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~~Unembeddable Meanings~~
The Meanings of Epistemic Modality[*]

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1 The Epistemic Containment Principle

(1) ??Every student$_i$ must be home if his$_i$ light is on.

(2) *The Epistemic Containment Principle (ECP)*[1]
     A quantifier cannot have scope over an epistemic modal.

(3) #Every student may be the tallest person in the department.

(i)	every student x (may x be the tallest)	sensible, *ECP
(ii)	may (every student be the tallest)	nonsense, ^{OK}ECP

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[*]The grandmother of this paper is our "Modals, Quantifiers, and *If*-Clauses" (2001), available at http://web.mit.edu/fintel/www/mqi.pdf. The mother is our "Epistemic Containment" (in progress), which supersedes the first part of the grandmother. The paper also has an aunt, "If and When *If*-Clauses Can Restrict Quantifiers" (2002), available at http://web.mit.edu/fintel/www/lpw.mich.pdf, which supersedes the second part of the grandmother. We leave it to the audience to draw the family tree of this clan.

[1]The name of this constraint was carefully chosen by one of the authors. The other author warned that he vaguely remembered from syntax courses he took as a graduate student that there was another principle that went with the abbreviation ECP. But he was assured that that had been a temporary aberration in the science and that the competing principle had now deservedly sunk into near oblivion. We realize that some oldtimers may occasionally misread the abbreviation but we're sure they will eventually adjust.

A Suggestion

A Why don't you say that epistemic modals need to take full propositions as their arguments since they signal a deduction of that proposition from the speaker's evidence base. And so they couldn't take something that has a variable in it.

K&S That won't work.

(a) Even clauses with variables in them denote propositions, it's just that what proposition it is varies with the variable assignment. But the modal wouldn't know about that.

(b) The standard semantics for modal operators doesn't make one expect that one couldn't bind into the scope of such an operator.

(c) Anyway, it just doesn't seem like that's the right generalization. The following data show that one can bind into the complement of epistemic modals.

Counterexamples

(4) Every student$_i$ thinks that Mary $\left\{ \begin{array}{c} \text{may} \\ \text{must} \end{array} \right\}$ like him$_i$ the most.

(5) It didn't take me long to find out which workers$_i$ the boss must have reprimanded t$_i$.

(6) The detective wants to talk to everyone who$_i$ may t$_i$ have seen the accident.

(7) *The ECP revised as a condition on QR*
A quantifier cannot *take* scope over an epistemic modal. More precisely,

At LF, a quantifier cannot bind its trace across an epistemic modal.

*Q$_i$ . . . [Epistemic Modal (. . . t$_i$ . . .)]

Let's Pretend

Speculation: Let's pretend that the problematic data didn't exist. Could we devise an explanatory account that would predict that there could be no variable binding into the complement of an epistemic modal from the outside? That is, if the following were indeed always impossible, could we hope to able to explain that?

(8) Q$_i$ . . . [Epistemic Modal (. . . x$_i$ . . .)]

Well, perhaps. We would actually be in good company.

2 Kratzer on German *ja*

Mapping the Semantics-Pragmatics Boundary: Context-Dependence.
Conference held at Cornell University, March 26-28, 1999.

- David Kaplan:
  The Meaning of 'Ouch' and 'Oops'

- Angelika Kratzer:
  Beyond 'Ouch' and 'Oops': How Descriptive and Expressive Meaning Interact
  http://semanticsarchive.net/Archive/WEwNGUyO/

The Meaning of *Ja*

(9) *Ja* α is appropriate in a context c if the proposition expressed by α in c is a fact of w_c which — for all the speaker knows — might already be known to the addressee.

(10) Du hast ja'n Loch im Ärmel.
      You have *ja*+a hole in+the sleeve

(11) Du hast ja'ne neue Frisur.
      You have *ja*+a new hairdo

(12) a. Who did Austin marry?
      b. *Austin hat ja Ashley geheiratet.
          Austin has *ja* Ashley married.

Expressive meaning in a separate dimension

Discourse particles and other kinds of expressives are ignored in the computation of descriptive meanings.

(13) Sie kann nicht kommen, weil sie ja ihre Zwillinge versorgen muß.
      She cannot come because she *ja* her twins take care of must

(14) a. Webster schläft ja.
      b. Are you sure?
          (= are you sure that Webster is sleeping?)
          ($\neq$ are you sure that the addresse might already know this?)

Computation of meaning$^+$, first shot

(15) a. Webster schläft ja.
          Webster sleeps *ja*
      b. Descriptive meaning: p = λs (sleep(Webster)(s))
      c. Expressive meaning contributed by *ja* (roughly):
          λs (p(w_s) & might(s)(λs'(knows(s')(p)(ιx(addressee(s)(x))))))

3

Main prediction: The No-Binding effect

Since the scope of a discourse particle has to express a proposition, the scope of a discourse particle cannot include pronouns that are bound from outside. That is, no discourse particle can intervene between a bound variable and its binder.

(16) Jeder von diesen Arbeitern$_i$ hat seinen Job verloren, weil er$_i$ (*ja) in der Gewerkschaft war.
      Each of these workers has his job lost because he *ja* in the union was

Principled Exception: Reported Speech

(17) Jeder der Zeugen$_i$ behauptete, er$_i$ habe ja mit eigenen Augen gesehen, daß . . .
      Each of the witnesses claimed he had *ja* with own eyes seen that . . .

Beyond *ja*

Very similar data involving (i) no effect on descriptive meaning, (ii) impossibility of binding can be found with other elements. Relevant here is much work on discourse particles, sentence adverbials, parentheticals, *since*-clauses, etc.

(18) a. Das Spiel wird abgesagt, weil es bekanntlich regnet.
          the game is cancelled because it as-is-known rains
      b. Das Spiel wird abgesagt, weil es bekannt ist, daß es regnet.
          the game is cancelled because it is known that it rains

      [from Heim's MA thesis (Heim 1977)]

(19) ?Jeder Spieler$_i$ wurde ausgepfiffen, weil er$_i$ bekanntlich zuviel verdient.
      every player was booed because he as-is-known too much earns.

(20) a. You should be ashamed, because obviously you did something wrong.
      b. You should be ashamed, because it is obvious that you did something wrong.

(21) ?Every player$_i$ was booed because he$_i$ obviously makes too much money.

(22) John stayed home because, as Mary had suspected, it rained hard.

(23) ?Every boy$_i$ cried because, as Mary had predicted, he$_i$ didn't like his$_i$ present.

3 The No-Binding Effect

Question. Why should elements like *ja* block binding of variables across them and how does that actually get implemented?

There are two possible kinds of answers.

- No tolerance for bound variables: *ja* is unhappy
- No access to bound variable: quantifier is unhappy

No tolerance for bound variables: *ja* is unhappy

The *ja*-type element does not tolerate a bound variable in its complement. This may be what Kratzer was envisaging:

"Since the scope of a discourse particle has to express a proposition, the scope of a discourse particle cannot include pronouns that are bound from outside. That is, no discourse particle can intervene between a bound variable and its binder."

Immediate Problem: Under the variable assignment $g^{x/i}$ that is passed down into the scope of the quantifier, the complement of the *ja*-element will in fact be able to supply a proposition.

(24) $[\![\text{he}_i \text{ left}]\!]^{g^{x/i}} = \lambda\text{w. } g^{x/i}(\text{i}) \text{ left in w} = \lambda\text{w. } g(x) \text{ left in w.}$

One could devise a system where the *ja*-element could detect whether its complement contains a variable bound from the outside and have it not tolerate that. But we don't know whether to pursue this.

No access to bound variable: quantifier is unhappy

It is easier to imagine ways to deny the quantifier access to the bound variable.

- Quantifier cannot bind across dimensions.
- Quantifier cannot bind into non-truthconditional meaning.

Christopher Potts (2002):

The Syntax and Semantics of *As*-Parentheticals.
Natural Language and Linguistic Theory, 20(3), 623-689.

The Lexical Semantics of Parenthetical-*as* and Appositive-*which*
Syntax, 5(1), 55-88.

Option 1: No binding across dimensions?

As we saw, we are probably dealing with meanings in two separate dimension. Does this help explain the no-binding fact?

Chris Potts (UC Santa Cruz, p.c.) is exploring the possibility that binding is impossible across dimensions. A hint that this may be so comes from one famous attempt in the literature to work out a two-dimensional system. Karttunen and Peters (1979) proposed that presuppositions (which they called conventional implicatures) create a second dimension of meaning. One problem they encounter is what is now known as the "binding problem" (see Beaver (1995) for the term). They note that the following sentence is odd:

(25)   Somebody managed to succeed George IV.

But in their two-dimensional system they derive these meanings:

(26) M_1: Someone succeeded George IV.
        M_2: Someone found it difficult to succeed George IV.

They note that the problem is that in their system *someone* fails to bind across dimensions so that there are two independent quantifications in the two dimensions. That is not as it should be: the example is odd because it presupposes that the very same someone who succeeded George IV was the one who found it difficult. This is often seen as a fatal problem for a two-dimensional analysis of presupposition.

Potts' suggestion now is to turn K&P's binding problem into a no-binding *virtue*. While a two-dimensional system with its no-binding problem does not seem adequate for a treatment of presuppositions (perhaps a system with partial meanings is better), it may be the right one for parentheticals and other elements that block binding.

Possible Problem: if there are constructions which might be best analyzed as two-dimensional but they do allow binding, there would be a problem. Some people would like it if a two-dimensional approach was used for some classic cases of conventional implicature such as the shade of meaning signalled by *but* in contrast to *and*, see Bach (1999). But there does not appear to be a no-binding effect:

(27)   At least one boy claimed (that he was sick) but (that he would come to school anyway).

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We will await the results of Potts' dissertation research into two-dimensional systems. But perhaps, we should consider other possible explanations of the no-binding effect.

Option 2: Merely Presuppositional Items Block Binding?

In Potts' recent papers on *as*-parentheticals (Potts 2002b,a), there is an intuitive generalization that items that do not contribute to the descriptive meaning block binding. As we just saw, the possible implementation in a two-dimensional system still needs to be worked out. The system employed in Potts' published work uses partial semantics, but does not have the advertised result (as admitted by Potts, p.c.). Nevertheless, one could still at least maintain the descriptive generalization.

(28)   A quantifier cannot bind into the complement of an element that has no effect on the descriptive meaning.

Counterexample:

(29)   Every boy$_i$ claimed that even his$_i$ mother hates him$_i$.

Option 3: Unembeddable Meanings?

Idea

The *ja*-items have *procedural* rather than descriptive meanings. They are speech act markers. But then the meaning of the whole expression is not based on truth-values anymore and thus not a meaning that can enter into the recursive semantics anymore $\Rightarrow$ *unembeddable meanings*!

Lewis (1972): (...) the entire apparatus of referential semantics pertains to sentence radicals and constituents thereof. The semantics of mood is something entirely different. It consists of rules of language use such as (...): React to a sentence representing the mood imperative with an S-meaning m (...) by acting in such a way as to make m true (...)

Prediction (formulation from Krifka 2001): If there is no other type of recursion, then illocutionary force indicators are always peripheral, and speech acts never occur embedded in other expressions.

[Many other authors have drawn such conclusions about speech act markers. See Green (2000) for references and discussion.]

Problem

The meanings can in fact be embedded. See Kratzer's:

(30)   Sie kann nicht kommen, weil sie ja ihre Zwillinge versorgen muß.
        She cannot come because she *ja* her twins take care of must

Or Green (2000):

(31)   It is obviously true that if, *as John claims*, snow is white, then grass is green.

So, as we have assumed, these items create meanings that at least at the descriptive level are truth-conditional and therefore can be embedded.

Elements like *ja* have procedural/non-truthconditional meanings but only in the dimension of expressive meaning (meaning$^+$).

Only embedding constructions that need access to meaning$^+$ will not be able to embed *ja*. Those are the quantifier variable constructions.

Problem

Krifka (2001) has argued that one can at least sometimes "quantify into speech acts". Here we are arguing that you can't. We'll need to resolve this conflict at some point.

(32)   What did everyone buy?
        = For everyone$_i$, I'm asking the question what x$_i$ bought.

Understanding Kratzer's Exception

(33)   Every witness$_i$ said that he$_i$ *ja* had seen …

Possible Explanation: The pronoun is not bound directly by the quantifier. It is a logophoric pronoun whose reference is the "I" of the reported speech act.

Conclusion

We will be able to explain the no binding effect either once the cross-dimensional system has been developed in full or by positing that the relevant operator creates unembeddable meanings (in the expressive dimension).

So now, can we subsume the ECP under such a picture? That is, can one plausibly argue that epistemic modality is similar to *ja* and other discourse operators?

4 Epistemic Modality as Expressive Meaning

Drubig, Hans Bernhard (2001):
On the Syntactic Form of Epistemic Modality
http://www.sfb441.uni-tuebingen.de/b2/papers/DrubigModality.pdf

Descriptive Linguistics

Statements abound in the descriptive literature on modality that epistemic modals serve as some kind of signal of the strength and/or source of the speaker's committment to the underlying proposition.

- "indication by the speaker of his (lack of) commitment to the truth of the proposition being expressed" (Palmer 1986, p. 51).

8

- "In its most normal usage, epistemic *must* conveys the speaker's confidence in the truth of what he is saying, based on a deduction from facts known to him (which may or may not be specified)" (Coates 1983, p. 41).

- "*May* and *might* are the modals of epistemic possibility, expressing the speaker's lack of confidence in the proposition expressed" (Coates 1983, p. 131).

- Westmoreland (1995, 1998), as summarized and endorsed by Drubig (2001):

  > Epistemic *must* (in contrast to root modals) is not a modal but must be analyzed as an evidential marker labelling the proposition in its scope as a deduction. It relates a proposition ϕ to some other information that serves as evidence for ϕ. An epistemic modal is part of the metalogical vocabulary, i.e. not equivalent to the square $\square$ but more like the sign $\therefore$ marking the deduction of an inference. In contrast to root modals with a deontic or dynamic reading, the epistemic modals *must* and *may/might* are evidential markers which do not contribute to the informative proposition, but disclose the source of information. The semantic content of epistemic/evidential modals forces them to operate from an extrapropositional position at least at LF.

Standard Modal Semantics

(34) $[\![\text{must}]\!](\text{p}) = \lambda w. \, \forall w' : wR_{epist}w' \rightarrow p(w') = 1$

Must p asserts that p is true in all worlds compatible with the evidence.

No reason to expect embedding or binding problems.

Note: the standard semantics does not do justice to the fact that *must* clearly signals deduction rather than direct observation. This remains to be accounted for.

Relevant Data about Epistemic Modals

Embedding under Attitudes

An example from *Alice in Wonderland*:

(35)   So, she began. "O Mouse, do you know the way out of this pool? ..."
         ...(Alice thought this *must* be the right way of speaking to a mouse;
         ...)

(36)   Alice thought "O Mouse" must be the right way of speaking to a mouse.

Drubig reporting Westmoreland on (36): "It is important to see that *must* ϕ in (36) is not the proposition which functions as the complement of the propositional attitude verb *think*. The propositional complement of *think* is ϕ. In other words, *must* ϕ does not affect the context; rather, stating *must* ϕ makes ϕ available to the context."

1. Of course, one will have to ensure that *must* knows it is embedded, since the example clearly conveys that what is reported is Alice's deduction, not the speaker's.

2. If accessibility relation is transitive and euclidean, there is an equivalence between $\Box\Box p$ and $\Box p$.

   So, if epistemic accessibility is transitive and euclidean, and if both *think* and *must* are necessity modals, one could not tell whether *must* is part of the embedded proposition.

   (37)   Alice thought that the Mouse must be arrogant. ($\Box\Box p = \Box p$)

   (38)   Alice thought that the Mouse might be arrogant. ($\Box\Diamond p = \Diamond p$)

   (39)   Alice was convinced that the Mouse $\left\{\begin{array}{l}\text{must} \\ \text{*might}\end{array}\right\}$ be arrogant.

Are you sure?

(40)   a.   It must be raining.
      b.   Are you sure?
          (= are you sure that it is raining?)
          ($\neq$? are you sure that from the evidence it can be deduced that it is raining?)

(41)   a.   It might be raining.
      b.   Are you sure?
          ($\neq$? are you sure that it is raining?)
          (= are you sure that it is compatible with the evidence that it is raining?)

Because

(42)   I'm going home because the package may have been delivered today.

Negation

Drubig's Claim: negation cannot have scope over epistemic modals.

(43)   a.   John must not be at home. ($\Box\neg$)
      b.   John may not be at home. ($\Diamond\neg$)
          cf. John may not leave. (deontic: $\neg\Diamond$)

We believe this is simply because of the syntactic height of epistemic modals (which may of course have semantic roots). Once one creates syntactic space above the modal, negation can scope above, showing that there is no semantic problem.

(44)   John does not have to be at home. ($\neg\Box$) He might be at work.

Furthermore, there are appear to be perfectly epistemic modals that are almost specialized as narrow scope epistemic modals:

(45)   a.   John *need not* be home. ($\neg\Box$) He might be at work.
        b.   John *can't* be at home. ($\neg\Diamond$) He must be at work.

Questions

Drubig's Claim: Epistemic modals cannot occur in *nonassertive* sentences.

Yes/No Questions

Claim: Epistemic modals cannot occur in yes/no questions.[2]

(46)   a. ?Must John have cancer?
        b.   Might John have cancer?

(47)   Might your keys be at Jack's house? (Brennan 1993, p. 24)

wh-Questions

Claim: Epistemic modals cannot occur in *wh*-questions.[3].

(48)   Why must/may John leave early tonight?

(49)   Who must/may leave early tonight?

Note that these involve episodic predicates, which Drubig elsewhere in his paper correctly discusses as resisting epistemic readings anyway.[4] We really need stative predicates for the test. The following are again from Brennan (1993, p. 24):

(50)   What may he have done?

(51)   Where must the murder weapon be hidden, in your view?

(52)   Who can have left this baby on my doorstep?

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[2]Drubig cites Jackendoff (1972, 100ff.), Leech (1971, 62, 72), and others. See also Cinque (1999, 86).

[3]Drubig cites McDowell (1987) in support

[4]Similarly, Drubig uses the wrong predicate to illustrate that epistemic modals are excluded from the protasis of a conditional:

(i)   If John must/may leave early tonight, . . .

Summary

- Epistemic modals are syntactically high.

- Therefore, some embedding is difficult.

- Other embeddings are semantically odd.

- But, most of the time, controlling for those factors, epistemic modals can be embedded and contribute to the descriptive meaning.

Something to Explore

At least for the acceptable cases of embedding, the standard semantics for epistemic modals is correct and adequate.

We will explore the idea that the epistemic modals *must* and *may/might* have two meanings. One like *ja* where they add an expressive non-truth-conditional meaning (and block binding), and one which is the standard modal logic meaning at the descriptive level.

must$_1 \approx$ *obviously*

must$_2 \approx$ *it is obvious that*

Uncertainties of judgment might be predicted correctly.

Alas

If there is a correlation between (i) low position and thus embeddability and (ii) absence of no-binding effect, we would expect ECP effects to go away, for example here:

Every student can't be home. *$\forall\neg\Diamond$, only $\neg\Diamond\forall$
Every student need not be home. *$\forall\neg\Box$, only $\neg\Box\forall$

So: it appears that the ECP is a real syntactic residue, not to be derived from semantics.

5 List of Things to Do

- Cross-linguistic investigation of embedding and quantificational properties of particles, parentheticals, evidentials (mentioned by Drubig, see also Izvorski), and epistemic modals.

- Indicative conditionals: there is a very widespread philosophical doctrine that indicative conditionals have a non-truthconditional meaning. How do they fit into the picture we are developing?

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More work on particles as speech act markers can be found on the web pages of Henk Zeevat and Elena Karagjosova:

http://www.hum.uva.nl/computerlinguistiek/henk

http://www.coli.uni-sb.de/~elka