Epistemic future and epistemic MUST: nonveridicality, evidence, and partial knowledge

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1 Epistemic future and MUST: Dutch, Greek and Italian

The question of whether the notional category 'future' in natural languages is a tense or modality has received a lot of attention in linguistic semantics, and it seems inescapable to conclude that the semantics of future involves a modal component (e.g. see Bertinetto, 1979; Enç 1996, Copley, 2002; Squartini, 2004; Kaufmann 2005; Mari, 2009,2010,to appear, Klecha 2014, Giannakidou 2012, Giannakidou and Mari 2012a,b, Broekhuis and Verkuyl 2014). Even a purely temporal analysis such as Kissine 2008 posits epistemic modality with the future. Future words, often and in many languages, exhibit purely modal readings. Consider as an initial example the English modal verb *will*.

(1) a. The French will be on holiday this week.
b. As far as I know, oil will float on the water. (Haegeman 1993)

The sentences here make no reference to the future, but seem to convey epistemic modality, e.g., given what I know, the French are on holiday this week. Modal uses for *will* are common (see Palmer 1987, Tsangalidis 1980), and likewise for future expressions in other European languages— e.g. they have been observed in Dutch (Broekhuis and Verkuyl 2014), German, Greek and Italian.

Broekhuis and Verkuyl treat the Dutch future verb *zullen* as an epistemic modal expressing that the prejacent proposition is the result of reasoning based on information that judged as 'reliable and well-founded'. They go on to 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 like *must*, as noted in Giannakidou 2014 and illustrated below:

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

(3) Context: I know for sure:
#Hein zal in de/op see zijn.

#Hein must be at sea. #Hein ist wohl auf Zee.

We see here that *zullen* is being used epistemically, as an equivalent to *must*. We also see that a modal particle can be used *wel, wohl* in German (Zimmernann 2011) to convey this meaning equivalent to *must*. Though the inference that Hein is at sea is drawn based on 'reliable and well-founded' information (as Broekhuis and Verkuyl put it), if the speaker actually *knows* that Hein is at sea, she cannot use *zullen* or *must*. *Zullen*, importantly, receives purely epistemic readings also with past tense, as shown below (example from Giannakidou 2014, attributed to J. Hoeksema):

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

(5) #He will have slept really bad.

Epistemic *zullen*, like *must*, allows an epistemic reading with a past, but *will* with the past appears to force future shifting.[1]

We will call this *must*-equivalent use of the future 'epistemic future', and modal particles such as *wel, wohl* will be thought on a par (Giannakidou 2014). Here is the puzzle they all present: *must*, epistemic future, and *wel, wohl* are used to convey 'strong' statements, products of reasoning that the speaker does; at the same time, they are all incompatible with full knowledge of the proposition, thus making weaker statements than unmodalized assertions.

In this paper, we study the Greek and Italian future morphemes in their epistemic readings. Data from these languages, though relatively well known in mostly descriptive and typological works (Rocci, 2001; Squartini, 2004; Pietrandrea, 2005, Mari, 2009,2010; Giannakidou and Mari, 2013a, Tsangalidis 1998, Chiou 2012), are not very well known or widely discussed in the formal semantics literature, in contrast to English. Unlike *will*, which is a modal verb, the future markers (which we call FUT in this paper) in Greek and Italian are a bound morpheme (Italian) and a particle (Greek). Their use as epistemic futures is quite widespread, and appears with both past and non-past. Epistemic future also associates with the imperfective aspect, as we see in Greek, and the progressive in Italian (6-b). The combination of non-past and imperfective is the equivalent of present tense in Greek (Giannakidou 2014). We extend this to Italian as well. For this reason, rather than non-past and imperfect non-past, we use pres in the glosses.

(6) a. I Ariadne tha troi tora.
the Ariadne FUT eat.pres now
'Ariadne must be eating now'
b. Giacomo ora starà mangiando.
Giacomo now FUT.be.3sg eating.
'Giacomo must be eating now'

(7) a. I Ariadne tha ine arrosti (ji'afto dhen ine edo).
the Ariadne FUT be.3sg.pres sick (for-this not is here)
'Giovanni must/#will be sick (that's why she's not here).'

[1]It must also be noted that there is considerable variability in judgements among native English speakers, and some accept purely epistemic readings of *will*, as in the Greek and Italian cases above. We have also encountered speakers that accept epistemic *will* with past adverbs. It remains true, however, that although the Greek and Italian epistemic futures are unexceptional and widely attested, purely epistemic *will* is harder to find, and its existence has been contested in the literature (see e.g. Copley 2002). Another relevant fact is that in English there is competition between *will* and *must* but in Greek and Italian, MUST equivalents can co-occur with FUT (Giannakidou 2012, Giannakidou and Mari 2013).

b. Giovanni sarà malato.
Giovanni FUT-be.3sg sick.
'Giovanni must/#will be sick (that's why he's not here).'

(8) a. I Ariadne tha itan arrosti xthes (ji'afto dhen irthe).
the Ariadne FUT be.past.3sg sick yesterday (for-this not came.3sg
'Ariadne must/#will have been sick yesterday (that's why she didn't come).'
b. Giovanni sarà stato malato ieri.
Giovanni FUT.be.3sg been sick yesterday.
'Giovanni must/#will have been sick yesterday (that why he didn't come).'

(9) a. I Ariadne tha milise xthes.
the Ariadne FUT talk.past.3sg yesterday.
'Ariadne must have spoken yesterday.'
b. Gianni avrà parlato ieri.
Gianni have.fut.3sg spoken yesterday.
'Gianni must have spoken yesterday.'

The past sentences contain the adverb meaning *yesterday* which makes it clear that the reading is not about the future. The reading we get is, to all intends and purposes, equivalent to epistemic *must*, and it is, as we said, fully productive.

The predictive future of FUT is illustrated below:

(10) 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.'

Here we observe the expected reading of prediction, which involves a non-past which excluded the present. This is a perfective non-past which can be thought of as a prospective form (see Giannakidou 2009, Giannakidou and Mari 2015 for more details on the predictive reading, which we do not discuss here).

Regarding the epistemic reading, as with *must*, the speaker has a strong attitude that the proposition is most likely true, but at the same time, she does not *know* that p is actually true. This is why she chooses to add the FUT. This difference becomes particularly obvious if we compare the FUT/MUST sentence with unmodalized ones, in both Greek (a sentences) and Italian (b sentences):

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

(12) 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.'

In the unmodalized present and past sentences, the speaker is fully committed to the truth of the sentences by asserting them. By asserting that Ariadne and Giacomo were sick, the speaker knows that Ariadne and Giacomo were sick, hence a continuation that questions this knowledge

is impossible because it would attribute to the speaker inconsistent knowledge. The epistemic future, on the other hand, is fine with *I am not entirely sure*. The sentences indicate an epistemic state where the speaker considers a proposition very plausibly to be true while not being fully certain about it. This is in contrast to the positive unmodalized assertion where the speaker has no doubt that p is true in the actual world, and we thus get a Moore effect.

We can impressionistically describe this difference, following Kartunnen 1972, by saying that the future/*must* sentences are 'weaker' than the unmodalized assertion. Below, we give examples in Greek and Italian with the equivalents of *must* illustrating the same thing (in Greek *prepi* takes a subjunctive *na*-complement, like all modal verbs; Giannakidou 2009):

(13) a. I Ariadne prepi na troi tora, alla den ime ke endelos sigouri.
the Ariadne must subj eat.pres.3sg now but not am and totally certain
b. Giacomo deve star mangiando #ma non sono sicura. .
Giacomo must be eat-gerund but not am certain
'Giacomo/Ariadne must/will be eating now, but I am not entirely sure.'

(14) I Ariadne prepi na milise xthes, alla den ime ke endelos sigouri.
the Ariadne must subj talk.past.3sg yesterday, but not am and totally certain
'Ariadne must have spoken yesterday, but I am not entirely sure.'

(15) a. Giovanni sarà stato malato, ma non sono totalmente sicura.
Giovanni FUT-be.3sg been sick, but not am totally certain.
b. Giovanni deve essere stato malato, ma non sono totalmente sicura.
Giovanni must.3sg be been sick, but not am totally certain.
'John must have been sick, but I am not entirely sure.'

The sentences with MUST, and the sentences with epistemic FUT are equivalent in speaker's intuitions. (We will be using MUST for the equivalents of *must* crosslinguistically, including, of course, *must* itself). They seem to be strong, but at the same time they are weaker than unmodalized assertions in that they are compatible with "I am not entirely sure". FUT and MUST can actually combine (Giannakidou 2012). The reading remains the same:

(16) I Ariadne tha prepi na milise xthes.
the Ariadne FUT must subj talk.past.3sg yesterday.
'Ariadne must have spoken yesterday.'

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

Giannakidou 2012, and Giannakidou and Mari 2013, 2015 characterize this co-occurence as modal concord (Huitink 2014 for a recent overview and references). Given the epistemic 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]

The current debate in the literature recruits the terms 'weak' and 'strong' (see von Fintel and Gillies 2010), but we find these labels unsatisfactory. In our work here, we will argue that universal modals appear 'weak' because, like *all* modals, they are *nonveridical* (Giannakidou 1998, 1999; Beaver and Frazee 2011). We will define two kinds of (non)veridicality— objective and subjective (relying on epistemic commitment; for a first approach see Giannakidou 1994,

[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.

1997). All modals are nonveridical objectively because they do not entail actual truth; and they are nonveridical subjectively because they do not entail knowledge of p by the speaker. At the same time, universal modals are *biased* modals: they entail p in the Best worlds, and this is what makes them appear strong. Our discussion, finally, implies that the category 'modal' is primarily a semantic category, not specifically tied to the morphosyntatic category 'modal verb'. This is an important conclusion when we consider the larger cross-linguistic picture.

The discussion proceeds as follows. In section 2, we present the notions of veridicality, nonveridicality, epistemic weakening and biased modal that we will use for the analysis of FUT and MUST. In section 3, we discuss evidentiality and partial knowledge, and in section 4 we deal with implications of our analysis when it comes to apparent Moore paradoxical effects.

2 FUT and MUST: non-veridicality, bias

In this section, we present the notions of veridicality and nonveridicality that serve as the foundation for our analysis of modality. After we clarify the core notions, we define *epistemic weakening* as commitment weakening of the speaker, i.e. the creation of a nonveridical epistemic space (Giannakidou 2014). Commitment weakening is decisive also for the analysis of subjunctive mood, as illustrated in Giannakidou this volume, and we refer to that paper for more on that topic.

2.1 Veridicality and Nonveridicality

Montague 1969 uses 'veridicality' to characterize sentences with direct perception verbs such as *see* (see Giannakidou 2013a for a formal connection between truth and existence in relative clauses and with progressives). Authors have also used other labels, e.g. factivity, factuality to refer to veridicality (Kartunnen 1971, Kartunnen and Zaenen 2005, Kiparksy and Kiparsky 1970), as well as actuality (Bhatt 2006, Hacquard 2010). Veridicality in this second use is understood objectively as truth in the actual world: a sentence is veridical if the proposition it denotes is true in the actual world (Egré 2008). Zwarts 1995 and Giannakidou 1994, 1997 define veridicality in terms of entailment as a property of expressions F such F entails the truth of its complement p:

(18) Def 1. Objective veridicality. (based on Zwarts 1995, Giannakidou 1997, 1998, 1999). A F be a monadic sentential operator. The following statements hold: F is veridical just in case F$p \rightarrow p$ is logically valid; otherwise F is nonveridical.

Functions that have veridicality and nonveridicality are propositional functions (but see Bernardi 2001 for type-flexible definitions). F is veridical iff Fp entails p, i.e. if whenever Fp is true, p is true too. F is nonveridical if Fp does not entail p, i.e. if when Fp is true, p may or may not be true. Note that nonveridical operators do not entail the falsity of p; this is a property of anti-veridical operators such as negation (Giannakidou 1998, 1999, 2013).

We call nonveridicality under this definition objective, because it does not make reference to parameters other than the propositions and the functions. There are no subjective parameters such as what individuals think or believe, though these will be needed for the treatment of modality and mood (see below). For now, consider that if a verb such as *know* is our function F, *know* p, if true, entails p, *know* is therefore veridical. But if *want* is the F, *want* p, even if it is true, does not entail p, therefore *want* is non-veridical. Negation, is also nonveridical, because *not* p does not entail p. Objectively, veridicality appears close to factivity and actuality,

and characterizes operators such as *know* which imply truth in the actual world. The sentences under the veridical or nonveridical operator can be called veridical and nonveridical too.

Consider now temporal operators, such as past and present. Veridicality now has to be relativized with respect to the utterance time, as suggested in Giannakidou 2002, and can be defined as follows (Giannakidou 2002 (23)):

(19) Def. 2. Veridicality of temporal operators.
Let F be temporal function, t an instant or an interval.
F is veridical iff , if Fp is true at a time t, it entails that p is true at a (contextually given) time $t' \leq t$; otherwise F is temporally nonveridical.

(20) If a sentence of the form PAST(p) is true at t_u, then it entails that p was true at a time prior to t_u.

(21) If a sentence of the form PRES(p) is true at t_u, then it entails that p is true at t_u.

Temporal veridicality is objective veridicality because the time of evaluation is an objective parameter and not a subjective one. Present and past, as we see are temporally veridical. The future is clearly not, by the definition above, since FUT p does not entail that p is true at a time prior or equal to t_u. Moving now to modals, Giannakidou, and Beaver and Frazee 2011 present nonveridicality as a defining property of the category modality. Consider:

(22) Nicholas might/must bring dessert.

(23) Nicholas might/must have brought dessert.

Nicholas bringing dessert is not, and cannot, be an actual fact under a modal. Logically, possibly p does not entail p. And *must* is also non veridical, since must p does not entail that p either. MUST does not validate the veridicality principle T that holds knowledge and aleithic modality (see Giannakidou 1998, 1999). As de Marneffe et al. 2012 put it: declaratives like Ariadne left convey firm speaker commitment, whereas qualified variants with modal verbs or embedded sentences imbue the sentence with uncertainty (deMarneffe 2012: 102). Similarly, Trnavac and Taboada 2012 use modals as nonveridical markers of uncertainty.

Objective veridicality appears equivalent to actuality, but veridicality is often also discussed in the context of commitment.

The speaker is said to be "fully committed" to the truth of an unmodalized sentence in the present or simple past, but is not fully committed in the case she uses a modal. Therefore, when we talk about the truth of a sentence, we talk about it in two ways: objectively, by appealing to what is the case in the actual world at a time, and subjectively by appealing to speaker's commitment to the truth of the sentence. Giannakidou tries to capture the connection between veridicality and speaker commitment, by making the veridicality judgement relative to *individual anchors*. The truth of a sentence is now anchored to the individual asserting it. In main clauses the anchor is by default the speaker.[3] Giannakidou defined *models of evaluation* to describe the information states of anchors. These models are sets of worlds, relative to i, corresponding to what i believes or knows.[4] We call these models epistemic states in our definition

[3]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 2010). The individual anchor is a parameter of evaluation similar to Lasersohn's (2005) *judge*. In embedded sentences, the main clause subject is also a potential anchor and this has repercussions for mood, as shown in Giannakidou's work.

[4]The difference between knowledge and belief is not so 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. Belief makes a difference for an agent typically when it is contrasted with knowledge, i.e.

below:

(24) Def. 3. *Epistemic state of an individual anchor* i (Giannakidou 1999: (45))
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 the epistemic state, we can now identify (non)veridicality subjectively. Truth is defined with respect to knowledge (and belief):

(25) Def. 4 *Subjective veridicality*
A function F that takes a proposition p as its argument is subjectively veridical with respect to an individual anchor i iff Fp entails that i knows or believes that p is true. This means that i's epistemic state $M(i)$ is such that: $M(i) \subseteq p$.

It follows that $\forall w[w \in M(i) \rightarrow w \in \{w'|p(w')\}]$. i knows/believes p, i is fully committed to p. Consider the following unembedded case:

(26) O Giannis kerdise to agona.
The John won.3sg the race.
'John won the race.'

(27) a. John won the race.
b. [[John won the race]]$^{M(speaker)}$ = 1 iff
$\forall w[w \in M(\text{speaker}) \rightarrow w \in \{w'|$ John won the race in $w'\}]$

If the speaker asserts *John won the race*, she must believe or know that John won the race, hence all worlds in M(speaker) are John-won-the race worlds: $M(\text{speaker}) \subseteq p$. The unmodalized sentence is therefore equivalent to *the speaker knowing p*. The indicative is therefore the mood that conveys homogeneity of a modal space M(i) as being a p space. This is useful also when we think of the direct evidential where it is simply an unmarked past or present. The simple past or present draws on "direct" evidence in the sense that it gives the more reliable, undisputed knowledge. In the absence of indirect evidential, all worlds in M(speaker) are p worlds.

Subjective nonveridicality, on the other hand, is epistemic uncertainty (or non-commitment): it indicates that the speaker does not know for sure that p is true. In this case, the epistemic state only intersects with p, and therefore contains worlds where p is not true:

(28) Def. 5. *Subjective nonveridicality*
A function F that takes a proposition p as its argument is subjectively nonveridical with respect to an individual anchor i iff Fp does not entail that i knows or believes that p is true. This means that i's epistemic state $M(i)$ is such that:$M(i)-\text{p} \neq \emptyset$.

From Def. 5, it follows that $\exists w' \in \text{M}(i) : \neg p(w')$. Hence, a subjectively nonveridical function imposes non-homogeneity on the epistemic state, since there is at least one non-p world. Modals are objectively nonveridical, as mentioned earlier, but also subjectively. A speaker asserting MUST/MAY p has, in her epistemic state, non-p worlds. Modals and the FUT are objectively nonveridical, as mentioned earlier, but also subjectively: the modal bases (which are subsets of M(speaker) have a p and a not p space, and M(speaker) likewise is partitioned into p and not p worlds. Like us, Condoravdi 2002 also acknowledges the nonveridicality of modals in her *diversity* condition that requires that there be one not p world in the modal base.

when the agent is aware that she doesn't have enough information to support a proposition. In this case, we can say that we have semantic narrowing (Geurts and van Tiel 2013).

Subjective veridicality can thus be extended to characterize the epistemic states themselves. A veridical epistemic state is a non-partitioned, homogenous epistemic state. A nonveridical epistemic state, on the other hand, is a space partitioned into p and $\neg p$ worlds.

(29) Def. 6 *Veridical, nonveridical epistemic states and commitment*

a. An epistemic state (a set of worlds) M(i) relative to an individual anchor i is *veridical* with respect to a proposition p iff all worlds in M(i) are p-worlds. (*full commitment*).

b. If there is at least one world in M(i) that is a $\neg p$ world, then M(i) is nonveridical (*weakened commitment, uncertainty*).

c. If all worlds in M(i) are $\neg p$ worlds, then M(i) is antiveridical (*counter-commitment*).

A veridical epistemic state is a non-partitioned, homogenous epistemic state, a state of full commitment. A knowledge state is veridical; as we said, umodalized sentences in the past reveal veridical states. A nonveridical state M(i), on the other hand, is defined as one that contains at least one $\neg p$ world. It is a non-homogenous, partitioned state; it allows uncertainty, and in this case we talk about *weakened* commitment. All epistemic modals convey weakened commitment, and states of indirect evidentials are also nonveridical (as discussed in Giannakidou and Mari 2015). Importantly, with modals, weakened commitment and nonveridicality arise because the modal base is ordered, and p is true only in the Best worlds conforming to the ordering source (Portner 2009). Modal ordering creates nonveridical spaces generally.

When all the worlds are $\neg p$, the state is *antiveridical*, as with negative and counterfactual assertions, which express *counter-commitment* of the anchor. Antiveridicality characterizes generally non-assertion, i.e. optative and imperative sentences, since at the issuing of optative and imperative p clearly doesn't hold, and some may be invitations to bring about p (e.g. the imperative). Counter-commitment and weakened commitment are non-commitment to p, though only weakened commitment operators carry uncertainty.

From the epistemic domain, we can move to generalize veridicality and nonveridicality to all kinds of modal spaces (sets of worlds), including various kinds of modal bases. Veridicality and nonveridicality are now properties of modal spaces:

(30) Def. 7. *Veridical, nonveridical modal spaces*

a. A set of worlds M is *veridical* with respect to a proposition p iff all worlds in M are p-worlds. (Homogeneity).

b. A set of worlds M is *non veridical* with respect to a proposition p iff there is at least one world in M that is a $\neg p$ world. (Non homogeneity).

c. A set of worlds M is *antiveridical* with respect to a proposition p iff M and p are disjoint.

Veridical spaces are homogenous whereas non veridical spaces are non-homogenous. All modal bases are non veridical spaces in this sense, since they are partitioned by their ordering in the Kratzerian semantics (see also Portner 2009, and Condoravdi's 2002 diversity condition that we mentioned earlier). Likewise, bouletic and deontic domains are nonveridical since they are also ordered. Ordering (Kratzer, 1981/1991) creates a partition, therefore necessarily a nonveridical modal space. (Anti-veridical states, on the other hand, are homogenous. A typical such example is the model of the speaker when interpreting a negative sentence.).

Given nonveridical spaces, we must distinguish the cases in which we have ordering sources (Kratzer, 1981,1991; Portner, 2009) from those in which we do not. Ordering sources characterize stronger modals such as *must*. With Portner we define ordering sources and Best worlds.

(31) Def. 8 *Ordering of worlds* - Portner, 2009, p.65.
For any set of propositions X and any worlds $w, v : w \leqslant_X v$ iff for all $p \in X$, if $v \in p$, then $w \in p$.

(32) Def. 9. Best worlds as per X. Best$_X$: $\{w' : \forall q \in X(w' \in q)\}$

Now we define *Support Set*:

(33) Def. 10. *Support Set of a proposition* p. In a nonveridical modal space M, the support set $W \subset M$ of a proposition p is the non-singleton set of worlds that rank as Best, and is such that all worlds w' in W are p-worlds.

Given the notion of support set, we can now define projected truth with respect to that set.

(34) Def. 11. *Actual truth.* p is actually true iff p is true in the actual world.

(35) Def. 12. *Projected truth*. p is *projectively* true iff p is true in all the worlds of the support set W: $W \subseteq p$.

In other words, a nonveridical modal space M supports a proposition if the there is a support set W for the proposition in M. Since the support set is the set of Best worlds, this structure reveals a *bias* towards Best worlds. Modals that come with support sets, such as MUST and FUT are nonveridical, like all modals, but are *biased*. We thus define the new category of biased modals:

(36) Def. 13. *Biased modals*. A modal operator *F* is biased if its modal base M contains a support set $W \subset M : W \subseteq p$.

We can think of the support set as the inner domain of the modal F, and the modal base as its outer domain. In this structure, it becomes clear that strength does not mean that the modal entails actual truth (veridicality). Rather, the biased modal entails p in the inner domain, i.e. in the support set, while p remains unsettled in the modal base which is nonveridical and allows non-p worlds.

There are two kinds of nonveridical epistemic modal spaces: those that contain a support set for a proposition (the biased modals), and the possibility modals that convey nonveridical equilibrium between p and $\neg p$ (Giannakidou 2013b):

(37) Def 14. *Nonveridical equilibrium* (Giannakidou 2013b). An epistemic state M is in nonveridical equilibrium iff M is partitioned into p and $\neg p$, and there are no Best worlds.

A nonveridical state with equilibrium reveals no preference because there is no ordering. Take for example *It might rain tomorrow*. This is a mere possibility statement, and there is no ordering that could create a support set for the proposition 'it rains tomorrow'. Ordering sources add information restricting sets of possibilities and creating support sets, thus privileging one subset of the modal base over its complement ($\neg p$). In terms of commitment, we propose the following scale of commitment strength, from strongest to weakest:

(38) Commitment strength
More committed < unmodalized p, MUST p, POSSIBLY p> less committed

The modal space M of an unmodalized sentence contains only p worlds. When all worlds in M are p worlds, we have veridicality, and this conveys the strongest commitment. With a biased modal like MUST, we have a nonveridical space with a set of Best worlds where p is true

(Giannakidou 2013b, Giannakidou and Mari 2013). In this case, the p worlds are the support set of p, but the modal base and M(speaker) still allow $non-p$ worlds. The possibility sentence, on the other hand, conveys equilibrium between p and non-p (Giannakidou 2013, Giannakidou and Mari 2015), i.e. there is no preference towards the p or non-p worlds, no best worlds, no support of p. This is so because there is no ordering with the possibility modal. Whenever there is ordering there are best worlds, the universal modal will therefore give rise to stronger commitment.

In other words, the universal modal is strong in the sense of partially supporting p in the Best worlds, but it is still weak because it is nonveridical objectively and subjectively. We define here the subjective nonveridicality of epistemic modals:

(39) Subjective nonveridicality of epistemic modals.
MODAL$_{epistemic}p$ p does not entail that the speaker knows that p is true.

All epistemic modals are subjectively nonveridical, possibility as well as necessity modals. Epistemic modals, then, are nonveridical both objectively (because MODAL$_{epistemic}p$ does not entail p, and subjectively, because MODAL$_{epistemic}p$ does not ential the speaker does not know that p. Hence, epistemic modals, even biased ones, are doubly weak (*pace* von Fintel and Gillies 2010). Recall the position of de Marneffe et al. 2012 that modal verbs imbue the sentence with uncertainty (also, Trnvac and Taboada 2012).

2.2 Epistemic future and MUST

As noted at the beginning, FUT has extensive epistemic use in Greek and Italian. We repeat the basic data. The epistemic use arises with non-past and with past, statives and eventives:

(40) a. I Ariadne tha milise xthes.
the Ariadne FUT talk.past.3sg yesterday.
'Ariadne must have spoken yesterday.'
b. Gianni avrà parlato ieri.
Gianni have.fut.3sg spoken yesterday.
'Gianni must have spoken yesterday.'

(41) a. I Ariadne tha ine arrosti.
the Ariadne FUT be.3sg sick.
'Ariadne must be sick.'
b. Giovanni sarà malato.
Giovanni FUT-be sick
'Giovanni must be sick.'

(42) a. I Ariadne tha itan arrosti.
the Ariadne FUT was.3sg sick.
'Giovanni/Ariadne must have been sick.'
b. Giovanni sarà stato malato.
Giovanni must been sick.
'Giovanni must have been sick.'

In all cases, the speaker is considering information she has and draws an inference based on that information. In accordance with what we said so far, the epistemic FUT/MUST modal base is nonveridical, as evidenced by the possibility of negative continuations illustrated below:

(43) a. I Ariadne ine arosti, #ala dhen ime ke endelos sigouri.
the Ariadne is sick, but not be.1sg and absolutely sure
b. Giacomo è malato, #ma non sono sicura.
Giacomo is sick, but not am certain.
'Ariadne/Giacomo is sick, #but I am not entirely sure.'

(44) a. I Ariadne tha ine arosti, ala dhen ime ke endelos sigouri.
the Ariadne FUT is sick, but not be.1sg and absolutely sure
b. Giacomo sarà malato, ma non sono sicura.
Giacomo be.3sg.fut, but not am sure.
'Ariadne must be sick, but I am not entirely sure.'

In contrast to an unmodalized sentence, the FUT/MUST sentence is compatible with a continuation revealing weakened certainty. This indicates that not all worlds in the modal base are p worlds. With unmodalized past sentences, on the other hand, the *not entirely sure* continuation is not possible, as we see, because they convey un-partitioned, veridical, epistemic states. We come back to these sentences in section 4.

Below, we give examples, in Greek and Italian with the verb equivalents of MUST, and note that they pattern with FUT, and contrast with unmodalized assertions:

(45) a. I Ariadne prepi na troi tora ala dhen ime ke endelos sigouri.
the Ariadne must subj eat.pres.3sg now but not be.1sg and absolutely sure
b. Giacomo deve star mangiando, ma non sono totalmente sicura.
Giacomo must be eat-gerund, but not am totally certain.
'Giacomo/Ariadne must/will be eating now, but I am not entirely sure.'

(46) a. I Ariadne prepi na milise xthes, ala dhen ime ke endelos
the Ariadne must subj talk.past.3sg yesterday, but not be.1sg and absolutely
sigouri.
sure
'Ariadne must have spoken yesterday, but I am not entirely sure.'
b. Gianni deve aver parlato ieri.
Gianni must have spoken yesterday, ma non sono totalmente sicura.
'Gianni must have spoken yesterday, but I am not entirely sure.'

Sentences with MUST and those with epistemic FUT are equivalent in the speaker's intuitions. FUT and MUST can combine— an instance of modal concord:

(47) I Ariadne tha prepi na milise xthes, ala dhen ime ke endelos
the Ariadne fut must subj talk.past.3sg yesterday, but not be.1sg and absolutely
sigouri.
sure.
'Ariadne must have spoken yesterday but I am not entirely sure .'

(48) Giacomo dovrà aver parlato ieri.
Giacomo must-FUT.3sg have spoken yesterday.
'Giacomo must have spoken yesterday, but I am not entirely sure'.

Given the epistemic FUT and the parallel with MUST, we will pursue the same semantics for both. In Giannakidou and Mari (2015) we show that the predictive reading differs from the epistemic only in the modal base (which in the predictive reading is metaphysical). In the present paper, we focus strictly on the epistemic reading.

Epistemic FUT associates with an epistemic modal base. Specifically, the modal base is the set of propositions known by the speaker (w_0 is the actual world): $M = \lambda w'.w'$ is compatible with what is known by i (the speaker) in w_0. Note that $M \subset M(speaker)$. (Our epistemic modality is thus *subjective*, see the objective vs. subjective distinction of Papafragou 2006. In fact, given that we relativize with respect to individual anchors, there can be no objective modality, strictly speaking, in our system). Given what the speaker knows, the modal base contains p worlds, but also $\neg p$ worlds; it is nonveridical, non-homogenous. Let us define the ordering and then Best worlds given the ordering.

(49) For any set of propositions $\mathcal{S}$ and any world w, w': $w \leqslant_{\mathcal{S}} w'$ iff for all $q \in \mathcal{S}$, if $w' \in q$, then $w \in q$.

(50) Best worlds given the ordering $\mathcal{S}$.
$\text{Best}_{\mathcal{S}} : \{w' \in M : \forall q \in \mathcal{S}(w' \in q)\}$.

$\text{Best}_{\mathcal{S}}$ are a subset of worlds in the epistemic modal base, in which *strange things do not happen* (see Portner, 1998; Mari 2014a). 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.

The modal base is thus partitioned and the modal space is subjectively nonveridical. One of the subsets of the modal base is ranked as the set of Best worlds given the ordering $\mathcal{S}$. FUT universally quantifies over the set $Best_{\mathcal{S}}$ (which is a subset of the modal base, as we see). Hence:

(51) At the utterance time t_u,
$[\![\text{FUT}_{epistemic}(\text{PRES(p)})]\!]^{\text{M}}$ will be defined only if the modal base M is nonveridical; if defined,
$[\![\text{FUT}_{epistemic}(\text{PRES(p)})]\!]^{\mathcal{S}}$ = 1 iff $\forall w' \in \text{Best}_{\mathcal{S}} : p(w', t_u)$

(52) At the utterance time t_u,
$[\![\text{FUT}_{epistemic}(\text{PAST(p)})]\!]^{\text{M}}$ will be defined only if the modal base M is nonveridical; if defined,
$[\![\text{FUT}_{epistemic}(\text{PAST(p)})]\!]^{\mathcal{S}}$ = 1 iff $\forall w' \in \text{Best}_{\mathcal{S}} : \exists t' \prec t_u \wedge p(w', t')$

This truth-conditional content of FUT is identical to MUST, to which we assign exactly the same truth conditions. By MUST we designate crosslinguistically expressions that are the semantic cognates of English must, and of course must itself:

(53) At the utterance time t_u,
$[\![\text{MUST}_{epistemic}(\text{PRES(p)})]\!]^{\text{M}}$ will be defined only if the modal base M is nonveridical; If defined,
$[\![\text{MUST}_{epistemic}(\text{PRES(p)})]\!]^{\mathcal{S}}$ = 1 iff $\forall w' \in \text{Best}_{\mathcal{S}} : p(w', t_u)$

(54) At the utterance time t_u,
$[\![\text{MUST}_{epistemic}(\text{PAST(p)})]\!]^{\text{M}}$ will be defined only if the modal base M is nonveridical; if defined,
$[\![\text{MUST}_{epistemic}(\text{PAST(p)})]\!]^{\mathcal{S}}$ = 1 iff $\forall w' \in \text{Best}_{\mathcal{S}} : \exists t' \prec t_u \wedge p(w', t')$

Following Giannakidou 2009 and Giannakidou and Mari 2015, we take it that the temporal information comes from the lower tense, which can be past or nonpast (see also Staraki 2013 for an analysis of Greek modals as purely modal operators and not mixed modal/temporal as in

Condoravdi 2002).

How about the actual world? Best worlds are those in which strange things do not happen. Typically the actual world tends to be non-extraordinary (Portner, 2009), 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. Given that the accessibility relation is epistemic and therefore reflexive, it is ensured that the actual world is in the modal base (see Matthewson et al. 2007; Portner, 2009), but it is not guaranteed that the actual world belongs to the p worlds. With universal quantification over the set of Best worlds, however, truth is projected within the support set and this is responsible for the sense of strength that comes with FUT and MUST; but it must not be confused with veridicality, which expresses full commitment to p and therefore does not allow for the possibility of $not\ p$ within the modal base.[5]

This account treats MUST as both strong (because of quantification within the set of Best worlds) and weak (because of the nonveridical modal base). p is entailed in the set of Best worlds over which MUST quantifies, although is it is not entailed in the modal base.

It is useful to compare our account to von Fintel and Gillies 2010. They posit the existence of a kernel K which is a set of worlds representing the privileged information. They then pose a presupposition of 'direct unsettledeness' in the kernel:

(55) (Strong must + evidentiality) Fix a c-relevant kernel K

a. [[$must\phi$]]^{c,w} is defined only if K does not directly settle [[ϕ]]^{c}

b. If defined, [[$must\phi$]]^{c,w} = 1 iff $B_K \subseteq$ [[ϕ]]^{c}

Von Fintel and Gillies say that K can *fail* to directly settle whether P even though K *entails* whether P (von Fintel and Gillies 2010: 372).

The modal base, in their account is a homogeneous space of p worlds, in our it is not. However, because of the ordering source, we are able to carve out a set of worlds in which p is also true, and it is on this set that MUST quantifies.

3 The evidential component: *partial* knowledge

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 biased modal statement compatible only with a partitioned, non-veridical epistemic state consisting of a subspace of Best worlds 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 Kartunnen's is that the epistemic weakening is not due to the fact that knowledge is indirect, but to the fact that knowledge is *partial*.

Kartunnen 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'.

[5] In a recent work, Mari (2014b) argues that some other modals are veridical with respect a restricted domain that contains the actual world, and nonveridical with respect to an outer domain. This, she argues, is what happens with past modals with present orientation, triggering the veridicality (a.k.a. actuality entailments). What is common to MUST/FUT and these modals, is that the modal domain is articulated into two subdomains, with the inner one being veridical and the outer one, being nonveridical.

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 arises because the speaker is reasoning with partial knowledge, and she knows that she does not have all the facts (see also Mari, 2010).

Recall the partition that lies at the heart of the truth condition of universal, biased modals: the partition between best and non-best worlds. When the speaker reasons with a universal modal, 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 universal modal, as evidenced in direct visual perception contexts:

(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, biased modals are similar to devices such as the German and Dutch modal particles, as we me mentioned in the introduction. 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, but the opposite: it is homogeneously supporting p. Epistemic weakeners are incompatible with the state of complete, homogenous knowledge that comes with direct perception.

Why we need partiality rather than indirectness of knowledge 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.

(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.'

In this context, I see a wet umbrella, but I don't see the rain, therefore I do not *know* that it is raining. 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. The biased epistemic and FUT modals 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, as we see.

Likewise, auditory perception is compatible with MUST and FUT because this too 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 do not know that 'it is raining', I only have the sound of rain. The sound might be caused by something else than the rain (hence, I am also missing the premise: if sound therefore rain). Only in the Best worlds is the sound of raining due to rain. Auditory perception therefore provides only incomplete knowledge, and the modal is allowed. In other words, the apparent evidential effect of universal epistemic modals is due to the fact that they are indicators of reasoning with non veridicality and incomplete knowledge. We summarize this in the following:

(59) *Evidential component of Universal Epistemic Modals: partial knowledge*

a. Universal epistemic modals 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 technically, it is a set of propositions that *entails* p.

c. All other knowledge is partial.

The generalizations that we establish here for universal modals are very relevant for the discussion of evidentiality, especially in languages that have indirect evidential morphemes but do not mark direct perception (e.g. Native American languages such as Cheyenne, Murray to appear, and Turkish, Bulgarian, Smirnova 2013a). The 'direct' evidential is typically an unmarked past or present, and the marked form is the so-called indirect evidential, which indicates that the source of information is not first hand knowledge of the speaker. The indirect evidential— like the universal in English, Greek and Italian— can thus be understood as expressing reduced speaker commitment to p. Direct perception, on the other hand, as we discussed in the case of rain, entails full knowledge. If I see the rain, I know it is raining, hence direct perception gives that kind of veridical, complete, knowledge.[6]

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 that every type of source of information comes as either *complete* 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 (see also Mari, 2010).

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

[6]Note, at the same time, that direct access in the sense of Willett (1988) 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 Lee 2012 explains, witnessing p is not equivalent to have visual evidence for p. 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.

(60) O Janis tha (prepi na) gini kala eipan.
the John FUT (must SUBJ) become.3sg well, say.3pl.

(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 universal biased modals. We reproduce here an example from Smirnova 2013b, 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 2013b: (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 universal modal is blocked in this context is that here the speaker has 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 veridical, and it contains no worlds that negate this information. FUT is incompatible with this state, and so is MUST. This example clearly shows that it is not indirectness that matters but whether the speaker knows or not. If one has full knowledge of p, even if this knowledge is due to something that someone else said, one cannot use an epistemic weakening device, not even a biased one (MUST, future, modal particles).

The inferential context, on the other hand, is compatible with the universal modals because it presents partial knowledge. We will use again an example modeled after Smirnova 2013b. 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, hence the knowledge is partial. An inferential context with missing premises is therefore an excellent environment for FUT, MUST and the other weakening devices. Again, it is not a matter of indirectness, as we see the piano directly: it is simply reasoning with incomplete knowledge so that we can effectively partition the modal base into worlds that support the proposition and those that do not, as is required by epistemic weakening.

Now finally, consider FUT/MUST 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 this context of veridical direct perception because it gives complete veridical knowledge.

We are saying that inferential knowledge cannot be used with the biased modal if complete, and 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.'

Here we have full knowledge of the situation, and c follows as a logical conclusion from the other two premises. Italian FUT is 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.'

Do these data challenge our idea of incomplete knowledge? We think not, because these do not seem to involve pure epistemic reasoning. They present an 'impure' (a term from Knobe and Szabo 2013) use of the universal modal, where epistemic reasoning is mixed with aleithic modality; or they are simply just aleithic because a conclusion is drawn based on the mathematical/logical disjunctive schema: p or q or r, $\neg p$ and $\neg q$, therefore r. Hence, the occurrence of universal modals in these contexts is indeed evidence for strength (as von Fintel and Gillies suggest) but not of strength of the epistemic MUST; rather, they signal aleithic use of MUST, whose strength is indisputable anyway. In support of this being a different use, we want to add that often, this aleithic use of MUST/FUT is signaled by focus on the modal— in contrast to the regular epistemic weakening case where MUST is typically unstressed and disallows focus: *The ball MUST be in C!* as opposed to *# John MUST be a doctor, but I am not entirely sure*,

which is quite odd with the emphatic stress on MUST. In other words, there is indeed evidence, at the suprasegmental level at least, that this use of MUST is distinct from the epistemic one.

To conclude, we have proposed a theory of FUT and MUST as biased universal modals. As modals, they are nonveridical (hence weak), both objectively (they do not entail p) and subjectively (they do not entail that the speaker knows that p). Reasoning with universal modals relies on partial knowledge, and they appear to be strong because in the worlds compatible with that knowledge p is true. It turned out that no recourse to a separate evidential component was necessary.

4 Moore effects with biased modals and informational flow

In this last section, we want to fine tune our analysis by examining some effects that appear to be Moore-paradoxical. The literature on the Moore paradox is vast, and we will not attempt a general analysis of it here, since our topic is not the paradox itself. Our new observations are that we find Moore-effect with biased modals, but different variants of Moore's paradox affect the modals in different ways. To explain the variation, we propose that Moore-effects do not necessarily reveal a veridicality conflict, but manifest also sensitivity to informational flow that previously has escaped attention.

The classical Moore paradox itself arises with sentences like below:

(69) #It is raining and I don't know that it is raining.

(70) #It is raining and I don't believe it.

The usual reaction is that the sentences above are odd, contradictory-sounding, and unassertable. In the literature, the sentences are treated as defective in that they involve the speaker in some kind of epistemic conflict. In our terms: as we said in section 2.1, a positive unmodalized assertion is subjectively veridical, i.e. the speaker is typically understood as knowing that p is true. If this is so, then in the sentences above the speaker's epistemic state M(speaker) is presented as both being included in p and allowing $\neg p$ worlds. This is a contradictory epistemic state, and the sentences are defective because of this veridicality conflict imposed by the two conjuncts.

Yalcin in a more recent discussion (Yalcin 2007) coins the term *epistemic contradictions* for Moore variants with logical forms such as ϕ *and it is not possible that* ϕ, e.g:

(71) #It is raining and it might not be raining.

(72) #It is raining and it is possible that it is not raining.

Yalcin calls these epistemic contradictions. Again, the conflict appears to be between a veridical epistemic state established by the unmodalized first conjunct (where all worlds are raining worlds), and a non-veridical state, allowing raining and non-raining worlds in the second conjunct. So, both Yalcin's examples and the classic Moore paradox examples involve an epistemic conflict which reveals a subjective veridicality conflict.

Interestingly from our perspective, future and MUST sentences give rise to what appears to be a Moore paradoxical effect. We observe it below. (We replace and with but to make the sentences more natural sounding, but as can be seen, the effect is observed):

(73) #It must be raining, but it might not be raining.

(74) #Tha vrehi, ala ine pithano na min vrehi.
FUT rain.pres.3sg ala is possible subj not rain.imperf.non-past.3sg
'#It must be raining, but it is possible that it it might not be raining. (epistemic)'

(75) Gianni sarà arrivato, #ma è possibile che non sia arrivato.
John be.3sg.fut arrived, but is possible that not be.subj.3sg arrived.
'John must have arrived, but it is possible that he has not arrived' (epistemic).

(76) #Prepi na vrehi, ala ine pithano na min vrehi.
must SUBJ rain.pres.3sg ala is possible subj not rain.imperf.non-past.3sg
'#It must be raining, but it is possible that it it might not be raining. (epistemic)'

If biased modals are non veridical, as we argue, and convey a partitioned state, how can the data above be explained? If the nonveridical spaces associated with FUT and epistemic MUST are nonveridical (thus allowing $\neg p$ worlds), as we are arguing, why aren't they compatible with a continuation that raises that possibility?

As we proceed to show how the Moore effect can be explained in our account, we want to recall first the new set of data, of similar structure, that we mentioned earlier and which in fact support the nonveridical analysis. Recall that we used them as evidence *for* it. Here is a sample of the sentences with *but I am not entirely sure*.

(77) a. I Ariadne tha ine arosti, ala dhen ime ke endelos sigouri.
the Ariadne FUT is sick, but not am and completely sure
b. Giacomo sarà malato, ma non sono completamente sicura.
Giacomo be.3sg.fut sick, but not be.1sg entirely certain.
'Ariadne/Giacomo must be sick, but I am not entirely sure.'

(78) a. I Ariadne prepi na troi tora, alla den ime ke endelos sigouri.
the Ariadne must subj eat.pres.3sg now, but not be.1sg and completely sure.
b. Giacomo deve star mangiando, ma non sono completamene sicura.
Giacomo must be eat-gerund, but not be.1sg completely sure
'Giacomo/Ariadne must/will be eating now, but I am not entirely sure.'

With continuations like *but I am not entirely sure*, the Moore effect seems to be removed. Crucially, the effect remains with an unmodalized veridical sentence:

(79) I Ariadne ine/itan arosti, #ala dhen ime ke endelos sigouri.
the Ariadne is/was sick, but not be.1sg and completely sure
Ariadne is/was sick, but I am not entirely sure.

(80) Giacomo è/era malato, #ma non sono completamente sicura.
Giacomo is/was sick, but not be.1sg completely certain.
'Giacomo is/was sick, #but I am not entirely sure.'

The present and past sentences are subjectively and objectively veridical. When the speaker utters them, as far as she knows, Ariadne and Giacomo were sick, and knowledge of that cannot be cancelled by a continuation that questions it. All worlds in M(speaker) are worlds in which Ariadne and Giacomo are sick, so the second conjunct induces epistemic contradiction that comes from this veridicality conflict (all worlds in M(speaker) are p worlds in the first conjunct, while not all worlds in the same space are p worlds in the second conjunct).

The epistemic future and MUST, on the other hand, are fine with *but I am not entirely sure*. Why? Because both conjuncts are not veridical, and they there're both of equal informational

strength, so there is no conflict between them. The first conjunct establishes a nonveridical modal base which allows $\neg p$ worlds, i.e. the worlds that are not Best. In the second conjunct, we move from the modal base, to the larger space, i.e. the speaker's epistemic state. The speaker is in a nonveridical epistemic state: *I am not entirely sure that p* is equivalent to *I am committed to p but not fully*, which means that my epistemic state is also biased toward p but allows $\neg p$ worlds. The presence of *entirely* is crucial in the sentence as it reveals the bias (as opposed to *I am not sure* which is a neutral sentence with no bias towards p. Hence, the two conjuncts make reference to nonveridical modal spaces which are in agreement and not in conflict, since they are both nonveridical and biased. We will call this situation informational harmony. We do not get a Moore-paradox with informational harmony, unlike with the positive unmodalized assertion where *I am not entirely sure that p* creates exactly the kind of contradiction the classical Moore continuation gives (a contradictory epistemic state). Hence, *I am not entirely sure* fully supports our nonveridical treatment of epistemic FUT and MUST.

What we just said relied on the notion of informational strength. The two sentences were of equal informational weight, we said. What goes wrong in the classical Moore cases and in our FUT/MUST variants of them is that the sentences do not have the same informational weight. This creates informational conflict that manifests itself in two ways: (a) as breakdown of information flow, which *normally* proceeds from weaker to stronger (as we define it below), and (b) as an "informational contradiction". The Moore effects with FUT and MUST are due to these. Consider first how the classical case illustrates breakdown of information flow:

(81) #It is raining and/but it might not be raining.

The first conjunct *It is raining* presents the rain as an actual fact (objective veridicality), or knowledge of the speaker of this fact (subjectively veridical), i.e. in all worlds compatible with the speaker's knowledge it is raining. The second conjunct conveys a weaker information, i.e. that the speaker considers it possible that it is not raining. This discourse makes the hearer conclude that the speaker is not being co-operative. She said something false either in the first or in the second conjunct, in both cases violating quality, thus being misleading. We end up with a conflict, as well as a breakdown of what can be thought of as normal information flow.

Proceeding from weaker to stronger is the normal course of information flow, expected by Gricean pragmatics:

(82) *Normalcy conditions on information flow*
Information flow is considered $normal$ iff:
(i) Information goes from weaker information A to stronger information B. Or,
(ii) A and B do not informationally contradict each other.

These conditions are nothing extraordinary, but mere summary of run-of-the-mill versions of Gricean views of how information normally proceeds. Weaker and stronger are the informational alternatives compared, i.e. the propositions denoted by the sentences. The problem, crucially, in the second conjunct, comes from the fact that a stronger information was established first: a veridical sentence is informationally stronger than a non-veridical sentence. And within non-veridical sentences, S with bias is stronger that S with equilibrium. Recall that the ordering source reveals bias. With equilibrium, there is no ordering source. With ordering sources the domain of quantification is more restricted and is thus informationally richer (à la Stalnaker). Below we give the relevant scale:

(83) Informational strength ordering relevant for Moore's contrasts
weaker $\langle$ might $\neg p$, $MUSTp$, $p\rangle$ stronger

Let us represent Moore's sentences S as a pair of alternatives $\langle S1, S2\rangle$:

(84) Moore's variant: p and might $\neg p$
Alternatives: $\langle S1$:p, $S2$:might¬p$\rangle$

$S1$ is a stronger alternative than $S2$ because the veridical epistemic state is not partitioned: all worlds are p-worlds. $S2$ says something that is both informationally weaker and in veridicality conflict with $S1$. The reverse order, from weaker to stronger, is predicted to be fine, and this prediction is borne out:

(85) It might not be raining, but in fact it is raining.

Here, conversation proceeds normally, because the weaker S2 precedes S1 (and we added *in fact* to help the sentences connect; notice that *in fact* has no effect on the other order: *It is raining but in fact it might not be raining* remains odd). In the order above, the second sentence seems to correct the first one, to strengthen it; and, because information proceeds normally, the difference in veridicality is in harmony with the strengthening. There seems to always be a discourse function that strengthening serves, but it will lead us to far astray to develop this in more detail (see Geurts 2010 for a recent neo-Gricean pragmatic theory that addresses in detail informational strengthening, while also arguing that it doesn't always serve the same function.) For now, suffice it to raise awareness that the ill-formedness of the classic Moore sequence reveals both a veridicality conflict, *and* a violation of informational normalcy. If the latter gets fixed, the difference in veridicality becomes innocuous.[7]

To go now to our FUT/MUST sentences, consider first the case of a negated possibility modal in the second conjunct:

(87) a. #Tha vrehi, ala ine pithano na min vrehi.
FUT rain.pres.3sg but is possible subj not rain.imperf.non-past.3sg
b. #Starà piovendo, ma è possibile che non piova.
Stay.3sg.fut rain.gerund, but is possible that not rain.3sg.subj.
'#It must be raining, but it might not be raining.'

(88) #Prepi na vrehi, ala ine pithano na min vrehi.
must SUBJ rain.pres.3sg ala is possible subj not rain.imperf.non-past.3sg
'#It must be raining, but it is possible that it it might not be raining.'

In the cases where a universal modal is followed by the negation of a possibility modal, we have utterances of modalized sentences in both conjuncts. But we don't have the same informational weight in both conjuncts. *Must p* conveys bias towards p worlds, while the possibility utterance conveys equilibrium; hence $S1$ is the stronger alternative, while $S2$ is informationally weaker: we go from a stronger S1 (with ordering sources revealing bias) to a weaker $S2$ (with no ordering sources and equilibrium):

[7]We think it is worth mentioning that the normalcy conditions we posited above are not specific to modality, but are general. Consider e.g. quantifiers:

(86) a. #Every linguistics student came to the Halloween party, and some linguistics students came to the party.
b. Some linguistics students came to the Halloween party; in fact, every linguistics student came to the party.

The odd sequence is not normal because it proceeds from strong (with universal quantification) to weak (with existential quantification). Here violation of normalcy leads to redundancy.

(89) Moore's variant: MUST p and might $\neg p$
Alternatives: $\langle S1$:MUST p, $S2$: might $\neg$p$\rangle$

According to the normalcy condition, information flow requires the stronger statement to be second. The information flow in the Moore sentence is thus not normal, and the sentence is defective for this reason. Notice, crucially, that if we reverse the order as we do below, the sequence is improved, and shows no Moore effect :

(90) a. Ine pithano na min vrexi, alla malon tha
is possible subj not rain.imperf.non-past.3sg, but probably FUT
vrexi.
rain.imperf.non-past.3sg.
'It is possible that is not raining, but most likely it must be raining.'
b. È possibile che non stia piovendo, ma starà piovendo,
Is possible that stay.3sg.subj not rain.gerund, but stay.3sg.fut rain.gerund,
vedrai.
see.2sg.
'It might not be raining, but I am pretty certain it is raining, you'll see.'

These discourses are normal because the stronger sentence follows the weaker one. This fact illustrates that the problem with the Moore sentences with strong modals in the first conjunct followed by negations of weaker modals, are due to breakdown of normal information flow. The two alternatives are not epistemically inconsistent but informationally not-normal.

Consider, finally, the continuations with *I don't believe it*:

(91) Gianni sarà arrivato, #ma non lo credo.
John be.3sg.fut arrived, but not that believe.1sg.
'#John must have arrived, but I do not believe it.'

Here, the alternatives are:

(92) Moore's variant: MUST p and *I do not believe that p*
Alternatives: $\langle S1$:MUST p, $S2$: *I do not believe that p* $\rangle$

The speaker establishes bias towards p with the use of a universal modal in the first conjunct. She continues then by saying that she does not believe that John arrived. Importantly, *believe* is a neg-raising verb, so *not believe that p* typically strengthens to *believe that not p*; (see Horn 1979 for a classical piece on neg-raising with belief verbs). In the strengthened reading, both conjuncts appear to be informationally equally strong, but, crucially, conflicting with each other: the first conjunct conveys bias towards the p set (*John arrived*) and the second alternative strengthens to the belief that John didn't arrive (there are no p worlds in the speakers epistemic state, counter commitment to p). This creates a conflict in the join utterance because the speaker is required to both have bias towards p and counter commitment to it. This is an informational "contradiction", a conflict that cannot be repaired. As we see, change of order has no effect:

(93) a. Den pistevo oti irthe o Janis, #alla tha irthe.
not believe.1sg that FUT.came.3sg the John, but FUT came.3sg.
b. Non credo che John sia arrivato, #ma sarà arrivato.
Not believe.1sg.pres that John be.3sg.subj arrived, but be.3sg.fut arrived.
'#I do not believe it that John arrived, but he must have arrived.'

Here the speaker remains in an informationally contradicting state where she is required to both have bias towards p, and believe p to be false. This is an impossible informational state. Notice that in the sentence below, without negation in the second conjunct, we have again informational harmony (though perhaps also a bit of redundancy:

(94) It must be raining and I believe that it is raining.

We will close our discussion here, by summarizing the three cases of Moore-continuations for $FUT/MUSTp$ that we found:

(a) A continuation that creates no effect, revealed with *I am not entirely sure*; this continuation illustrates informational harmony.
(b) A continuation that violates informational normality from weaker to stronger information (with *might not p*); this effect can be fixed with reversing the order of conjuncts.
(c) A continuation that creates informational contradiction (with *I do not believe p*). Order has no effect on this one.

Certainly further study is required to understand better the interactions between modals in Moore sentences, and to refine how the notion of informational strength we proposed interacts with the semantics. Here, we offered but a few initial, and we hope helpful, observations about the behavior of FUT/$must$ in Moore like sentences.

5 Conclusions

In this article, we identified three new categories. The first one is the category of epistemic future. Epistemic future is equivalent to the epistemic modal verb *MUST*, and this fact is evidence that the grammatical category 'future' cannot be a purely temporal one, in agreement with 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 contribution is the category *biased* modal. The epistemic future and MUST are biased modals, we argued, and biased modals are both strong and weak. They are strong because they entail p in the set of Best worlds (the support set), but they are weak because their modal base is nonveridical and therefore contains non-p worlds too. Biased modals express weaker epistemic commitment of the speaker towards the propositional content, and function generally as *epistemic weakeners*. The category of biased modals includes, besides FUT and MUST, also modal particles such as *wohl, wel* in German and Dutch. Though we didn't offer an explicit analysis, we want to suggest that certain indirect evidentials, in languages exhibiting a binary opposition between evidential vs. unmarked, are also epistemic weakeners. The function os epistemic weakening is to create a nonveridical epistemic space, i.e. a partitioned space with at least one non-p world.

The third category, then, is the category of (non)veridicality. Veridicality is a property of natural language expressions entailing the truth of their complement (objective veridicality), or knowledge of an individual of the truth of a proposition (epistemic, or subjective veridicality). Veridicality and nonveridicality are fundamental in characterizing the truth conditions of modal expressions (modal verbs and particles), but also propositional attitudes and mood choice (as is further discussed in Giannakidou's paper in this volume and in earlier work). The licensing of negative polarity items also seems to be sensitive to nonveridicality. We developed a frame-

work for (non)veridicality of modal expressions that is flexible enough to allow analysis of new phenomena within a number of limited and well understood premises.

Concerning, finally, the evidential component of MUST, we suggested that contrary to what has been claimed in the literature about indirectness, the key 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 to 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. In other words, what much literature characterized as evidential component of MUST is simply an epiphenomenon, reflecting the nonveridical nature of MUST, and its incompatibility with full knowledge.

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