Epistemic weakening with future and *must*: non veridicality, evidentiality, and partial knowledge

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Abstract

In this paper, we show that future morphemes in Greek and Italian have purely epistemic non-predictive readings, behaving as equivalent to English *must*. We call this use 'epistemic future'. Epistemic future appears to have an evidential component: it cannot be used if the speaker *knows*, either via visual perception, or via a report, that the prejacent proposition p is true. This renders epistemic futures nonveridical, on a par with *must* (Giannakidou 1998, 1999, Giannakidou and Mari 2012a,b). The judgment with the future is epistemically weaker than an unmodalized assertion, and relies on *partial* knowledge supporting p. We show that partial knowledge is not indirect knowledge. Our analysis contrasts with von Fintel and Gillies 2010 who argue that *must* is 'strong', and further refines the classical 'weak' analysis of universal epistemic modals (Kartunnen 1972, Kratzer 1981, Giannakidou 1998, 1999 and more recently Lassiter 2013).

1   Epistemic future: core data from English, Dutch, Greek and Italian

The question of whether the category 'future tense' in natural languages is a tense or modality has received a lot of attention in linguistic semantics, and both answers have been explored (for modal accounts see Bertinetto, 1979; Enç 1996, Copley, 2002; Squartini, 2004; Kaufmann 2005; Mari, 2009,2010,to appear, Klecha to appear, Giannakidou 2012, Giannakidou and Mari 2012a,b, Broekhuis and Verkuyl to appear; for a defense of the temporal analysis see Kissine 2008). The English future word 'will' is a modal verb, and admits epistemic, non future readings. We read, e.g. in Palmer, that 'it is tempting to refer to the meaning of *will* as probability, alongside possibility and necessity for *may* and *must*.' (Palmer 1987: 136).[1]

(1) a. The French will be on holiday this week.
     b. No doubt, you'll remember John.

The sentences here are conjectural as *will* seems to convey a sort of epistemic modality: given what I know, it is quite likely or it is quite plausible, or in cases of stronger certainty, it must be the case that the French are on holiday this week. Other non-predictive uses of *will* circulated in the literature are generic or mixed-deontic readings:

(2)   a.   Ed will get upset over nothing.
        b.   Ed will lay in bed all day reading trashy novels. (Huddleston 1995)
        c.   As far as I know, oil will float on the water. (Haegeman 1993)

So, *will* appears to be a modal verb that also receives a variety of non-future uses, including epistemic and deontic/generic uses as in the examples above, especially (2-c).

Modal uses have been reported for future modals in other European languages, for instance Dutch. In a recent paper, Broekhuis and Verkuyl to appear claim that Dutch *zullen* 'will' is an epistemic modal operator expressing that the prejacent proposition is the result of reasoning based on information that judged as 'reliable and well-founded'. They go onto say that when using *zullen* 'the speakers feel sufficiently confident to say p is true at n [now] or is to be made true at i [later than now]'. This confidence relies on information judged as reliable and well-founded. It may take all sorts of form dependent on the situation: as a hypothesis, a confident expectation, a reassurance, etc. What these circumscriptions have in common is that the speaker has entrance to sufficiently many worlds to be able to pick out the ones that seem convincing.' (Broekhuis and Verkuyl *ibid.*: Conclusions). This passage renders Dutch *zullen* akin to a purely epistemic modal, as illustrated in the following cases, from (Giannakidou to appear):

(3)   Context: I   can't see Hein.
        Hein   zal (wel) in de/op see zijn.
        'He must/will be at sea (swimming/on a boat).'

(4)   Context: I know for sure:
        #Hein zal in de/op see zijn.
        #He must/will be at sea.

We see here *zullen* being used with no future reference, as a universal epistemic expression suggesting a high degree of certainty that Hein is at the sea. At the same time, if the speaker actually knows for sure that Hein is at the sea, she cannot use *zullen* or *must, will*, so it makes an epistemically weaker statement than the sentence without it. *Zullen* can be accompanied by the modal particle *wel*, a cognate of German *wohl*, also known to have epistemic uses like this (see discussion in Zimmermann 2011, Giannakidou to appear about the similarity of future and modal particles).

Zullen receives purely epistemic readings also with past tense, unlike *will*:

(5)   A: He is so grumpy!
        Hij zal wel slecht geslapen hebben!
        'He must have slept really bad!'

(6)   #He will have slept.

This example is important because it shows that epistemic *zullen* is like *must*, allowing a purely epistemic reading, and unlike *will* which, with the past, forces future shifting. We will call futures like *zullen*, which are equivalent to epistemic *must*, 'epistemic futures'.

Greek and Italian futures, as we shall see, are such epistemic futures.

There are two initial lessons from the examples discussed so far. Epistemic futures express pure epistemic modality akin to *must*; second, just like *must*, they express a statement stronger than mere possibility, but still not *full* certainty of the speaker. In the state of full knowledge, the use of epistemic future and *must* is prohibited, as we saw.

For the future, Italian and Greek do not employ modal verbs, but a bound morpheme (Italian), and a particle that precedes the tensed verb (Greek). We we will call them both FUT in this paper. Greek and Italian FUT are like Dutch *zullen* and English *must* in allowing purely epistemic readings with nonpast and past:

(7) a. I   Ariadne tha   kimate   (tora). (Greek)
         The Ariadne FUT sleep.INP.3sg now.
         'Ariadne must be sleeping now.'
     b. I   Ariadne tha   ine   giatros.
         The Ariadne FUT be.INP.3sg doctor.
         'Ariadne must be a doctor.'
     c. I   Ariadne tha   pezi   (tora).
         the Ariadne FUT play.INP.3sg now.
         'Ariadne must be playing now.'

(8) a. Giacomo dormirà (adesso).
         (Italian) Giacomo FUT-sleep (now).
         'Giacomo must be sleeping (now).'
     b. Giacomo sarà   dottore.
         Giacomo FUT-be.3sg doctor.
         'Giacomo must be a doctor.'
     c. Giacomo giocherà   (adesso).
         Giacomo FUT-play.3sg (now).
         'Giacomo must be playing (now).'

In all cases, the reading is inferential: I am considering information I have, and draw an inference based on that information. For example, with regard to the a examples, I know that Ariadne/Giacomo have the habit of taking a nap at 2pm, I also know that they always stick to schedule, and I also know that today has been a regular day. So at 2:10 pm, I utter the sentence expressing my relative certainty that Ariadne and Giacomo are, *for all I know*, asleep. Likewise, I know also that usually by 6 pm Ariadne is down at the yard playing with her friends. At any time after 6 pm then, I can utter (7-c) with the same degree of certainty. Finally, (7-b) expresses an inference based on evidence: I have witnessed Ariadne expressing opinion on medical matters, she cites reliable medical sources all the time etc., hence I am entitled to conclude (7-b). We give some past examples below:

(9) I   Ariadne tha   milise   xthes.   (epistemic, past)
     the Ariadne FUT talk.past.3sg yesterday.
     'Ariadne must have spoken yesterday.'

(10) Giovanni sarà   malato. (epistemic, now)
      Giovanni FUT-be.3sg sick.
      'John must be sick.'

(11) Giovanni sarà   stato malato. (epistemic, past)
      Giovanni FUT-be.3sg been. PERF. sick.

‘John must have been sick.’

Here, we have similar reasoning with respect to a sentence about a past event. None of the examples with the present or the past is predictive; they do not refer to events that follows the utterance time. Rather, as can be seen in the translations, the sentences with epistemic FUT all express epistemic reasoning, similar to sentences with *must*. In all these cases, the speaker has evidence, knowledge of facts, as well as normalcy conditions at the time of the utterance that support p. Given these, she judges p to be likely to be true.

But at the same time, the speaker is not completely confident that p is *actually* true. She allows some doubt. This becomes particularly obvious if we compare the FUT sentence (26) with an unmodalized assertion (25) in both Greek (a sentences) and Italian (b sentences):

(12)   a.   I Ariadne ine arosti, #ala dhen ime ke endelos sigouri.
        b.   Giacomo è malato, #ma non sono sicura.
                'Ariadne/Giacomo is sick, #but I am not entirely sure.'

(13)   a.   I Ariadne tha ine arosti, ala dhen ime ke endelos sigouri.
        b.   Giacomo sarà malato, ma non sono sicura.
                'Ariadne must be sick, but I am not entirely sure.'

So, epistemic future indicates indeed an epistemic state where the speaker considers a proposition to be true with high probability (we will see that in Italian low confidence is also allowed, *pace* Squartini, 2012; see Mari, to appear); still, however, the speaker is aware that she cannot be fully certain about it, she seems to still allow other possibilities, unlike with the positive bare assertion where the speaker is fully committed to the truth of p. We can impressionistically describe this difference by saying that the future/*must* sentence is 'weaker' than the unmodalized assertion. Below, we give examples, in Greek and Italian with the verb equivalents of MUST that illustrate the same phenomenon (in Greek *prepi* takes a subjunctive *na*-complement, like all modal verbs; Giannakidou 2009):

(14)   a.   I   Ariadne prepi na   troi   tora. (epistemic, now)
               the Ariadne must subj eat.non-past3sg now.
        b.   Giacomo deve star mangiando.
               Giacomo must be   eat-gerund.
               'Giacomo/Ariadne must/will be eating now.'

(15)   I   Ariadne prepi na   milise   xthes.   (epistemic, past)
       the Ariadne must subj talk.past.3sg yesterday.
       'Ariadne must have spoken yesterday.'

(16)   a.   Giovanni sarà   stato malato. (epistemic, past)
               Giovanni FUT-be.3sg been. PERF. sick.
        b.   Giovanni deve   essere stato malato.
               Giovanni must.3sg be   bee, sick.
               'John must have been sick.'

The sentences with MUST, and the sentences with epistemic FUT are equivalent in speaker's intuitions. They express positive confidence about the likelihood of p, confidence that arises from reasoning that the speaker does. And, just like epistemic futures, Greek/Italian MUST sentences are also weaker than unmodalized assertions in that they

do not express full commitment.

FUT and MUST can actually combine. The reading remains the same:

(17) I   Ariadne THA prepi na   milise   xthes.   (epistemic, past)
      the Ariadne FUT must subj talk.past.3sg yesterday.
      'Ariadne must have spoken yesterday.'

(18) Giacomo dovrà   aver parlato ieri.
      Giacomo must-FUT.3sg have spoken yesterday.
      'Giacomo must have spoken yesterday'.

Given the epistemic non-predictive usage of FUT and the parallel with MUST, it becomes very appealing to argue that the epistemic future is an epistemic modal akin to *must*, and this what we pursue here, following our earlier works.[2] Given the parallel with MUST, we think it is useful to talk about 'universal epistemic modals' (UEMs) as a class. We will argue that UAMs, as a class induce 'epistemic weakening' and we will define epistemic weakening as the creation of a non-veridical epistemic space (following Giannakidou 1998, 1999, to appear, Giannakidou and Mari 2012a,b). Our main analysis can be summarized in the following:

(19)   *Universal Epistemic Modals (UEMs), epistemic weakening, and partial knowledge*
      a. UEMs can only effectively weaken a proposition p, if the speaker's knowledge that supports p is not complete, and the speaker knows that it.
      b. Complete knowledge is knowledge of all the relevant facts for p. More technically, it is a set of propositions that *entails p*.
      c. All other knowledge is partial.

Partial knowledge, we argue, is the key to understanding the common observation that UEMs are 'evidential' and rely on 'indirect' knowledge. We offer a more satisfactory understanding of their evidential nature by showing that it is incompleteness of knowledge that is needed, not indirectness. UEMs require reasoning based on missing premises; if all relevant facts are known then UEMS cannot be used. UEMS do rely on knowledge that support their prejacent proposition, but at the same time, this knowledge does not enable full commitment of the speaker to the proposition (veridicality), because the speaker also knows that the knowledge she uses is not complete.[3]

Universal epistemic modals and epistemic futures are interesting because they seem to comprise a somewhat dual nature. On the one hand, they are universal modals, hence stronger than mere possibility modals. So, when a speaker choses to use a universal epistemic modal, she has considerable confidence about the the truth of p, as opposed to when she uses a mere possibility modal. On the other hand, UEMs still convey a modalized judgement, and are therefore 'weaker' than an unmodalized assertion (Kartunnen 1971). Giannakidou (1999:392) states that 'If I know that Frank is ill, i.e. if you just told me so, then I cannot utter *Frank is ill*. I should say *Frank must be ill*. So, if I say that *Frank must be ill* it is implied that I do not know for sure that Frank is ill, hence I am not committed to the actual truth of *Frank is ill*'. In other words, the MUST and FUT sentences indeed

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[2]In previous works we argued that the epistemic interpretation holds with both statives and eventives (and more precisely with perfective non-past in Greek), an issue that we do not discuss here.

[3]Mari, 2013b shows that veridical future in French uses complete knowledge and discusses in depth the relation between indirect/direct knowledge and complete/partial knowledge.

express confidence about the truth of *p*, but at the same time, they impose a partition on the knowledge space and allow the possibility of ¬*p*. We will call this *epistemic weakening*, and argue that it is the creation of a non-veridical space. An unmodalized assertion is veridical, i.e. conveys actual truth, and does not impose any partition on the knowledge space of the speaker.

For the sake of completeness, we must mention that the future interpretation, which we call predictive, arises only when a perfective non-past is used in Greek (20). Notice the use of the temporal adverbial 'tomorrow':

(20) a. Gianni arriverà   domani.
          John   arrive-FUT.3sg tomcorrow.
          'John will/#must arrive tomorrow.'

      b. O   Janis tha   ftasi   avrio.
          The John FUT arrive.nonpast.perf.3sg tomorrow.
          'John will/# arrive at 5pm/tomorrow.'

A paraphrase with *must*, in the epistemic reading, is pretty odd in this case (though a deontic paraphrase seems ok). In this, *must* contrasts with the existential epistemic *might*, which is fine with the future orientation.

(21) a. If John continues to smoke like this, he might be sick in a few years.
      b. For all I know, John might win the game tomorrow.

The unambiguously epistemic *might* makes clear that there is no incompatibility of epistemic modality with future temporal orientation of the embedded clause. This is an important point to make, especially because it is often, quite impressionistically claimed that future and epistemic modality don't go together. As we see with might, we can indeed form hypotheses about future events, (see also, among others Condoravdi, 2002). The reason why *must* is excluded could be due to the fact that we have the competing specific (thus stronger) form *will* for the future universal modal in English, and this is what a speaker is expected to use. In not using it, it is understood that something else is intend, and this 'dooms' *must* to the realm of the deontic modality with the future adverb. In Greek and Italian, there is no competition by another form, and the epistemic modal FUT, just like the existential, can be used to make an inference about a future action. Giannakidou and Mari (2013,to appear) propose a detailed analysis of the predictive reading, but in the present paper, we do not consider the predictive reading at all, and focus on the epistemic future.

The discussion proceeds as follows. In section 2, we present the idea of epistemic weakening as the creation of a non-veridical epistemic space. We present first some basic data from English that show that positive veridical assertion can be weakened in two ways: either strongly– with a possibility modal– or weakly, with a UEM. UEM expresses a certainty of the speaker, though not her full commitment. We present data from adverbs that show that the UEM is truly weaker than Kratzer's strong necessity, since *must* and FUT are flexible and combine with adverbs of variable, ranging from high probability to even weaker adverbs (in Italian). In section 3, we continue with the question of partial knowledge. Full commitment relies on what the speaker perceives as complete knowledge, but in using the UEMs, the speaker is aware that she has partial acknowledge. This is, we argue, the evidential component of sentences with FUT/*must*. The illusion of

'indirectness" of evidence is simply incompleteness of knowledge, reasoning with indirect premises, hence indirectness need not be posited as an additional evidential condition. Finally, we consider an argument from von Fintel and Gillies that allegedly supports a strong analysis of MUST; we show this argument to involve not epistemic *must*, but MUST with 'a taste of the deontic' (in the sense of Knobe and Szabo's 2013).

2 Epistemic weakening with MIGHT and MUST: non-veridicality, best worlds, and speaker's confidence

The claim that *must* is 'weak' in that it does not entail the truth of its proposition goes back to Kartunnen (1972). Kartunnen argued that the *must* statement is weaker than the non-modalized one, and it is weaker in virtue of the type of evidence that is used. In Kartunnen words, this is indirect evidence. Kratzer (1991) and Giannakidou (1999) offered similar analyses of *must* as weak, and likewise in Giannakidou and Mari to appear, we argued that FUT is weak and relies on indirect knowledge. Before we address in section 3 the issue of indirectness, we want to first establish here the status of FUT as a UEM, and show that the 'weakness' of UEMs as a class is epistemic weakening in the sense of creating a nonveridical, i.e. partitioned, non-homogeneous, epistemic space. Our analysis will also address two recent challenges by von Fintel and Gillies (2010), and show them to be harmless for the non veridical analysis of *must*.

With an existential modal we have uncertainty about the truth of p; so there is no debate about the weakness of *might*:

(22)   Ariadne might be a doctor.

In asserting the sentence above, the speaker conveys that she considers it possible that Ariadne is a doctor, and nothing more than that. There is no commitment on her part that Ariadne is a doctor, she merely states that she does not consider impossible that she is. We assume that the following holds:

(23)   Might p = the intersection of the modal base and p is non-empty.

The sentence with an existential epistemic modal doesn't say very much, i.e. the information conveyed by it doesn't allow any confidence about the likelihood of p. In this sense, the statement created is rather 'weak'. If you know that Ariadne is a doctor, you are being un-cooperative in uttering a sentence with *might* simply because you are choosing to convey less than what you know.

Now consider the UEM versions with MUST and FUT:

(24)   I Ariadne tha/prepi na ine giatros.
         Giacomo sarà / deve essere un dottore.
         'Ariadne/Giacomo will be/must be a doctor'

As we said earlier, universal epistemic modals and epistemic futures seem to comprise a somewhat dual nature. They convey more information than mere possibility modals: in the sentences above we get the message that the likelihood of Ariadne being a doctor is high, that the speaker has some kind of commitment, i.e. partial commitment, to it. So UEM statements are stronger that possibility modals. However, they are still weaker than unmodalized assertions, they do not convey flu speaker commitment. The speaker seems

to have combined knowledge that supports p in way stronger than mere possibility, but also allowing for the possibility of $\neg p$; recall our earlier examples:

(25)   a.   I Ariadne ine arosti, #ala dhen ime ke endelos sigouri.
       b.   Giacomo è malato, #ma non sono sicura.
            'Ariadne/Giacomo is sick, #but I am not entirely sure.'

(26)   a.   I Ariadne tha ine arosti, ala dhen ime ke endelos sigouri.
       b.   Giacomo sarà malato, ma non sono sicura.
            'Ariadne must be sick, but I am not entirely sure.'

Lassiter (2013) offers a wealth of data from *must* illustrating, likewise, that *must* indicates reduced speaker commitment:

(27)   Probably this must have been done before, *but I couldn't find enough information* on this in the ISS docs.

(28)   If the handgun was engraved or had some sort of fancier finish then *I figured he must be a pistolero. I might have been wrong but those were my initial impressions.*

The strength of speaker's commitment here is governed by *I figured*, so these are clearly far from showing the full speaker comittment of unembedded assertions– our criterion for strength. There are numerous parallel examples in Lassiter 2013. (We are using commitment here in a non-formal way, we will talk about confidence later, providing a technical definition for it).

As the weakness of *might* is straightforward, the challenge is to capture the weakness of *must*. We are going to argue that both are non veridical and convey epistemic weakening, but the semantics of *must*, unlike that of *might*, is more textured. It comprises three main ingredients, among which an ordering source over worlds –such that p worlds rank as best – and a measure of speaker's confidence (given by the adverb) that the actual world is a p world. *Might* lacks these two components and this explains its neutral, uncertainty flavor. Notice:

(29)   a.   It might be the postman, but it might also be my mother.
       b.   It must be the postman, #but it is perhaps my mother.

The reason why the *must* sentence is odd, we will argue, is not because it excludes the possibility that not-p, but because it commits the speaker to p in an epistemic subspace, and this commitment cannot be overruled pragmatically by a continuation raising another possibility. Examples such as the above have been discussed in von Fintel and Gillies as indicating strength, but they don't really. What they actually show is that there is a pragmatic conflict between the speaker having been committed to p as very likely wrt a given eventuality, while then asserting another possibility for the same eventuality. This seems to create a pragmatically inconsistent situation.

2.1   Epistemic weakening with FUT/MUST: creation of a non-veridical space

There are three ways in which the term *veridicality* has been used in the literature, and this in fact may be a little confusing. Montague 1969 uses it to characterize sentences with direct perception verbs such as see (see Giannakidou to appear for a formal connection

between truth commitment and existence, especially at reveals itself in relative clauses and with progressives). Authors have also used other labels, e.g. factivity, or factuality to refer to veridicality (Karttunen 1971, Kartunnen and Zaenen 2005, Kiparksy and Kiparsky 1970), and typically in this use veridicality is understood objectively: a sentence is true in the actual world, irrespective of epistemic agents (see also Zwarts 1995, Egré 2008). In this sense, veridicality is more or less equivalent to the traditional realis: a veridical sentence refers to a fact. Any sentence that does not refer to a fact is nonveridical.

This notion of objective veridicality is challenged when we consider modality, negative polarity, and mood choice (Giannakidou 1998, 1999, to appear); we need instead a subjective (non)veridicality that allows veridicality judgments to depend on what epistemic agents know or believe to be true, and other factors in the context relating to the epistemic status of individuals. Subjective (non)veridicality is also shown, in recent work, to be important in extracting truth assessment from texts; de Marneffe et al. 2012 say that declaratives like *Ariadne left* conveys firm speaker commitment, whereas qualified variants with modal verbs or embedded sentences imbue the sentence with uncertainty' (de Marneffe 2012: 102). Finally, Trnavac and Taboada (2012) posit a correlation between nonveridicality and evaluation that further supports the subjective nature of the veridicality judgment.

To capture the idea that truth is assessed relative to an individual Giannakidou (1997, 1998, 1999) defined models of evaluation wrt epistemic agents. These models are sets of worlds, epistemic or doxastic alternatives representing what the epistemic agent i believes. We can think of them as 'modal bases' associated with individuals. In main assertions, the model represents the epistemic space of the speaker, and it includes worlds compatible with she believes, what she knows, or believes that she knows. I will call such a model epistemic, though as I said, it may also contain beliefs. A proposition p of a main assertion will be evaluated with respect to this model:

(30)   Epistemic model of an individual i (Giannakidou 1999: (45)) An epistemic model M(i) ∈ M is a set of worlds associated with an individual i representing worlds compatible with what i believes or knows.

(31)   Truth in an epistemic model A proposition p is true in an epistemic model M(i) iff M(i) ⊆ p: $\forall w[w \in M(\mathrm{i}) \rightarrow w \in \lambda w'.p(w')]$

(32)   a. John won the race.
        b. [[John won the race]]= 1 iff
            $\forall w : w \in$ M(speaker) $\rightarrow w \in w'$. John won the race in w'

If the speaker decides in a context to truthfully assert the sentence John won the race, (s)he must believe or know that John won the race. Believing the proposition means that all worlds in the model of s(peaker) are John-won-the race worlds. Hence: M(s) ⊆ p. In the unembedded assertion, therefore, the speaker is fully committed, within her belief/knowledge space, to the truth of the proposition she expresses with the sentence she utters. Hence, unembedded unmodalized assertions expresses full speaker commitment, and we will call them veridical.

(33)   Veridicality and Nonveridicality (Giannakidou 1998, 1999, 2011) i. A propositional operator F is veridical iff Fp entails or presupposes that p is true in some individual's model M(i); p is true in M(i), if M(i) ⊂ p, i.e. if all worlds in M(i) are p-worlds. ii. If (i) is not the case, F is nonveridical.

(34)   a.   *Veridical and non-veridical epistemic space* (Giannakidou 1998, 1999)
          (i) An epistemic space (a set of worlds) W relevant to an epistemic agent i
          is *veridical* with respect to a proposition p just in case all worlds in W are
          p-worlds. (*Homogeneity*).
    b.   If there is at least one world in W that is a $\neg p$ world, W is nonveridical.
        (*Non-homogenous space*).

A veridical epistemic space is homogenous: all worlds are p worlds; and there is no further
ordering source to create partition. This is the space of 'full commitment'. A non-veridical
modal space, on the other hand, is not homogeneous: it contains p and $\neg p$ worlds. A
non-veridical space is typically ordered by some other function (e.g. ordering sources of
modals, desires, goals, etc.), and this yields a partitioned domain. non-veridical spaces
are spaces where p and $\neg p$ are options, and propositions are not fully resolved, decided,
or settled (to use the phrasing from von Fintel and Gillies 2010).

    Given (non)veridicality, we can define epistemic weakening as follows (see also Gian-
nakidou to appear):

(35)   *Epistemic weakening* Epistemic weakening is the creation, by an epistemic agent
        i, of a non-veridical epistemic space.

    Now, consider epistemic modals and FUT, and recall our earlier examples:

(36)   a.   I Ariadne ine arosti, #ala dhen ime ke endelos sigouri.
         Giacomo è malato, #ma non sono sicura.
         'Ariadne/Giacomo is sick, #but I am not (entirely) sure.'
    b.   I Ariadne tha ine arosti, ala dhen ime ke endelos sigouri.
        Giacomo sarà malato, ma non sono sicura.
        'Ariadne must be sick, but I am not entirely sure.'

Here we have epistemic states where the speaker considers a proposition to be highly
probable; still, however, the speaker allows herself to not be entirely sure. UEM sentences
are non veridical, in contrast to bare assertions which are veridical.

    We assume the theory of modality in Kratzer (1981, 1991), and Portner (2009), with
two conversational backgrounds as arguments of a modal expression - the modal base and
the ordering source. The modal base f is the factual background, and the ordering source
g is a normative background. With FUT, in this non-predictive use, the modal base is
epistemic; specifically, it is the set of propositions known by the agent i, i.e. the speaker
in an unembedded context: $\cap f_{epistemic}(w) = \lambda w'.w'$ is compatible with what is known by
i (the speaker) in w.

    In Greek and Italian, Giannakidou and Mari (2012a,b) propose a universal analysis
for FUT that renders it exactly like *must*. Importantly, the truth condition that we posed
renders FUT a universal only in the set of best worlds:

(37)   For any world w, conversational backgrounds f, g and epistemic agent i:
        $[FUT]^{w,f,g,i} = \lambda q <st> .\forall w' \in Best_{g(w)}(\cap f(w)) : q(w') = 1$
        where $Best_{g(w)(X)}$ selects the most ideal worlds from X, given the ordering $g(w)$
        determined by i

The reader actually realizes that this is the semantics for *must* too.

(38)   For any world w, conversational backgrounds f, g and epistemic agent i:

$[\text{MUST}]^{w,f,g,i} = \lambda q < st > .\forall w' \in Best_{g(w)}(\cap f(w)) : q(w') = 1$

where $Best_{g(w)(X)}$ selects the most ideal worlds from X, given the ordering $g(w)$ determined by i

We can already see that p and $\neg p$ are not two equivalent options, given what the speaker knows. *Must* creates a space that is not homogenous in two ways. First because it contains p and $\neg p$ words, secondly because one of these spaces is ranked as best. In the best worlds, p is true. The ordering source $g(w)$, orders the worlds in $\cap f(w)$ according to normalcy assumptions, following Kratzer (1991) and Portner (2009). Modal expressions of necessity quantify over those worlds *that adhere to the norms in the ordering source as much as possible*. We can call these worlds *Best* following (Portner, *ibid.*).

The type of ordering source that we adopt is crucial here. What we mean by normalcy conditions, is that *strange things do not happen* (see Mari, 2013a, Giannakidou and Mari, 2013,to appear; see also discussion in Portner, 1998). For instance, if I have red cheeks and sneezing nose, then, under normal circumstances, I have the flu. However, circumstances are not necessarily normal. In such extraordinary circumstances these symptoms are secondary and indeed indicative of a potentially much worse disease. Typically the actual world tends to be non-extraordinary, but we also know that strange things happen. As a consequence, we do not claim that the epistemic agent actually knows that the actual world belongs to the set of best worlds (see Mari, 2013a for extended discussion). Given, on the other hand, that the accessibility relation is epistemic and therefore reflexive, it is ensured that the actual world is in the modal base. What it is not ensured is that the actual world is also in the set of best worlds. Only in the *Best* worlds is p true.

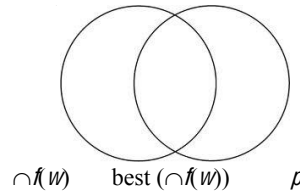The pictures that we get for *might* and *must* are in figures (38) and (38) respectively.

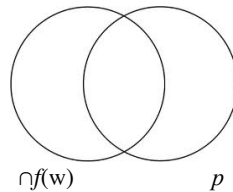Figure 1: Epistemic space for *must*

Figure 2: Epistemic space for *might*

As we can see in Figure (38), there is no ordering source for *might*, and existential quantification introduced by *might* has, as its domain, the entire modal base.

As shown in Figure (38) for *must*, there is an ordering source, and the universal quantification introduced by *must* has, as its domain, the set of best worlds.

Crucially, while *might* is a quantifier over the entire modal base, *must* quantifies over a restricted set of the modal base, the best worlds. In Knobe and Szabo's 2013 terminology, it has an inner domain (the best worlds) and an outer domain (the whole modal base). By being a universal, MUST and FUT are homogenous within their inner domain, but non-veridical with respect to the outer domain. This is coherent with the fact that *must* appear strong– and compared to *might*, we want to argue, bears more information. Adding information, as classical assumed within a Stalnakerian view, restricts the set of worlds rather than enlarging it.[4]

To sum up, *might* is an unrestricted quantifier over the entire modal base, but the UEM is a partly restricted quantifier, with an inner domain consisting of the best worlds where it quantifying universally, while also retaining an outer domain where p is not true. This, we believe, accounts for the apparent dual nature and more informative character of FUT and *must*. The simultaneous presence of both an inner and an outer domain will also help us understand the claim about *partial* knowledge we will make soon.

2.2 Confidence: the role of adverbs

What about the actual world ? Is p true in the actual world ? The speaker is making an estimate about this, and her confidence is reflected in the use of the adverb.

Consier again our base data.

Context: Ariadne/Giacomo is sneezing, has a fever, watery eyes, etc.

(39) a. Tha exi   gripi.
          must have.3sg flu.
      b. Tha prepi na   exi   gripi.
          FUT must subj. have.3sg flu.
          'She must have the flu.'
      c. Exi   gripi.
          She has the   flu.
          'She has the flu.'

(40) a. Avrà   la febbre.
          have-FUT.3sg the flu.
      b. Deve   avere la febbre.
          must.3sg have the flu.
          'He must have the flu.'
      c. Ha   la febbre.
          He has the flu.
          'He has the flu.'

The doctor is assessing, and given what he knows (the symptoms, his knowledge of what the symptoms mean, the time of the year, etc) he concludes, in the c. examples, that Ariadne/Giacomo has the flu. In all the worlds compatible with his knowledge/evidence, etc., this is his verdict, he is absolutely certain about it. However, if he choses one of the modal versions, his modal base allows also for worlds in which Ariadne does not have the flu ($\neg p$) but e.g. an allergy, or pneumonia. The doctor's judgment may be that these worlds are not the correct basis for forming his current diagnose, they are not best (in the sense we just discussed). But such non-p worlds are indeed in the modal base when

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[4]See Mari, to appear for an extensive discussion on this, in relation with the Italian future.

using FUT/MUST; but they are not when the speaker choses not to use the modal.

Now, notice that the UEM sentence can be qualified with probability adverbs. *Tha* typically co-occurs with high probability adverbs e.g. *malon* 'probably/most likely', and necessity *sigoura* 'certainly', *oposdhipote* 'definitely':[5].

(41) I   Ariadne malon/profanos/sigoura   tha ine   jatros.
      the Ariadne probably/obviously/certainly FUT be.3sg doctor.
      'Ariadne must probably/obviously/certainly be a doctor.'

(42) I   Ariadne isos/pithanon   *tha ine   jatros.
      the Ariadne maybe/possibly FUT be.3sg doctor.
      'Maybe Ariadne is a doctor.'

These contrasts support our analysis that the force of the modality of *tha* is stronger than mere possibility. As far as Greek in concerned, the same pattern characterizes the necessity modal *prepi* (see Giannakidou and Mari to appear for more details).

We will argue here that the adverbs encode the speaker's confidence in the reasoning about where the actual world is. These combinations not only further plea for considering the future a modal rather than a temporal operator, but also allow us to propose a new way of disentangling different contributions of epistemic expressions. The term 'modal concord', for the phenomena we are studying, is a misnomer because the relation between the adverb and FUT is not one of identity or even matching, as is understood from work on modal concord such as e.g. Huitink 2012. This more flexible behavior of Greek and English MUST, along with Italian *dovere* (which appears to be even more flexible, as we are going to show in the remaining of this section) challenges the necessity of the Kratzerian distinction between *should* (weak necessity) and *must* (strong necessity). Natural languages MUSTs seem to be more flexible and typically convey both.

Italian FUT is also good with stronger adverbs, just like in Greek, (Bertinetto, 1979, Mari 2010).

(43) Probabilmente Giacomo sarà un dottore.
      Probably Giacomo be-FUT.3sg a doctor.
      'Giacomo must probably be a doctor.'

Differently from Greek, though, the Italian FUT is not categorically excluded with weak possibility modals like *forse* (Bertinetto, 1979; Mari, 2009,2010, to appear; *pace* Squartini, 2012):

(44) Forse   Giacomo sarà   un dottore.
      Maybe Giacomo be-FUT.3sg a   doctor.
      'Giacomo may possibly be a doctor.'

This sentence expresses a degree of uncertainty in the assessment due to the possibility adverb. (When predicting, even Greek removes the threshold, as shown in Giannakidou and Mari 2013,to appear but we do not discuss the details here.)

Moreover, the facts about future and epistemic modal *dovere* are parallel (see Mari, to appear). The future morpheme, the epistemic modal *dovere* and their combination are

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[5] von Fintel and Gillies (2010) argue that strong adverbs signal that *must* is strong, and so does Squartini (2012), rejecting the argument that epistemic strong adverbs, reveal a certain amount of uncertainty. However, note that in a scenario in which I have tasted a kiwi, I cannot utter '#Il kiwi è sicuramente buono' *The kiwi is certainly good.*

all compatible with weak epistemic adverbs. Consider the scenario in which Giacomo is absent from school. The teacher tries to figure out why he is absent. She has various options:

(45) a. Sarà forse malato.
          be-FUT.3sg maybe sick.
      b. Deve   forse   essere malato.
          must.3sg maybe be   sick.
      c. Dovrà   forse   essere malato.
          Must-FUT.3sg maybe be   sick.
          '(As far as I know), Giacomo must be sick.'

Similar weaker construals have been observed for MUST. The following examples are from Lassiter 2013, who notes that '*must* frequently combines with weaker attitudes, modalities':

(46) Last August, when they called me and asked whether I'd speak at The Global Leadership Summit held by the Willow Creek Association, I thought *maybe there must have been* a mix up.

(47) in fact, the words we hear as 'pity' can also be translated to mean that when Jesus looked at the man, he 'snorted like a war horse.' Now that's some kind of anger. It's deeply rooted, instinctive even. *As perhaps it must have been.*

So, what do the adverbs do? Given the flexibility, we cannot say that the adverbs directly compose with p or $FUTp$: it is impossible to combine FUT (a universal) with the adverbs in a concord like manner. Even the most flexible theories of modal concord (such as Huitink 2012) would require at least matching force. So, the adverb is forced to contribute at the non-at issue level, something consistent with the fact that modal adverbs are speaker oriented (Ernst 2009) and seem to 'scope' high in the sentence.[6]

We will claim that the modal adverbs capture the speaker's confidence. They are a measure of confidence in the evaluation of the epistemic agent i which measures how confident i is that the actual world will be within the set of the best worlds. We would like to claim that this as a generalized contribution of epistemic modals: they do not simply make a claim about the possible worlds, but bear relevance to whether an agent i thinks that the actual world is one that conforms to the best ordering, and to what degree. So here is how we put this all together:

(48) Epistemic FUT (= epistemic future)
      Epistemic-FUT p asserts *necessarily p*, relative to an epistemic modal base, an ordering source and an epistemic agent i.
      Presupposition: there is a measure function $\mu_{confidence}$ determined by i that measures how confident i is that the actual world will be within the set of the best worlds. The default value of $\mu_{confidence}$ will range above 70%.
      Truth condition: p is true only in the best worlds, given the evidence: $\forall w' \in Best_{g(w)}(\cap f(w)) : p(w') = 1$.

As indicated in the presupposition, we will assume that bare FUT, with no adverb, contributes a default of high confidence (which we arbitrarily fix as being 70%). But

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[6]Ernst therefore argued that they are positive polarity items.

with the use of adverbs, the value becomes more specific and can express higher or lower confidence. This captures the variability in the epistemic judgement between very high, middle, and low confidence.

In support of this analysis, it is important to note that the confidence presupposition survives negation.

(49)   a.   Gianni non arriverà   mica.
                Gianni not arrive-FUT.3sg even
                'Gianni must not be arriving.'
        b.   Gianni non sarà   malato.
                Gianni not be-FUT.3sg sick.
                'Gianni will not be sick / John must not be sick.'

The speaker retains the default degree of high confidence that the actual world is not in the set of best worlds that make p true. And is also consistent with the observation that epistemic modals generally scope above negation (e.g. Cinque, 1999; Hacquard, 2006; Homer, 2010) and likewise modal-evidentials across languages, e.g., Japanese (McCready and Ogata 2007).

Our proposal is that the analysis that we have provided, also applies to other UEM such as *must* in English.

(50)   Epistemic MUST (= future for past and present)
        Epistemic-MUST p asserts *necessarily* p, relative to an epistemic modal base, an ordering source and an epistemic agent i.
        Presupposition: there is a measure function $\mu_{confidence}$ determined by i that measures how confident i is that the actual world will be within the set of the best worlds. The default value of $\mu_{confidence}$ will range above 70%.
        Truth condition: p is true only in the best worlds, given the evidence: $\forall w' \in Best_{g(w)}(\cap f(w)) : p(w') = 1$.

We can now explain the oddness of (51).

(51)   It must be raining, #but perhaps it isn't raining.

Uttering the *must*-sentence, quantification is over best worlds and the speaker is highly confident that the actual world belongs to the set of best worlds. This confidence creates a positive perspective: the continuation then comes to contradict this positive perspective. In other words, in addition to their textured semantics, UEMs create positive perspective due to their universally quantifying within their inner (best worlds) domain.

When *might* is used, quantification is over the modal base, and the speaker is *agnostic* as of whether the actual world belongs to the set of p worlds or not. As a consequence, both options in (52) are eligible, i.e. the actual world is equally expected to belong to p worlds or $\neg p$ worlds).

(52)   It might be raining, but perhaps it isn't raining.

Our analysis for *might*, which follows standard assumptions and adds confidence is as (53):

(53)   Epistemic MIGHT
        Epistemic-MIGHT p asserts *possibly* p, relative to an epistemic modal base and

an epistemic agent i.

Presupposition: the speaker is agnostic as of whether the actual world belongs to the set of p or $\neg p$ worlds.

Truth condition: p is true is a subset of worlds of the modal base, given the evidence: $\exists w' \in (\cap f(w)) : p(w') = 1$.

Before we close this discussion, we wanted to offer some comments on the two related analyses, both indicating that the speaker refrains from being fully committed to p using modal/evidential. One analysis is the one offered by McReady and Ogata (2007) on Japanese evidential. They posit the following truth condition for $\Delta(\alpha)(\phi)$, where Δ is the evidential epistemic operator:

(54)   Truth conditions $\Delta(\alpha)(\phi)$ is true wrt *a probability measure μ*, iff $0.5 < \mu\ ([[\phi]])$ $< 1 <$, where $[[\phi]]$ is $\{w \in W \mid w$ is a world that supports $\phi\}$.

In this analysis too, the proposition cannot be true in all accessible worlds (nonveridicality). Additionally, the truth condition imposes explicitly in the semantics a probability measure that captures the degree of commitment of Japanese evidentials to the truth of p. The measure is set to the interval between 0.5 and 0.9. In an analysis of this style, the adverb is the indicator of the probability measuring– but in ours it is indicator of the confidence about whether the actual world will be among the best worlds.

The other relevant analysis is Matthewson et al. (2007), Matthweson (2010). They posit a choice function that selects from the Best worlds the very best ones, according to some additional norm. Here is an example from Matthewson 2010 to make this clear.

(55)   gúy't=ka ti=sk'úk'wm'it=a
        sleep=deon det=child=exist
        'The child must/should/can sleep'
        Modal base (presupposed to be circumstantial): Worlds in which the relevant facts about our family are the same as in the actual world.
        Ordering source (presupposed to be normative): The best worlds are those in which my desire for an early night is fulfilled.
        Choice function: Picks out a potentially proper subset of the best worlds.
        Universal quantification: In all worlds in the subset of the best worlds picked out by the choice function, the child sleeps.

The interesting fact about Salish modals is that they seem to have variable quantificational force, ranging from existential to universal. This is reminiscent, but not identical of the Italian situation we just described, where the UEM is compatible with an existential adverb, but we still have two modals. Matthewson et al. and Matthweson 2010 derive the flexibility of the Salish modal by positing one modal, a universal, and varying the size of the quantificational domain by adding a choice function that further constraints the domain in the best worlds. It is said that 'Since quantification is over a potentially proper subset of the best worlds, sentences [with modals] can be interpreted with any strength ranging from a pure possibility to a strong necessity". In Greek, we do have a threshold of high probability that cannot be breeched as we saw earlier (also, Giannakidou 2012), and Italian does have a necessity and a possibility modal (see Mari, to appear). So we cannot transfer this analysis to Italian by letting the adverb operate directly on the size of the best worlds (see Mari (to appear) for a proposal along these lines for the Italian future). We therefore delegate their function to the presuppositional domain of speaker

confidence about whether the actual word is in the bet worlds or not (for more detailed discussion of adverbs, see Giannakidou and Mari, to appear).

Let us move now to the evidential component of UEM: the relation between partial knowledge and epistemic weakening.

3 The evidential component: perception, missing premises, and *partial* knowledge

As we have already mentioned, in his seminal work, Kartunnen (1972) held that the weakness of MUST is intimately related to the weakness of the source of information. The view that we hold here is that epistemic weakening makes the UEM statement, MUST and FUT alike, compatible only with a partitioned, non-veridical epistemic state consisting of a subspace that supports p (the inner domain), and a subspace that doesn't (the outer domain, the modal base).

An important difference between our view and that of Kartunnen, is that the epistemic weakening is not due to the fact that knowledge is indirect, but to the fact that knowledge is *partial*.

Kartunnen (*ibid.*) ties 'weakness' to indirect evidence: when the speaker has indirect evidence that the prejacent is true, she uses the modal to signal that she is uncertain about the truth of the prejacent. Von Fintel and Gillies (2010:361) challenge this position: 'Our point is simple: weakness and indirectness are not two sides of a single coin at all. They are just different'. Their claim is that the epistemic modal *must* presupposes indirect evidence, but it is 'strong'. In our view of epistemic weakening, the indirectness is reduced to a mere side-effect, not a real phenomenon. The key is *partial* knowledge: epistemic weakness and non-verdicality of UEMs arises *because* the speaker is reasoning with partial knowledge, and she knows it. Recall the partition that lies at the heart of the truth condition of UEMs: the partition between best and non-best worlds. When the speaker reasons with UEMs, she is aware that she does not have all the knowledge she needs to draw a valid conclusion in all worlds in the modal base. When she has complete knowledge, she cannot use UEM, as evidenced by the fact that in direct visual perception contexts, one can simply not use the UEM sentence:

(56)   *Context: Direct visual perception of rain*
    a. #It must be raining.
    b. #Tha vrexi.
       FUT rain.
    c. #Piovera.
       rain-FUT.3sg.
    d. #Tha prepi na   vrexi.
       FUT must subjunctive rain.
    e. #Dovrà   piovere.
       Must-FUT.3sg rain.

Recall that in this, UEMs are similar to devices such as the German and Dutch modal particles, which have also been analyzed as involving 'weakened' speaker commitment (Zimmermann 2011, Giannakidou to appear). Now, if I see the rain, I know that it is raining, and knowledge is veridical: if I know p, then all worlds compatible with my

knowledge are p worlds. My epistemic space is not partitioned, it is rather homogeneously supporting *p*. Epistemic weakeners are incompatible with this state of complete, homogenous knowledge. They require instead some degree of uncertainty, a distinction between an inner and outer domain. This distinction doesn't have to do with indirectness of knowledge, but, we argue, it is an indication of the incompleteness of it.

Why we need partiality rather than indirectness is nicely illustrated in the contrast between the context above where I see the rain, and the following case (57), where I only see a wet umbrella and I use missing premises. We assume a scenario in which the rain is *not* the only possible cause of the wet umbrella, and this is where *partality* of knowledge arises (unlike von Fintel and Gillies, *ibid.*; we consider cases in which the speaker has complete premises in section 3.2).

(57)   I see a wet umbrella
    a. It must be raining.
    b. Tha/Prepi na   vrexi.
        FUT/Must subjunctive rain.
    c. Deve star piovendo.
        Must be   raining.
    d. Pioverà.
        FUT-rain.3sg.
    e. Deve star piovendo, ma non sono sicura.
        'It must be raining, but I am not sure.'
    f. Deve probabilmente star piovendo.
        'It must probably be raining.'

In this context, I see a wet umbrella, but I don't see the rain. The wet umbrella is an indication of rain, and can support 'It is raining', by licensing the missing premise that the umbrella got wet because of the rain. UEMs such as must, FUT *dovere* are fine in this case, in contrast to the direct perception of rain that we just saw, where they are bad. Continuation with 'I am not sure' is allowed here. Moreover epistemic adverbs can be used, as indicated, showing a gradability of the confidence of the speaker.

Likewise, auditory perception is compatible with UEMs provided it gives incomplete knowledge.

(58)   Context: I am in a room with no windows, but I hear sounds of rain on the roof
    a. It must be raining.
    b. Tha vrexi.
        FUT rain.
    c. Pioverà.
        rain-FUT.3sg.
    d. Tha prepi na   vrexi.
        FUT must subjunctive rain.

I do not see the rain, so I am missing the premise 'There is rain', I only have the sound of it. And moreover, the sound might be caused by something else than the rain (hence, I am also missing the premise: if sound therefore rain). Auditory perception is incomplete, and the modal is allowed.

We summarize this in the following:

(59)   *Evidential component of Universal Epistemic Modals (UEMs): partial knowledge*
     a.   UEMs can only effectively weaken a proposition p, if the speaker's knowledge
          that supports p is not complete.
     b.   Complete knowledge is knowledge of all the relevant facts for p. More tech-
          nically, it is a set of propositions that *entails p*.
     c.   All other knowledge is partial.

Note that direct access in the sense of Willett (1988) (visual perception for instance) does
not count per se as a case of complete knowledge. There is a difference between 'seeing
some facts that are compatible with p being true' and 'knowing that p is true in virtue of
visual evidence'. As Mari, 2013b explains, witnessing p is not equivalent to have visual
evidence for p (see also Lee, 2012 for a related discussion). Likewise, visual evidence can
be incomplete evidence for assessing the truth of p (in (57), I *see* the umbrella, but I do
not see the rain). Similarly, inferential knowledge can be complete or incomplete: it is
complete if all the premises allowing to conclude that p is true are given and incomplete
if there are some missing premises for concluding that p is true.

Now, given partial knowledge, p is only compatible with the evidence when the outer
domain is considered (i.e. the non-veridical modal base). p is instead entailed in the
inner domain (the best worlds), and for this reason it seems that epistemic modals have a
presupposition of inferential component.[7] But this is only a consequence of partiality of
knowledge, and, as we show, when inferential complete knowledge is used, the epistemic
reading becomes impure and acquires a taste of deontic (see discussion in section 3.2).

What is the status of our generalization above? We humbly claim that it is mere
common sense: what motivates it is the fact that UEMS rely on knowledge, but not
sufficient enough knowledge for full commitment (veridicality). The nature of the source
is related to this too. Current classification of sources of evidence focus on the distinction
between direct and indirect knowledge, with visual evidence counting as direct evidence
entailing full knowledge, and reprobative and other internal evidence counting as indirect,
thus implying incomplete knowledge.

Our claim is instead that every type of source of information come as either *com-
plete* or *partial*. *Complete* knowledge is a set of propositions that entail p and partial
knowledge is a set of proposition that is only compatible with p.[8] Epistemic modals use
partial information. We offer further evidence for this, and consider in the end a possible
challenge.

3.1   More evidence for partial knowledge: reports, inferential con-texts

Greek and Italian do have a reportative evidential form (lei, ipan, si dice, dicono, pare):
FUT can co-occur with it:

(60)   O   Janis tha   gini   kala   eipan.
         the John FUT recover.3sg, say.3pl.

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[7]The mystery of the association between epistemic modality and inference (von Fintel and Gillies,
2010) seems to be solved.

[8]See Mari, 2013b on how partiality/completeness of knowledge interact with the types of sources of
information.

(61) Gianni guarirà,   pare.
      Gianni recover-FUT.3sg, it seems.
      'John must recover, it seems.

However, the reportative context by itself is not sufficient to trigger FUT/UEM. We reproduce here an example from Smirnova 2012, to show the contrast between the Greek/Italian FUT and the Bulgarian evidential which is fine in this context.

(62) Reportative context: you and your sister were out of touch for a couple of years. Today she calls you on the phone to catch up. She tells you that her daughter Maria plays the piano. Later, you tell your husband:

      a. Maria svirela   na piano.
          Maria play.EV on piano Bulgarian evidential OK (Smirnova 2012: (2))
      b. #I Maria tha/prepi na pezi piano.
          #Maria must play the piano.
      c. #Maria suonerà il piano.
          #Maria must-FUT.3sg play the piano.

The reason why the UEM is blocked in this context is that here the speaker has complete knowledge that p provided by her sister's utterance. The assertion "Maria plays the piano' is part of the common ground due to the report, so the speaker's epistemic state is homogenous, veridical, and it contains no $\neg p$ worlds. FUT is incompatible with this state, and so is MUST. This example clearly shows that it is not indirectness that matters but complete knowledge.

The inferential context is compatible with the use of future/UEM, granted that the information is not complete. You and your sister were out of touch for a couple of years. Today you visit her for the first time. As she shows you around her apartment, you see that there is a piano. Later, you tell your husband:

(63) a. Maria svirela na piano. (Bulgarian evidential)
          Maria play   on piano.
      b. Maria tha   pezi/prepi na   pezi piano.
          Maria FUT play/must subjunctive play piano.
      c. Maria suonerà/deve   suonare il   piano.
          Maria play.FUT.3sg/must play   the piano.
      d. Maria must play the piano.

Here we have a piano, but we don't actually see Maria playing it. So the knowledge is partial. An inferential context with missing premises is therefore an excellent environment for FUT and the other UEMs. Again, it is not a matter of indirectness, as we see the piano directly: it is simply reasoning with missing premises, hence with incomplete knowledge.

Now finally, consider FUT in a mirative use. Such uses have been reported for evidentials, e.g. in Gitiksan. If the speaker sees John standing in the doorway, as in (64), he has complete evidence. Both Greek and Italian futures are banned.

(64) Gitkasan, Peterson (2010:143, ex. (30)
      =hiwitxw=t
      John EVID=CND arrive=PND

(65) #Tha irthe o Janis!
      #Sarà Gianni!

Again, FUT cannot be used in the context of veridical direct perception.

Having illustrated the relevance of *partial* knowledge, we now turn to a final challenge.

3.2 FUT and MUST with complete premises: a taste of the deontic

Here we consider a case from von Fintel and Gillies 2010 that seems to challenge the claim we just made about partial knowledge.

We crucially made the claim that inferential knowledge cannot be used with the future/UEM if knowledge is complete, i.e. if there are no missing premises. In support of this, Mari (2009,to appear; see also previous discussion in Pietrandrea, 2005) notes that the italian future cannot be used in the following context of complete premises:

(66) a. La palla è in A, B, o C.
          'The ball is in A, B or C.'
      b. Non è nè in A, nè in B.
          'It is neither in A nor in B.'
      c. #Sarà in C.
          'It will be in C.'

Assuming that the future signals epistemic weakening that relies on partial knowledge, here we have full knowledge of the situation, and *c* follows as a logical conclusion from the other two premises. Italian FUT is nicely banned from this use, as expected under our analysis. However, Mari (*ibid.*) also notes that the epistemic modal *dovere* (*must*) is indeed acceptable, and so is *must*:

(67) a. La palla sarà in A, B, o C.
      b. Non è nè in A, nè in B.
      c. Deve essere in C
          'It must be in C.'

In Greek, both FUT and MUST are licensed in this complete knowledge context.

(68) a. The ball is in A, B, or C.
      b. The ball is neither in A nor B.
      c. I   bala prepei na   ine   / tha ine sto   C.
          the ball must   SUBJ be.3s / FUT be.3s in.the C
          'The ball must be/ FUT be in C.'

What is going on? Do we have to modify our analysis for such cases? Our answer is no. Crucially, we will argue, these are NOT cases of pure epistemic reasoning. Instead, they involve an 'impure' (a term from Knobe and Szabo 2013) use of the UEM, where epistemic reasoning is mixed with deontic.

Knobe and Szabo, in their footnote 24, mention that epistemic modals sometimes do carry mixed, factual information: sentences like *Cheerios may reduce the risk of heart disease* and *Late Antarctic spring might be caused by ozone depletion carry factual information* strike them as expressing the results of actual research (see also Yalcin, 2007). They then go on to suggest that these are *impure epistemic modals* whose ranking is fixed by predominantly but not exclusively information about what is known. Predominantly, but not exclusively. In our case above, the ranking is determined by the mathemati-

cal/logical disjunctive schema: p or q or r, $\neg p$ and $\neg q$, therefore r. Hence, the occurrence of UEMs in these contexts is not a counterexample to our analysis of epistemic weakening requiring partial knowledge. They rather support Knobe and Szabo's idea about impure modality. The authors discuss primarily teleological cases of modality, but the cases we reveal here show that epistemic modality is not immune to impurity either.

As for Italian, we must say that the future is immune from impurity, but and the modal *dovere* is not, like *must*. In Greek, both FUT and MUST can take impure readings. Why languages would parametrize this way is not something that this paper can, or should, address. The more specialized the item, the more restricted its uses will be: and the Italian future has a more restricted set of uses and poses more constraints on the modal bases, which do not include those in which complete premises are used, giving rise to the 'taste of deontic'.[9]

4 Conclusion

Our study allows three major conclusions. The first is about the future: in some languages, 'future' forms receive systematically epistemic readings, with no predictive meaning, equivalent to English *must*. This by itself is evidence that the grammatical category 'future' cannot be a purely temporal one, as indeed has been suggested in a substantial amount of recent work on Dutch, Greek, and Italian futures. We offered an analysis of epistemic future as a universal epistemic modal identical to MUST, and showed that in Greek and Italian the two can even co-occur.

Our second conclusion is that the epistemic future and MUST function as *epistemic weakeners*, to express weaker epistemic commitment of the speaker towards the propositional content. As a class, then, epistemic future and MUST are non-veridical (*pace* von Fintel and Gilies 2010). Their occasional 'strong' flavor is due to the fact they do quantify universally over an inner domain of best worlds, and therefore express a commitment within that domain. But their outer domain, the modal space, is non-veridical and contains non-p worlds. MUST and FUT are therefore 'weak', but not as weak as a possibility modal that does not have, we argued, an inner domain, and merely requires intersection of the modal base with p. Ultimately, the difference between the existential and the universal modal (including the future) can be thought of as a difference in *perspective*: the universal has a positive perspective on the proposition, which is responsible for the appearance of "strength"; but the existential has no perspective at all, or simply the neutral perspective of uncertainty.

The third lesson concerns the evidential component of MUST and epistemic future. We showed that contrary to what has been claimed in the literature about indirectness, the key to understanding the evidentiality of MUST and epistemic future is partial knowledge. Partial knowledge represents a partitioned, non-homogenous, therefore non-veridical epistemic state, and explains nicely why the use of universal epistemic modals is constrained in such states. We also showed that visual perception of an event is privileged because it leads to complete knowledge, and therefore FUT and MUST, being non-veridical, cannot be used with direct visual perception.

The overall conclusion of this work is that talking about 'weakness' or 'strength' or 'indirectness' of universal epistemic modals is unhelpful. We can do better by acknowledging that universal epistemic modals are nonveridical. Once we do this, we can explain their

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[9] See also also Pietrandrea, 2005, and Mari, 2010 for further discussion on this.

function as epistemic weakeners and their ensuing reliance of partial knowledge without having to use vague and poorly understood notions such as the above.

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