.

Willett, T. 1988. A cross-linguistic survey of the grammaticalization of evidentiality. *Studies in Language 12*: 51-97.

Wolf, L. 2013. Degrees of Assertion. PhD Dissertation, Ben Gurion University.

van der Wouden, T. 1994. *Negative Contexts*. PhD. University of Groningen.

Zanuttini, R. 1992. Negation and Clausal Structure: A Comparative Study of Romance Languages. PhD thesis Penn.

Zeijlstra, E. forthcoming. Universal quantifiers PPIs. To appear in Glossa.

Zwarts, F. 1995. Nonveridical contexts. Linguistic Analysis.