

Biased modality and epistemic weakness with the future and MUST: non veridicality, partial knowledge

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Abstract

In this paper, we discuss the purely epistemic reading of the future morphemes in Greek and Italian. In this reading, which we call ‘epistemic future’, the future morpheme behaves as equivalent to the universal epistemic modal *must*. Like *must*, epistemic future appears to have an evidential component: it cannot be used if the speaker *knows* that the pre-jacent proposition *p* is true. 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 renders epistemic futures and *must* nonveridical, therefore epistemically weaker than unmodalized positive assertions— and contrasts with von Stechow and Gillies 2010 who argue that *must* is ‘strong’. We explain the effect of strength by arguing that future and *must* are *biased* modals in that they partially support *p* in the set of best worlds. All modals that come with ordering sources are biased, therefore stronger than mere possibility modals. Our analysis makes a distinction between actual and *projected truth* which creates bias towards the best worlds; universal epistemic modals are both strong (because they are biased) and weak (because they are nonveridical).

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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 language— e.g. Dutch (Broekhuis and Verkuyl 2014), and in our own work on Greek and Italian that we rely on here. We use these crosslinguistic observations as the starting point for our present paper.

Broekhuis and Verkuyl claim that the Dutch future verb *zullen* 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 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*. And 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 the sea, she cannot use *zullen* or *must*. We will call this use ‘epistemic future’, and these are its puzzles: like *must*, epistemic future seems to convey a strong statement, a certainty that the proposition it applies to holds; but at the same time, and again like *must*, it is incompatible with full knowledge of the proposition, thus making a weaker statement than the sentence without it. Notice that *zullen* can be accompanied by the modal particle *wel*, a cognate of German *wohl*, also known to have epistemic uses like this, i.e. combining certainty and weakness (see Zimmermann 2011, and Giannakidou 2014 who is the first to observe the similarity of future and modal particles). The sentences with with the particles are epistemically weaker than the sentences without them.

Zullen receives purely epistemic readings also with past tense:

- (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.

(Thanks to Jack Hoeksema for supplying this example). This example shows that epistemic *zullen*, like *must*, allows an epistemic reading with a past, but unlike *will* with the past forces future shifting.¹

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 in Greek and Italian (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). They admit a purely epistemic reading, and this use is quite widespread. Epistemic future recruits the imperfective aspect (13-a), as we see in Greek, and the progressive in Italian (6-b), non-past statives (7) or past (15-a) below FUT:

- (6) a. I Ariadne tha troi tora.
the Ariadne FUT eat.imperf.non-past3sg 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.nonpast sick (for-this not is here)
'Giovanni must/#will be sick (that's why she's not here).'
- 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 epistemic future of Greek and Italian is akin to *must*, like with *zullen*. The past sentences contain the adverb meaning *yesterday* which makes it clear that the reading is not about the

¹It must also be noted, however, 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).

future. The reading we get is, to all intents and purposes, equivalent to epistemic *must*, and it is fully productive.

The predictive future of FUT is illustrated below:

- (10) a. Gianni arriverà domani.
John arrive-FUT.3sg tomorrow.
'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.'

In this reading we have the expected reading of prediction, which we will not discuss as it has been discussed in detail elsewhere (Giannakidou and Mari, 2013, 2014).

Regarding the epistemic reading, as we said earlier, the speaker has a strong attitude towards the proposition, i.e. she judges *p* to be likely to be 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 becomes particularly obvious if we compare the FUT sentence with an unmodalized one, 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 indeed an epistemic state where the speaker considers a proposition very plausibly to be true while not being fully certain about it. We do not get a Moore-paradox, unlike with the positive unmodalized assertion where the speaker has no doubt that *p* is true in the actual world.

We can impressionistically describe this difference by saying that the future/*must* sentences are 'weaker' than the unmodalized assertion (as is common since Karttunen 1971). 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.non-past3sg now.
b. Giacomo deve star mangiando.
Giacomo must be eat-gerund.
'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
'Ariadne must have spoken yesterday, but I am not entirely sure.'

- (15) a. Giovanni sar  stato malato, ma non sono totalmente sicura.
 Giovanni FUT-be.3sg been. PERF. sick, but not am totally
 (epistemic, past)
 certain.
- b. Giovanni deve essere stato malato, ma non sono totalmente sicura.
 Giovanni must.3sg be bee, sick, bit 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. They seem to be stronger than mere possibility statements, but at the same time they are weaker than unmodalized assertions in that they are compatible with "I am not entirely sure", and therefore do not express full commitment of the speaker. FUT and MUST can actually combine (Giannakidou 2012). The reading remains the same:

- (16) I Ariadne THA prepi na milise xthes. (epistemic, past)
 the Ariadne FUT must subj talk.past.3sg yesterday.
 ‘Ariadne must have spoken yesterday.’
- (17) Giacomo dovr  aver parlato ieri.
 Giacomo must-FUT.3sg have spoken yesterday.
 ‘Giacomo must have spoken yesterday’.

Giannakidou 2012, and Giannakidou and Mari 2013, 2014 characterize this co-occurrence 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

There is a debate in the literature as to whether MUST is *weak* or *strong*, and authors typically understand the disjunction as exclusive. In our work here, we will offer more refined characterizations of what the strength and weakness of MUST and FUT are, and we conclude that once we acknowledge nonveridicality and *bias*, MUST and epistemic future are both weak (because of nonveridicality) and strong (because of partial support of *p* and bias).

The discussion proceeds as follows. In section 2, we present the notions of veridicality, non-veridicality, 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 a potential challenge coming from Moore paradoxical effects with FUT and MUST.

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.

²In 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.

2.1 Veridicality and Nonveridicality

Montague introduces the term *veridicality* to characterize sentences with direct perception verbs such as *see*. Zwarts 1995, and Giannakidou (1997, 1998, 1999) define (non)veridicality as relating to truth (see Giannakidou 2013a for a relation between the two definitions). Veridicality is understood objectively as truth in the actual world: a sentence is veridical if the proposition it denotes is true in the actual world (Zwarts 1995, Giannakidou 1997, Egré 2008), and non-veridical otherwise. Authors have also used other labels, e.g. *factivity*, *factuality* to refer to veridicality (Karttunen 1971, Karttunen and Zaenen 2005, Kiparsky and Kiparsky 1970), as well as *actuality* (Bhatt 2006, Hacquard 2010).

Following Zwarts (1995) and Giannakidou (1997, 1998), we define veridicality *objectively* as a property of propositional functions such that if an expression entails the truth of its proposition it is veridical:

(18) Def 1. *Objective veridicality*.

A function F is objectively veridical iff Fp entails p ; otherwise F is objectively non-veridical.

Functions that have veridicality and nonveridicality, as can be seen, are propositional functions (but see Bernardi 2001 for type-flexible definitions). A veridical or nonveridical function F takes the denotation of a sentence, i.e. a proposition p , as an argument and creates a veridical or nonveridical proposition. Sentences that denote veridical and nonveridical propositions can then also be called veridical and nonveridical:

(19) Def. 2. *Objective (non)veridicality of sentences*.

- a. A sentence that denotes a proposition of the form Fp , where F is objectively veridical, is an objectively veridical sentence.
- b. A sentence that denotes a proposition of the form Fp , where F is objectively nonveridical, is an objectively nonveridical sentence.

Veridicality objectively is equivalent to the traditional *realis*: a veridical sentence is true in the actual world, i.e. it refers to a fact. Any sentence that does not refer to a fact is nonveridical. Unmodalized, non-negated, sentences in the simple past or present (which is the present progressive in English) are objectively veridical:

(20) Nicholas brought dessert.

(21) Nicholas is washing the dishes.

The sentences here refer to events that happened in the past or are happening right now; in the present, the speaker may even be witnessing the event unfolding. PAST is an objectively veridical function. $PASTp$ entails p . The same for PRES p . Veridical sentences are therefore *actually* true—and the actuality entailments discussed in the literature (Bhatt 2006, Hacquard 2010) are veridicality entailments. The future sentence *Nicholas will wash the dishes*, on the other hand, is objectively nonveridical, i.e. it does not entail actual truth. All prospective domains (future, subjunctive, optative, bouletic and deontic domains), and traditional *irrealis* domains, lack veridicality (see e.g. Condoravdi, 2002; Copley, 2002; Kaufmann, 2005; Giannakidou 1998, 1999, 2014). Modal statements as a class are nonveridical (Giannakidou 1997, 1998, 2013), and likewise Beaver and Frazee 2011, crediting Giannakidou, 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. Notice that temporal orientation doesn't matter. Possibility modals are simply not factual and therefore nonveridical. Logically, *possibly p* does not entail *p*. And *must* is also non veridical, since *must p* does not entail that *p* is actually true, i.e. in the actual world. MUST does not validate the veridicality principle T that is valid for 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.

This notion of objective veridicality is equivalent to actuality, as noted, and in the veridical sentence, there is no choice for the speaker between *p* and $\neg p$, since the actual world is a *p* world (if the sentence is true). Now, from the perspective of assertion, apart from this objective dimension, veridicality is often discussed in the context of what is called in the literature *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, 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 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 identify (non)veridicality *subjectively*. Truth is defined not with respect to the actual world but with respect to the anchor's epistemic state:

- (25) Def. 4 *Subjective veridicality*
 A function *F* that takes a proposition *p* as its argument is subjectively veridical with respect to an epistemic state $M(i)$ iff $M(i) \subseteq p$.

From (25), it follows that $\forall w[w \in M(i) \rightarrow w \in \{w' | p(w')\}]$. As mentioned earlier, PAST is an objectively veridical function, i.e. $PAST(p)$ entails *p*. PAST is also subjectively veridical: *p* is true in all worlds in the speaker's epistemic state. Subjectively veridical functions such as

³Individual 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 Laserson'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.

⁴The 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. 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).

PAST or PRES impose homogenous epistemic states which are included in p .

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

If the speaker asserts *John won the race*, she must believe or know that John won the race, hence all worlds in $M(\text{speaker})$ are John-won-the-race worlds: $M(\text{speaker}) \subseteq p$. The past (and present) sentence is therefore equivalent to *the speaker knows that p*. This is also useful when we think of evidential contrasts in e.g. languages that have so-called "indirect" evidentials, and which form minimal pairs with simple past or present. The simple past or present is said to draw on "direct" evidence in the sense that it conveys the more reliable, undisputed knowledge (see Giannakidou and Mari 2014 for more discussion).

Subjective nonveridicality, on the other hand, comes with epistemic states that only intersect with p , and therefore contain $\neg p$ worlds:

- (27) Def. 5. *Subjective nonveridicality*
 A function F that takes a proposition p as its argument is subjectively nonveridical with respect to an epistemic state $M(i)$ iff $M(i) - p \neq \emptyset$.

From (27), it follows that $\exists w' \in M(i) : \neg p(w')$. Hence, a subjectively nonveridical function imposes non-homogeneity on the epistemic state, since there is at least one *non p* world. Again, a subjectively (non)veridical function F creates a subjectively (non)veridical proposition, which characterizes a (non)veridical sentence:

- (28) Def. 6. *Subjective (non)veridicality of sentences*
 a. A sentence that denotes a proposition of the form Fp , where F is subjectively veridical, is a subjectively veridical sentence.
 b. A sentence that denotes a proposition of the form Fp , where F is subjectively nonveridical, is a subjectively nonveridical sentence.

Modals and the FUT are objectively nonveridical, as mentioned earlier, but also subjectively: the modal bases (which are subsets of $M(\text{speaker})$ interact with p but are not included in it, and $M(\text{speaker})$ is also not included in p .

From the above it becomes clear that subjective veridicality can 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. 7 *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, unmodalized 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 2014, to appear). 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 create 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. 8. *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 (a fact emphasized in Giannakidou 2013b). 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 on modals). 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. 9 *Ordering of worlds* - Portner, 2009, p.65.

For any set of propositions X and any worlds $w, v : w \leq_X v$ iff for all $p \in X$, if $v \in p$, then $w \in p$.

(32) Def. 10. Best worlds as per X . $\text{Best}_X: \{w' : \forall q \in X(w' \in q)\}$

Now we define *Support Set*:

(33) Def. 11. *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. 12. *Actual truth*. p is actually true iff p is true in the actual world.

- (35) Def. 13. *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 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*:

- (36) Def. 14. *Biased modals*. A modal operator F is biased if its modal base M contains a support set $W \subset M : W \subseteq p$.

The support set is the inner domain of the modal F , and the modal base is 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. Both biased and unbiased modals are weaker than unmodalized assertions because they are nonveridical; but 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 2013):

- (37) Def 15. *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 $M(\text{speaker})$ still allow *non-p* worlds. The possibility sentence, on the other hand, conveys equilibrium between p and non- p (Giannakidou 2013, Giannakidou and Mari 2014, this volume), 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 than the possibility modal. In other words, the universal modal is strong in the sense of partially supporting p in the best worlds, but it is still weak with respect to the non-modal veridical sentence which conveys full commitment.

- (39) Commitment weakening of epistemic modals
i. All epistemic modals are nonveridical: they convey weaker speaker commitment.
ii. Biased epistemic modals convey stronger commitment than possibility modals because they contain best worlds that support p .

Biased modal statements are always strong with respect to possibility statements, and at the same time weak with respect to veridical statements. This discussion is relevant also for evidentiality, as will become clear in the course of the paper, but let us now first see how this framework applies to the analysis of epistemic future.

2.2 Epistemic future

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.'

These are all epistemic statements, with no future reference. FUT is equivalent to epistemic MUST. In all cases, the speaker is considering information she has and draws an inference based on that information. We will argue that the epistemic FUT/MUST modal base is nonveridical, as with predictive future (Giannakidou and Mari 2012, 2013, 2014). Nonveridicality is 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 sentence is compatible with a continuation revealing uncertainty. This indicates that not all worlds in the modal base are *p* worlds. With unmodalized past sentences, on the other hand, the uncertainty continuation is not possible, as

we see, and we take this to show that they convey un-partitioned, veridical, epistemic states that are included in p . We come back to these sentences in section 4.

In the literature, *must* is known to be ‘weaker’ than the unmodalized assertion, and the idea that MUST is weak goes back to Karttunen 1971 (see also discussion in von Stechow and Gillies 2010 and references therein, as well as Giannakidou 1997, Giannakidou and Mari, 2014). 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 prepri na troi tora ala dhen ime ke endelos
the Ariadne must subj eat.non-past3sg now but not be.1sg and absolutely
sigouri.
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 prepri 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.’

The sentences with MUST and the sentences with epistemic FUT are equivalent in the speaker’s intuitions. FUT and MUST can actually combine— an instance of modal concord. The reading remains the same:

- (47) I Ariadne tha prepri 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 non-predictive usage of FUT and the parallel with MUST, it becomes very appealing to argue that with the epistemic future the reading can be derived parallel to *must*. In Giannakidou and Mari (2014b) we show that the analysis of the epistemic reading of MUST runs parallel to the analysis of FUT in the predictive reading, differing only in the modal base. In the present paper, we focus strictly on the epistemic reading.

In the epistemic use, FUT associates with an epistemic, not metaphysical, modal base. Specifically, the modal base is the set of propositions known by the speaker (w_0 is the actual world): $\cap f_{epistemic}(w_0) = \lambda w'.w'$ is compatible with what is known by i (the speaker) in w_0 . Note that $\cap f_{epistemic}(w_0) \subset M(\text{speaker})$. (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' : $w \leq_{\mathcal{S}} w'$ iff for all $q \in \mathcal{S}$, if $w' \in q$, then $w \in q$.
- (50) Best worlds given the ordering \mathcal{S} .
 $\text{Best}_{\mathcal{S}} : \{w' \in (\cap f_{epistemic}(w_0)) : \forall q \in \mathcal{S}(w' \in q)\}$.

$\text{Best}_{\mathcal{S}}$ are a subset of worlds in the epistemic modal base, in which *strange things do not happen* (see Portner, 1998; Mari 2013). 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 partitioned in the way depicted in (50). The modal space is thus subjectively nonveridical. One of the subsets of the modal base is ranked as the set of Best worlds given the ordering \mathcal{S} .

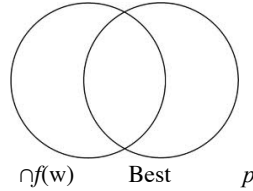


Figure 1: Epistemic space for *FUT*

FUT universally quantifies over the set $\text{Best}_{\mathcal{S}}$ (which is a subset of the modal base, see (50)).

Epistemic future:

- (51) At the utterance time t_u ,
 $\llbracket \text{FUT}(\text{NON-PAST}(p)) \rrbracket^{\mathcal{S}} = 1$ iff $\forall w' \in \text{Best}_{\mathcal{S}} : \exists t' \in [t_u, \infty) \wedge p(w't')$
- (52) At the utterance time t_u ,
 $\llbracket \text{FUT}(\text{PAST}(p)) \rrbracket^{\mathcal{S}} = 1$ 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.

Epistemic *MUST*:

- (53) At the utterance time t_u ,
 $\llbracket \text{MUST}(\text{NON-PAST}(p)) \rrbracket^{\mathcal{S}} = 1$ iff $\forall w' \in \text{Best}_{\mathcal{S}} : \exists t' \in [t_u, \infty) \wedge p(w't')$
- (54) At the utterance time t_u ,
 $\llbracket \text{MUST}(\text{PAST}(p)) \rrbracket^{\mathcal{S}} = 1$ iff $\forall w' \in \text{Best}_{\mathcal{S}} : \exists t' \prec t_u \wedge p(w't')$

Following Giannakidou 2009, 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 therefore bias is revealed towards the p worlds, as is the case also the predictive reading. Bias 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 M .⁵

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

In his seminal work, Karttunen (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 Karttunen's is that the epistemic weakening is not due to the fact that knowledge is indirect, but to the fact that knowledge is *partial*.

Karttunen 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 Stechow 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 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:

- (55) *Context: Direct visual perception of rain*
- a. #It must be raining.
 - b. #Tha vrexì.
FUT rain.

⁵In a recent work, Mari (2014) 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.

- c. #Piovera.
rain-FUT.3sg.
- d. #Tha prepì na vrexì.
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 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 (56), where I only see a wet umbrella.

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

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.

- (57) 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 vrexì.
FUT rain.
 - c. Pioverà.
rain-FUT.3sg.
 - d. Tha prepì na vrexì.
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 in effect due to the fact that they are indicators of reasoning with non veridicality and incomplete knowledge. We summarize this in the following:

- (58) *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 technically, it is a set of propositions that *entails* *p*.
 - c. All other knowledge is partial.

The generalizations that we establish here for UEMs 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 UEM in English, Greek and Italian—is a nonveridical marker that marks the 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. This is the case of veridical commitment, of full complete knowledge. Direct perception, naturally gives that kind of knowledge⁶

Given partial knowledge, *p* is entailed only in the support set (the best worlds, or von Stechow and Gillies's kernel). Otherwise, in the modal based *p* remains unsettled. 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 reprobativ 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:

- (59) O Janis tha gini kala eipan.
the John FUT become.3sg well, say.3pl.
- (60) 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 UEM. We reproduce here an example from Smirnova 2013b, to show the contrast between the Greek/Italian FUT

⁶Note, 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 (56), 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.

and the Bulgarian evidential which is fine in this context.

- (61) 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 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 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 full knowledge. 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.

The inferential context, on the other hand, is compatible with the use of future/UEM 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:

- (62)
- 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 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 in a mirative use. Such uses have been reported for evidentials, e.g. in Gitksan. If the speaker sees John standing in the doorway, as in (63), he has complete evidence. Both Greek and Italian futures are banned.

- (63) Gitksan, Peterson (2010:143, ex. (30))
=hiwitxw=t
John EVID=CND arrive=PND

- (64) #Tha irthe o Janis!
#Sarà Gianni!

Again, FUT cannot be used in this context of veridical direct perception because it gives com-

plete knowledge. The mirative use is treated as an additional inference that the evidential triggers in view of the fact that it cannot have its regular contribution. The UEMs, clearly, lack this inference.

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

4 Moore-like effects with FUT and informational conflict

In this last section, we want to discuss a potential challenge for our analysis: FUT can give rise to 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 FUT, but different variants of Moore's paradox affect future sentences in different ways. To explain the variation, we propose that Moore-effects do not necessarily reveal an epistemic (veridicality) conflict, but manifest also sensitivity to informational flow that previously has escaped attention.

The classical Moore paradox itself arises with sentences like below:

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

(66) #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 $M(\text{speaker})$ 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:

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

(68) #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):

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

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

(71) Gianni sar  arrivato, #ma   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).

If FUT is non veridical, as we argue, and conveys a partitioned state, how can the data above be explained? At first sight, they seem to pose a challenge for our proposal, since the conflict in the classical cases, as we just mentioned, appears to be due to a veridicality conflict. 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 of FUT 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*.

- (72) a. I Ariadne tha ine arosti, ala dh:n 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.'
- (73) a. I Ariadne prepri na troi tora, alla den ime ke endelos
the Ariadne must subj eat.non-past3sg now, but not be.1sg and completely
sigouri.
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:

- (74) 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.
- (75) 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 $M(\text{speaker})$ 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 $M(\text{speaker})$ 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 ⁷). 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 situation 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:

(76) #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). The statement is also 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 is odd, and the hearer must 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:

(77) *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 than 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:

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

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

(79) Moore's variant: p and might $\neg p$
Alternatives: $\langle S1 : p, S2 : \text{might} \neg p \rangle$

⁷Note that the 'I am not sure' continuation is odd.

$S1$ 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:

(80) 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.⁸

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

(82) a. #Tha vrekxi, ala ine pithano na min vrekxi.
FUT rain.perf.non-past.3sg but is possible subj not rain.perf.non-past.3sg

b. #Pioverà, ma è possibile che non piova.
Rain.3sg.fut, but is possible that not rain.3sg.subj.
'#It will rain, but it is possible that it will not rain.'

(83) a. #Tha vrehi, ala ine pithano na min vrehi.
FUT rain.imperf.non-past.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.'

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): \langle might, must \rangle , going from weaker to stronger:

(84) Moore's variant: *MUST p* and *might $\neg p$*
 Alternatives: $\langle S1 : \text{MUST } p, S2 : \text{might } \neg p \rangle$

⁸We think it is worth mentioning that the normalcy conditions we posited above are not specific to modality, but are general. Consider e.g. quantifiers:

(81) 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.

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 :

- (85) a. Ine pithano na min vrekxi, alla tha vrekxi,
 is possible subj not rain.perf.non-past.3sg, but FUT rain.perf.non-past.3sg,
 tha dhis.
 FUT see.2sg
- b. È possibile che non piova, ma pioverà, vedrai.
 Is possible that not rain.3sg.subj, but rain.3sg.fut, see.2sg.fut.
 'It is possible that it will not rain, but it will rain, you'll see.'
- (86) a. Ine pithano na min vrexì, alla malon tha
 is possible subj not rain.imperf.non-past.3sg, but probably FUT
 vrexì.
 rain.imperf.non-past.3sg.
 'It is possible that it 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 is possible that it is not 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, at least when we think of their Greek and Italian counterparts, is not a veridicality conflict, but 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*:

- (87) Gianni sar  arrivedo, #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:

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

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 speaker's 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 below, change of order has no effect:

- (89) 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 sar  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:

- (90) 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 $FUT/MUST_p$ 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, and information flow in general. Here, we offered but a few initial, and we hope helpful, observations about the behavior of $FUT/must$ in Moore like sentences. In the light of our observations, it appears to be too simplistic to think of the Moore's contrasts as being due to veridicality conflict only. The improvements with order reversals from weak to strong were crucial in revealing the dimension of information flow. In case of no conflict, as with continuations *but I am not entirely sure* there is no Moore paradox. Such cases, in fact, and their contrast with unmodalized assertions, which are incompatible with *but I am not entirely sure*, can be used as a diagnostic of the nonveridical nature of the modalized first conjunct. In the case of informational contradictions, the conflict is irreparable, but it is not indicative of a veridicality conflict.

5 Conclusion

In this study, we made three new contributions. The first is about the future: often, 'future' forms receive systematically epistemic readings, with no predictive meaning. Epistemic futures are equivalent to English epistemic *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 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 (their inner domain), but they are weak because their modal base (their outer domain) is nonveridical and therefore contains non- p worlds too.

Biased modals thus express weaker epistemic commitment of the speaker towards the propositional content– but they are still stronger than unbiased possibility modals that simply raise the possibility that p and do not contain a support set for p .

The third contribution 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.

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