Epistemic modals, deduction, and factivity

Teodora Mihoc, Diti Bhadra, and Anamaria Fălăuş

Introduction. Existing analyses of epistemic *will* treat it identically to epistemic *must*. We provide novel empirical evidence from English and Romanian in deduction and factive contexts to argue that this identical treatment is not warranted. We propose a solution based on novel ways to (i) look at weakness in *must* and *will* and (ii) encode the factive presupposition when the complement of the factive is a modalized proposition (an interaction that, to our knowledge, has not been analyzed formally before).

Epistemic future. English *will* is ambiguous between a future tense and an epistemic interpretation. Romanian has two related but morphologically distinct variants of *will*, one that is ambiguous between future tense and epistemic uses, just like English *will*, and which we will abbreviate *va* (after its 3SG form), and one that is restricted to unambiguously epistemic contexts, and which we will abbreviate *o* (after its 3SG form) (Mihoc 2014).

(1) a. John will be home. EPI✓, FUT✓
b. Ion va fi acasă. EPI✓, FUT✓
John VA be home

(2) Ion o fi acasă. EPI✓, FUT✗
Ion O be home

Two novel empirical puzzles. The epistemic future has been analyzed the same as epistemic *must* (cf. e.g., Condoravdi 2003 for English *will*; Giannakidou and Mari 2018 for the Greek and Italian epistemic future). However, the two differ in crucial ways. Epistemic *must* is felicitous in deduction, no uncertainty contexts (von Fintel and Gillies 2010, Goodhue 2017) and under factive attitude predicates (Lyons 1977, Papafragou 2006, Rett 2012), (3-a) and (4-a). The epistemic future on the other hand is ruled out in both these contexts: *will*/*va* can only have a future tense interpretation, (3-b) and (4-b), and *o* (which can only be epistemic) is entirely out, (3-c) and (4-c) (for *o* cf. also Fălăuș 2014).

Deduction context: *Chris has lost her ball, but she knows with full certainty that it is either in Box A or B or C. She says:* The ball is in A or in B or in C. It is not in A. It is not in B.

(3) a. So, it must be in C.
b. (i) So, it will be in C. FUT✓, EPI✗
(ii) Atunci va fi în C. FUT✓, EPI✗
then VA be in C
c. #Atunci o fi în C.
then O be in C

Factivity context: *Chris is part of a team of detectives trying to figure out John's location. She got a call saying they have narrowed it down to Honolulu. She says to another team member:*

(4) a. I just found out that John must be in Honolulu.
b. (i) I just found out that John will be in Honolulu. FUT✓, EPI✗
(ii) Tocmai am aflat că John va fi în Honolulu. FUT✓, EPI✗
just have.1SG found.out that John VA be in Honolulu
c. #Tocmai am aflat că John o fi în Honolulu.
just have.1SG found.out that John O be in Honolulu

The contrasts above show that epistemic future cannot be reduced to epistemic *must*. They differ crucially in their ability to be used in contexts with full speaker certainty: epistemic *must* is compatible with full certainty contexts, but the epistemic future (*o* and the epistemic uses of *will*/*va*) isn't. Previous analyses of uncertainty (e.g., von Fintel and Gillies 2010, Giannakidou and Mari 2018) do not allow for these crucial differences to exist. Below, we capture the differences in an analysis that gives us desirable results for the factivity puzzle as well.

Proposal. We endorse an analysis of modals à la Kratzer (1991). Modals are interpreted relative to a modal base $f(w_@)$ and an ordering source $g(w_@)$. They quantify over a subset of $\bigcap f(w_@)$, namely, those worlds of $\bigcap f(w_@)$ ranked the highest by the ordering source $g(w_@)$, which is often abbreviated as *Best*. We assume this holds for all of *must*/*will*/*va*/*o*, (5).

(5) $[\![$must/will/va/o$]\!] = \lambda p \,.\, \lambda w \,.\, \forall w' \in Best(\bigcap f(w), g(w))[p(w')]$

Capturing the deduction contrast: We argue that the difference between epistemic *must* and the epistemic future (the epistemic uses of *will/va* and *o*) lies with the ordering source g: epistemic *must* allows it to be empty, whereas the epistemic future does not. Technically, this means that in the former case $Best$ can be equal to $\bigcap f(w_@)$, but in the latter not. This in turn corresponds to whether *[universal modal] p* is able to entail *p*. Since for epistemic modals $f(w_@)$ picks out the propositions true at $w_@$, this means that $w_@$ is always in $\bigcap f(w_@)$. Consequently, if $Best = \bigcap f(w_@)$, then *[universal modal] p* entails *p*. Note that, by specifying both the evidence and the reasoning schema according to which it is interpreted, and moreover by having this schema such that the clues end up entailing the conclusion, deduction contexts like the one in (3) are cases where $Best = \bigcap f(w_@)$.

Relating this to our paradigm, then, epistemic *must* tolerates an empty ordering source, which explains its use in deduction contexts. The epistemic future (*o* and the epistemic uses of *will/va*) does not, which is why it is bad in such contexts. (Conceivably, the future tense of *will/va* can be regarded as a special case where it tolerates an empty ordering source, but we don't pursue that here.) This account thus maintains a uniform semantics for these items as universal epistemic modals, while capturing their different behavior with respect to (un)certainty.

Capturing the factivity contrast: What we learned from the deduction data is that some universal epistemic modals, e.g., *must*, are compatible with uses in which *[universal modal] p* entails *p*, but others aren't. We argue that in factive contexts this difference crucially determines whether the presupposition of the factive is going to be able to be satisfied or not. More concretely, following Spector and Egré (2015), we assume that factive attitude predicates can be decomposed into a presuppositional part requiring the complement to be true at $w_@$ and a non-factive attitude component akin to *believe*, (6). (For the truth conditions of attitudes and embedded modals, such as *believe p* and *believe modal p*, we assume Anand and Hacquard 2014; in the modal case, the modal quantifies over the worlds provided by the attitude predicate.) For example, an utterance of *John knows that p* presupposes that p is true at the actual world, $[\lambda w \,.\, p(w)](w_@) = 1$ and asserts that John believes this, (6).

(6) $[\![$know that p$]\!] = \lambda x \,.\, \lambda w : p(w) = 1.\ [\![$believe$]\!]\,(p)(x)(w) = 1$

We propose that *John knows that [universal modal] p* presupposes the same thing, namely, that $[\lambda w \,.\ [\![$[universal modal]$]\!]\,(p)(w)](w_@) = 1$, (7). Moreover, we propose that in this presupposition the modal is interpreted relative only to a modal base – for epistemic modals, the facts at $w_@$. Thus, the presupposition becomes $[\lambda w \,.\, \forall w' \in \bigcap f(w)[p(w')]](w_@)$, which simplifies to $\forall w' \in \bigcap f(w_@)[p(w')]$. *John knows that [epistemic must/future] p* thus presupposes that the facts at $w_@$ entail *p*, i.e., $p(w_@) = 1$. As discussed for deduction contexts, only *must* can be used this way – the epistemic future (*o* and epistemic *will/va*) can't.

(7) $[\![$know that modal p$]\!] = \lambda x \,.\, \lambda w : [\![$modal p$]\!]\,(w) = 1.\ [\![$believe that modal p$]\!]\,(x)(w) = 1$

On this account, the strength of the presupposition is relative to the modal in the complement of the factive. We leave it to future work to determine the constraints on such relativization. Crucially though, our approach formally accounts for the puzzling and previously undiscussed distributional facts about epistemic modals and epistemic future we laid out above.

Outlook. This account very easily generalizes to embedded existential epistemic modals. The factive presupposition for an utterance of the form *John knows that [existential modal] p* is $[\lambda w \,.\, \exists w' \in \bigcap f(w)[p(w')]](w_@)$, which simplifies to $\exists w' \in \bigcap f(w_@)[p(w')]$. Thus, *John knows that might p* merely presupposes that the facts at $w_@$ are compatible with *p* – a presupposition that is easy to satisfy. This ties in nicely with cross-linguistic observations that existential epistemic modals embed more easily under attitudes in general than universal epistemic modals (Rett 2012 for English, Anand and Hacquard 2013 for Romance languages).

References

Anand, P. and Hacquard, V. (2013). Epistemics and attitudes. *Semantics and Pragmatics*, 6(8):1–59.

Anand, P. and Hacquard, V. (2014). Factivity, belief and discourse. *The art and craft of semantics: A festschrift for Irene Heim*, 1:69–90.

Condoravdi, C. (2003). Moods and modalities for *will* and *would*. In *Invited communication at Amsterdam Colloquium*.

von Fintel, K. and Gillies, A. S. (2010). Must... stay... strong! *Natural Language Semantics*, 18(4):351–383.

Fălăuș, A. (2014). Presumptive mood, factivity and epistemic indefinites in Romanian. *Borealis–An International Journal of Hispanic Linguistics*, 3(2):105–124.

Giannakidou, A. and Mari, A. (2018). A unified analysis of the future as epistemic modality. *Natural Language & Linguistic Theory*, 36(1):85–129.

Goodhue, D. (2017). Must φ is felicitous only if φ is not known. *Semantics and Pragmatics*, 10.

Kratzer, A. (1991). Modality. In von Stechow, A. and Wunderlich, D., editors, *Semantics: An international handbook of contemporary research*. de Gruyter.

Lyons, J. (1977). Semantics 2. *Cambridge CUP*.

Mihoc, T. (2014). The Romanian future-and-presumptive auxiliary. *McGill Working Papers in Linguistics*, 24(1):64–80.

Papafragou, A. (2006). Epistemic modality and truth conditions. *Lingua*, 116(10):1688–1702.

Rett, J. (2012). On modal subjectivity. *UCLA Working Papers in Linguistics*, 16:129–148.

Spector, B. and Egré, P. (2015). A uniform semantics for embedded interrogatives: An answer, not necessarily the answer. *Synthese*, 192(6):1729–1784.