

Must . . . Stay . . . Strong!

Kai von Fintel¹ Anthony S. Gillies²

¹MIT, Linguistics and Philosophy

²University of Michigan, Philosophy

MIT LF Reading Group — December 10, 2007

`<http://mit.edu/fintel/mss-{slides|handout}.pdf>`

Our Trilogy on Epistemic Modals

- ① An Opinionated Guide to Epistemic Modality
- ② CIA Leaks
- ③ *Might* Made Right
- ④ *Must . . . Stay . . . Strong!*

Outline

- Motivating Example
- The Mantra
- The Tension Between the Mantra and the Standard Semantics
- Kratzer's Solution
- Contra Mantra
- Another (Almost) Mantra Instead
- Implementation
- Issues

In the Rain

- (1) Looking out the window during our Arizona trip, I see pouring rain.
 - a. ✓ It's raining.
 - b. !! It must be raining.

- (2) In a windowless conference room, I see people coming in folding up their wet umbrellas.
 - a. ✓ It's raining.
 - b. ✓ It must be raining.

In the Rain

- (1) Looking out the window during our Arizona trip, I see pouring rain.
 - a. ✓ It's raining.
 - b. !! It must be raining.

- (2) In a windowless conference room, I see people coming in folding up their wet umbrellas.
 - a. ✓ It's raining.
 - b. ✓ It must be raining.

Mantra

- (3) a. John left.
 b. John must have left.

Karttunen (1972): “Intuitively, (3b) makes a weaker claim than (3a).”

Mantra, Mantra

- (4) a. She climbed Mount Toby.
b. She must have climbed Mount Toby.

Kratzer (1991): “It has often been observed that I make a stronger claim in uttering (4a) than in uttering (4b).”

Mantra, Mantra, Mantra

Groenendijk & Stokhof (1975: 69): “A statement like

(5) John must be at home

is weaker than

(6) John is at home

(6) expresses more conviction on the part of the speaker than (5) does.”

Mantra, Mantra, Mantra, Mantra

Lyons (1977: 808): “Although it might appear that a statement is strengthened by putting the proposition that it expresses within the scope of the operator of epistemic necessity, this is not so, as far as the everyday use of language is concerned. It would be generally agreed that the speaker is more strongly committed to the factuality of *It be raining* by saying *It is raining* than he is by saying *It must be raining*.”

Mantra, Mantra, Mantra, Mantra, Mantra

“[E]pistemic modals are nonveridical with respect to the speaker’s epistemic model. If I know that *Frank is ill*, i.e. if he just told me so, then I cannot utter *Frank must be ill*; rather, I should say *Frank is ill*. So, if I say that *Frank must be ill*, it is implied that I don’t know for sure that Frank is ill, hence I am not committed to the truth of *Frank is ill*.” (Giannakidou 1999)

The Mantra*

Must p is a weaker claim than p .

A fortiori: *must p* \nRightarrow p .

In the Rain — Explained

- (1) Looking out the window during our Arizona trip, I see pouring rain.
- a. ✓ It's raining.
 - b. !! It must be raining.
- (2) In a windowless conference room, I see people coming in folding up their wet umbrellas.
- a. ✓ It's raining.
 - b. ✓ It must be raining.

(1b) is too weak. (For Gricean reasons, (1a) is preferred.)

The Standard View of Epistemic Modality

- The standard view of epistemic modals treats *must* as universally quantifying over worlds compatible with what is known.
- Given what “know” means, the actual world is compatible with what is known.
- Straightforward prediction: $must\ p \Rightarrow p$.
- The mantra contradicts this prediction.

Slightly More Formally

- Epistemic modals are universal quantifiers over worlds supplied by an epistemic modal base
- A modal base (supplied by context c) is a function from worlds to sets of worlds
- $B_c = \lambda w. \{v : v \text{ is compatible w/ } c\text{-relevant information at } w\}$
- Epistemic modal bases are *reflexive* and *euclidean*:
 - Reflexive: $w \in B_c(w)$
 - Euclidean: $v \in B_c(w) \Rightarrow B_c(w) \subseteq B_c(v)$
- Reflexivity is what ensures that *must* $p \Rightarrow p$.
 - $\forall w' \in B_c(w) : w' \in \llbracket p \rrbracket^c$
 - $w \in B_c(w)$
 - $\therefore w \in \llbracket p \rrbracket^c$

[*must* p]
[Reflexivity]
[p]

Solutions

- ① Kratzer (1991): make *must p* weaker than the standard meaning
- ② Veltman (1985): make *p* stronger!

Today: concentrate on Kratzer's proposal.

Kratzer Orders the Worlds

- (4) a. She climbed Mount Toby.
- b. She must have climbed Mount Toby.

“In uttering (4b) rather than (4a), I convey that I don’t rely on known facts alone. I use other sources of information which are more or less reliable. These other sources may include facts concerning the normal course of events, a map, a tourist guide or hearsay. If the ordering source for the modal in (4b) is, say, a conversational background assigning to every world the set of propositions which represent the normal course of events in that world, then the proposition expressed by (4b) will not imply the proposition expressed by (4a) anymore. There are worlds w such that among all the worlds which are compatible with what we know in w , those which come closest to the normal course of events in w don’t include w itself.” (Kratzer 1991: 645)

Contra Mantra: *Must* Is Not Weak

- (7) The ball is in A or in B or in C.
It is not in A. It is not in B.
So, it must be in C.


Contra Mantra²

- (8) if p , must q
 p
 \therefore so, q

That's a super argument — an entailment, we'd say. But not if the mantra were right: if we make *must* q weak compared to flat-out q , then the premises are just too weak to get the conclusion. That's not good, we really want to maintain modus ponens for *must*-conditionals.

Contra Mantra³

You know that just outside the building there is a Hollywood shoot going on. You know that tomorrow they're going to film a scene in the rain and that they already have the necessary equipment around. Now, you see people coming in folding up their wet umbrellas. You are almost certain that rain is the only explanation since you don't think that the movie crew will use their rain equipment until tomorrow. But there's a slight twinge of doubt. What do you say?

- (9)
- a. It's raining.
 - b. It must be raining.
 - c.  It's probably raining.

Contra Mantra⁴

If *must p* doesn't entail *p*, then the following should be perfectly coherent: *must p, but perhaps not p*.

But that's terrible:

(10) #It must be raining, but perhaps it is not.

Contra Mantra⁵

- (11) A: It must be raining.
B: [Opens the curtains] It's not. You were wrong.
A: #I was not! Look, I didn't say it was raining. I only said it must be raining. Stop picking on me!

Contra Mantra⁶

- (12) A: They said it was going to rain. I wonder whether it has started.
- B: I don't think so, it was still dry when I came in 5 minutes ago.
- A: Look, they're coming in with wet umbrellas. **There is no doubt at all. It must be raining now.**

What Now?

- (1) Looking out the window during our Arizona trip, I see pouring rain.
- a. ✓ It's raining.
 - b. !! It must be raining.

Question If the problem with (1b) isn't that it is too weak, why is it not good to use *must* here?

Answer *must* signals that the speaker reached the conclusion via an inference rather than via direct observation.

Master Frege

(Frege 1879: p. 5): “What distinguishes the apodeictic from the assertoric judgment is that it indicates the existence of general judgments from which the proposition may be inferred — an indication that is absent in the assertoric judgment.”

Karttunen

- (4) a. John left.
b. John must have left.

(Karttunen 1972: p.12): “In general, one would use the epistemic *must* only in circumstances where it is not yet an established fact that John has left. In stating (4b), the speaker indicates that he has no first-hand evidence about John’s departure, and neither has it been reported to him by trustworthy sources. Instead, (4b) seems to say that the truth of *John has left* in some way logically follows from other facts the speaker knows and some reasonable assumptions that he is willing to entertain.”

Westmoreland

Westmoreland (1998: 79): “Thus the content of a sentence of the form MUST ϕ is twofold. It contains the propositional content proper, that is, it conveys the content of ϕ , which may then be added to the context in the usual fashion. Beyond that, however, the word *must* labels the content of ϕ as something known indirectly (hence, in most cases, less certainly).”

Possibility Modals

Epistemic possibility modals seem to carry the same signal. But this will only be detectable when they're negated:

- (13) Looking out the window during our Seattle trip, I see brilliant sunshine.
- a. ✓ It's not raining.
 - b. !! It can't be raining.
- (14) In a windowless conference room, I see people coming in putting away their sunglasses.
- a. ✓ It's not raining.
 - b. ✓ It can't be raining.

Possibility Modals

Epistemic possibility modals seem to carry the same signal. But this will only be detectable when they're negated:

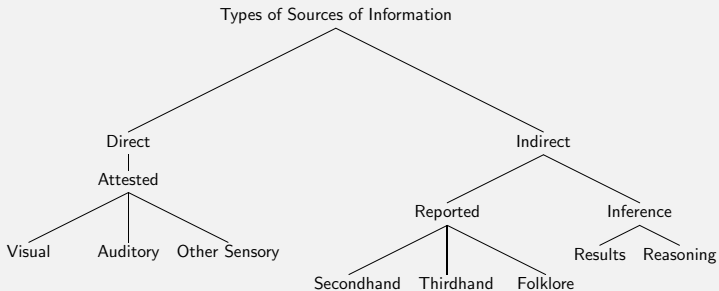
- (13) Looking out the window during our Seattle trip, I see brilliant sunshine.
- a. ✓ It's not raining.
 - b. !! It can't be raining.
- (14) In a windowless conference room, I see people coming in putting away their sunglasses.
- a. ✓ It's not raining.
 - b. ✓ It can't be raining.

The Generalization

Epistemic modals are also evidential markers: they signal that the prejacent was reached through an inference rather than on the basis of direct observation or trustworthy reports.

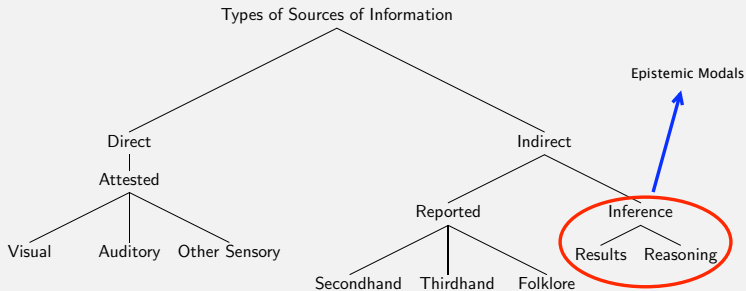
Evidential Systems

The place of epistemic modals in Willet's (1988) taxonomy of evidentials:



Evidential Systems

The place of epistemic modals in Willet's (1988) taxonomy of evidentials:



Kernels

Our implementation relies on giving further structure to epistemic modal bases. We distinguish

- a *kernel* \mathcal{K} of trusted pieces of evidence;
- the set of worlds compatible with the kernel.

Kernels, more formally

A kernel \mathcal{K} for modal base B (in c , at w) is a set of propositions — not necessarily a logically closed set of propositions! — such that:

- every proposition in $\mathcal{K}_c(w)$ is entailed by $B_c(w)$
- the set of worlds compatible with the result of closing $\mathcal{K}_c(w)$ under entailment gives us $B_c(w)$

$$(15) \quad \begin{array}{l} \text{a. } P \in \mathcal{K}_c(w) \Rightarrow B_c(w) \subseteq P \\ \text{b. } \bigcap \text{Cn}(\mathcal{K}_c(w)) = B_c(w) \end{array}$$

Inspiration from Belief Dynamics

Sven Ove Hansson (1999): A belief system is structured into

- a *belief base*, a non-logically closed set of sentences, and
- its logical closure under inference operations

The belief base contains those beliefs that are “self-sustained” (worth retaining for its own sake).

The Evidential Signal

The Claim: Epistemic modals signal that their prejacent is not directly settled by the salient kernel.

An Unsettled Kernel?

An Unsettled Kernel?



An Unsettled Kernel?



Colonel Klink, of course.

Slightly More Formally

A kernel \mathcal{K} (set of propositions)

- satisfies ϕ if $\llbracket \phi \rrbracket \in \mathcal{K}$,
- falsifies ϕ if $(W \setminus \llbracket \phi \rrbracket) \in \mathcal{K}$,
- doesn't directly settle ϕ iff it neither satisfies nor falsifies ϕ

In the Rain — Explained, Again

- (1) Looking out the window during our Arizona trip, I see pouring rain.
 - a. ✓ It's raining.
 - b. !! It must be raining.

 - (2) In a windowless conference room, I see people coming in folding up their wet umbrellas.
 - a. ✓ It's raining.
 - b. ✓ It must be raining.
- (1b) incorrectly signals that the salient kernel (which certainly includes the directly observed fact that it is raining) doesn't directly settle the question of whether it is raining.

The Status of the Evidential Signal

- Presupposition
- Conventional Implicature
- Conversational Implicature
- What else?

Cross-Linguistic Stability

Epistemic modals (especially necessity modals) carry this evidential signal reliably across languages.

⇒ The evidential signal should not be a stipulated, arbitrary part of their lexical meaning, so it shouldn't be a lexically specified presupposition or conventional implicature.

[If you have a counter-example, please tell me. You'd be making my day.]

Conversational Implicature? How?

- *must* ϕ simply asserts that ϕ is true in all worlds compatible with the kernel;
- it doesn't presuppose that the kernel doesn't directly settled ϕ ;
- but it is in competition with **another sentence that conveys that the kernel satisfies ϕ : ϕ by itself**;
- so if the kernel satisfies ϕ , the speaker should just assert ϕ by itself;
- so if the speaker doesn't just assert ϕ by itself but asserts *must* ϕ instead, she thereby implicates that she couldn't have asserted ϕ by itself;
- so asserting *must* ϕ signals that the kernel doesn't satisfy ϕ ;
- since the truth-conditions of *must* ϕ entail that the kernel also doesn't falsify ϕ , it follows that using *must* ϕ implicates that the kernel doesn't directly settle ϕ .

Problem

Just plainly asserting ϕ does **not** convey that the kernel satisfies ϕ .

So, we don't have the appropriate competitor to *must* ϕ in English to run a conversational implicature story.

Alas ... (or?)

For Now: Our Semantics

must ϕ

- presupposes that the salient kernel \mathcal{K} doesn't directly settle ϕ ;
- asserts that ϕ is true in all worlds compatible with the salient kernel \mathcal{K} .

Finally: Weakness?

- (4) a. John left.
- b. John must have left.

(Karttunen 1972: p.13): “The intuitive feeling that (4b) is a weaker assertion than (4a) is apparently based on some general conversational principle by which indirect knowledge—that is, knowledge based on logical inferences—is valued less highly than “direct” knowledge that involves no reasoning.”

Must Is Strong!

- Speakers who say *must p* are just as strongly committed to the prejacent as those who assert *p* by itself.
- There are prejacent for which intuitively direct evidence is more convincing evidence than indirect inferential evidence.
- So, a speaker who chooses nevertheless to use the strong *must p* incurs a higher degree of risk.
- So, we may judge that in many cases, *must p* is more likely to be false than *p* by itself would have been if there had been direct evidence for the prejacent.
- But a sentence being more likely to be false than another is far from an argument that it is *weaker*!

I Must Be Hungry

(16) I must be hungry.

Usually, we have direct perception of our internal state of hunger. (16) is unusual in that it signals that while the speaker is committed to being hungry, this is based on an indirect inference (the kernel does not directly settle whether the speaker is hungry). But by choosing *must*, a strong necessity modal, the speaker nevertheless fully commits herself to the inference. If she had wanted to be more tentative, there would have been other options: *I'm probably hungry*, etc.

Conclusion

The mantra that epistemic *must* is a marker of weakness is an overreaction to a misdiagnosis of the much more interesting fact that epistemic *must* is an evidential marker signalling an indirect inference.

References I

- Frege, Gottlob. 1879. *Begriffsschrift, eine der arithmetischen nachgebildete Formelsprache des reinen Denkens*. Halle: L. Nebert. Translation by Stefan Bauer-Mengelberg, from Jean van Heijenoort (ed.) *From Frege to Gödel: A Source Book in Mathematical Logic, 1879-1931*, Cambridge, MA: Harvard University Press. 1967.
- Giannakidou, Anastasia. 1999. Affective dependencies. *Linguistics and Philosophy* 22(4): 367–421.
doi:10.1023/A:1005492130684.
- Groenendijk, Jeroen A.G. & Martin J.B. Stokhof. 1975. Modality and conversational information. *Theoretical Linguistics* 2(1/2): 61–112.
- Hansson, Sven Ove. 1999. *A Textbook of Belief Dynamics: Theory Change and Database Updating, Applied Logic Series*, vol. 11. Dordrecht: Kluwer Academic Publishers.

References II

- Karttunen, Lauri. 1972. *Possible and Must*. In J. Kimball (ed.) *Syntax and Semantics*, vol. 1, 1–20. New York: Academic Press.
- Kratzer, Angelika. 1991. Modality. In Arnim von Stechow & Dieter Wunderlich (eds.) *Semantics: An International Handbook of Contemporary Research*, 639–650. Berlin: de Gruyter.
- Lyons, John. 1977. *Semantics*. Cambridge: Cambridge University Press.
- Veltman, Frank. 1985. *Logics for Conditionals*. Ph.D. thesis, University of Amsterdam.
- Westmoreland, Robert. 1998. *Information and Intonation in Natural Language Modality*. Ph.D. thesis, Indiana University.
- Willett, Thomas. 1988. A cross-linguistic survey of the grammaticalization of evidentiality. *Studies in Language* 12(1): 51–97.