Embedded Epistemic Modals Pragmatically
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Abstract. In Slovenian there is an attitude verb, *dopuščati* (‘allow for the possibility’), which is like an existential dual of *believe*. My goal is to explain why it cannot embed epistemic modalities with universal force, like *must* and *cannot*. I will say that it is because of a competition and equivalence with the corresponding belief sentence. I will revise the contribution of epistemic modals and use blind scalar implicatures to achieve this.

Keywords: epistemic modal, embedding, existential belief, exhaustification.

1. Introduction

There is an asymmetry in embedding epistemic modals under attitudes of different strengths:

(1) Situation: John sees people come in with wet umbrellas. You report:
      John thinks that it {might, must} go rain
      ‘John thinks that it {might, must} be raining.’
      John allows that it {might, must} go rain
      ‘John allows for the possibility that it {might, must} be raining.’
   c. Janez {misli, *dopušča*}, da ne more biti sončno.
      John {thinks, allows} that it can’t be sunny.

A strong attitude verb like *think* embeds epistemic modals across the board (Stephenson, 2007), while a weak one like *dopuščati* clashes with an embedded universal (epistemic) force. This is illustrated in (1b) with *mora* and (1c) with *ne more*. Intuitively, these sentences are odd because *dopuščati* is too weak of a choice to combine with such a strong embedded epistemic.

In §4 I will explore the idea that the oddnesses with embedded epistemic modals above have the same source as a series of other cases previously observed in natural language, such as *Some Italians come from a warm country* (Magri, 2009, 2011). In order to be able to extend the mechanism proposed for those cases to (1b)/(1c), I will reconsider what epistemic modals (qua evidence-sensitive items) contribute pragmatically. Building on Mandelkern (2019) and Močnik (2019) in §3, I will take epistemic modals to be sensitive to a constraint against the unlearning of evidence (formally from Mandelkern (2019)) and to a constraint that is sensitive

1Special thanks to Kai von Fintel, Danny Fox, Irene Heim, and Roger Schwarzschild. Thanks also to the following: Rafael Abramovitz, Amir Anvari, Moshe Bar-Lev, Christopher Baron, Rajesh Bhatt, David Boylan, Gennero Chierchia, Cleo Condoravdi, Luka Crnič, Milica Denić, Jon Gajewski, Valentine Hacquard, Martin Hackl, Sabine Iatridou, Justin Khoo, Daniel Lassiter, Giorgio Magri, Matthew Mandelkern, Lisa Matthewson, Dilip Ninan, Mitya Privoznov, Jessica Rett, Floris Roelofsen, Daniel Rothschild, Viola Schmitt, Benjamin Spector, Frank Staniszewski, anonymous reviewers, and participants at 24.991, ESSLLI29, FASL27, Vienna, Crete, and SuB23.
2I use * to mark unacceptability, without making a claim about its source. Question marks (??, ?) are used to signal lesser degrees of unacceptability.
to the state of affairs in the current body of evidence. First, however, a brief overview of the relevant properties of *dopuščati* and embedded epistemic modals.

2. Patterns of embedding epistemic modals

Following the recent interest in the contribution of embedded epistemic modals (a.o. Stephen-son (2007), Hacquard (2006), Yalcin (2007)), Anand and Hacquard (2013) investigate the landscape of epistemic-embedding attitudes. They observe for Romance that doxastic verbs like *fear, hope, or doubt* (analysed as existential) do not embed modals like *must*.\(^3\)

Slovenian provides an additional data point with *dopuščati*, which does not encode a bias that one could exploit in order to understand why some epistemic embeddings are odd.\(^4\) It simply expresses that something is consistent with the attitude holder’s belief state.\(^5\) As illustrated below, *dopuščati* contributes weak quantification, (2), that can be reinforced into a claim about the whole belief state, (3). Thus, it should be perfectly acceptable to say (1b) on the reading ‘it is consistent with John’s beliefs that it is raining in all of the worlds compatible with his (and possibly other’s) evidence.’

\(\text{(2) Situation: John is either inside the house or outside the house. The speaker is asked whether they know where John is.} \)

\[D_p \land D \neg p\]

\[\text{Dopuščam, da je notri, dopuščam pa tudi, da je zunaj.} \]

\[\text{I.allow that is inside I.allow though also that is outside} \]

\[\text{‘I allow for the possibility that he’s inside but I also allow for the possibility that he’s outside.’} \]

\(\text{(3) Seveda, dopuščam, da je Zemlja okrogla – trdno verjamem, da je.} \)

\[D_p \land B_p\]

\[\text{of course I allow that is Earth round firmly I.believe that is} \]

\[\text{‘Of course I allow for the possibility that the Earth is round – I firmly believe that it is.’} \]

2.1. The basic paradigm

Epistemic modals are sensitive to the force of the attitude, as shown in (1). A universal epistemic modal (or a negated existential one, but let’s keep the discussion limited to (1a)–(1b) for the moment) triggers oddness when it is anchored to the existential *dopuščati*.\(^6\) This leaves us with three combinations of force that do not lead to a clash. It is worth pointing out that a successful account should not collapse the two that contain an existential modal in the embedded clause. Consider (4).

\(\text{(4) Situation: Othello is asked whether he thinks that D is cheating on him. He replies:} \)

\(^3\)See also Crnič (2014) and Ippolito (2017).

\(^4\)Anand and Hacquard (2013), for example, use a diversity presupposition, which essentially requires there to be \(p\) as well as non-\(p\) worlds among the belief worlds.

\(^5\)It also does not have any discursive properties like *concede, accept or allow (for the sake of the argument)*.

\(^6\)The generalization seems to be that oddness arises as long as the modal is epistemic (and not e.g. deontic) and when it understood to be anchored to the attitude holder, rather than some other body of evidence (e.g. via ‘according to’). Even though I will only consider the anchored cases, the mechanism I will use is in principle flexible and one could plausibly tweak it to study the shifted cases as well.
a. Dopuščam, da me mogoče vara.  
I allow that me maybe cheats.on  
‘I allow for the possibility that she might be cheating on me.’
b. Mislim, da me mogoče vara.  
I think that me maybe cheats.on  
‘I think she might be cheating on me.’

Speakers report Othello to have perhaps some reason for suspecting Desdemona of cheating in (4b). By contrast, Othello expresses in (4a) that, well, in principle she might unfaithful. The account I will provide will make a step towards understanding this distinction by preserving a difference in force between the two cases and interpreting embedded epistemics as making reference to evidence.

2.2. Negated attitude verbs

Let’s take a look at what happens when we negate the attitude verb. Judgments vary somewhat between speakers, so I will mark the most charitable interpretation (e.g. ‘??’ should be read as ‘?? or worse’).

(5) Situation: You, me, and John see Bob go home from work early. We sit down on some couches in front of Bob’s office. John has his back turned to Bob’s door. He puts on some headphones and starts cheating on the latest homework. After a while, Bob, who has a secret entry to his office, which he used to come back, creeps out of his office and comes up behind John’s back. John, still immersed in cheating, does not notice this. I nudge you and whisper, with both of us staring at Bob:

a. John does not think that Bob might be behind his back.
   ¬B♦p  
b. ??John does not think that Bob must be behind his back.
   ??¬B□p  
c. It’s not the case that John thinks that Bob must be behind his back.
   ¬B□p  
d. Janez ne misli, da je Bob mogoče za njegovim hrbtom.  
   John not thinks that is Bob maybe behind his back  
   ‘John does not think that Bob might be behind his back.’
   ¬B♦p  
e. ??Janez ne misli, da mora biti Bob za njegovim hrbtom.  
   John not thinks that must be Bob behind his back  
   ‘John does not think that Bob must be behind his back.’
   ??¬B□p  
f. Janez ne dopušča, da je Bob mogoče za njegovim hrbtom.  
   John not allows that is Bob maybe behind his back  
   ‘John does not allow that Bob might be behind his back.’
   ¬D♦p  
g. ??Janez ne dopušča, da mora biti Bob za njegovim hrbtom.  
   John not allows that must be Bob behind his back  
   ‘John does not allow that Bob must be behind his back.’
   ??¬D□p

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7I tested the adverb at the time, but the same intuition should remain with utegnit. Even in English, compare: I think she might be cheating on me vs I allow that she might be cheating on me.
Given \((5b)/(5e)\) and \((5g)\), necessity modals seem to be dispreferred under either force.\(^8\) This is in line with the observations in Anand and Hacquard (2013), Homer (2015: ex. (106)), Crnič (2014: ex. (62)), and Ippolito (2017: fn. 9). Interestingly, while oddness is observed above with \textit{misli}, which does not seem to be a neg-raiser, the effect disappears under \textit{it’s not the case that} in \((5c)\). The account I will provide will have a way to think about this flexibility.

Further work is needed to investigate the exact conditions under which an embedded necessity modal is odd. Kai von Fintel (p.c.), for example, points out that the context in \((5)\) does not give John any reason for entertaining the thought that Bob must be behind his back, which is why \((5b)\) could be odd. In \((6)\), where this has been changed, speaker still resist \textit{must}.\(^9\)

\begin{enumerate}
\item Context: You and I have had the opportunity to work as assistants to Sherlock Holmes, who is investigating a recent murder. Sherlock has taken an interest in the gardener and the butler. You and I are discussing what Sherlock thinks about who the murderer is.?
\end{enumerate}

3. **Analysing what epistemic modals express**

I will build on earlier work in Močnik (2019), which offers a compositional account of the ideas explored in this section (I refer the reader to that work for certain details).

Recall that what we want to capture is the observation that embedded universal epistemic force is odd under \textit{dopuščati} and negated doxastic attitudes. To do this, we will use two constraints on epistemic modal bases, taking them to be a reflect of how speakers reason with evidence.

The first constraint is formulated in Mandelkern (2019). He proposes that epistemic modals are inherently local, i.e. the modal base is restricted to the information state it is evaluated against, such as the belief state in \((7)\).

\begin{equation}
\forall w' \in B^w_a : MB(w') \subseteq B^w_a \quad \text{(adapted from Mandelkern (2019))}
\end{equation}

(for all of the worlds \(w'\) in the agent \(a\)’s belief worlds from \(w\): the worlds compatible with the agent’s evidence in \(w'\) are part of the agent belief worlds)

To give this principle some intuitive ground, suppose that our individual beliefs serve as pieces of evidence, which we use to navigate the world. For example, my belief that it is raining can be my evidence ‘it is raining’ for John being at home. When an epistemic modal is under a belief predicate, it is understood to be restricted by this particular body of evidence (the attitude holder’s beliefs).

Notice that Locality allows for the modal base to form a proper subset of the belief state. A way to think about this is that people can also consider whatever they are not sure of, so propositions that are merely consistent with their beliefs. For example, I might act in accordance with the proposition \textit{The weather report is accurate} even if I do not fully trust weather reports. As it

\(^8\)While I did not systematically check this with all the native speakers, \textit{have to} is similarly odd in \((5b)\) and \((6)\) to the ones that I did ask.

\(^9\)Some speakers feel that \((6)\) is as bad as \((5b)\). The difference observed with the others might be related to the fact that \textit{because}/\textit{since} can suspend implicatures, e.g. \textit{Some students passed the exam because all of them did}. 
It turns out, it was a good thing to bring an umbrella. On the other hand, it does not seem rational for me to do the same with propositions that blatantly contradict my beliefs, such as the horoscope being correct.

Is this just a mere restatement of having various degrees of credence in a proposition? It seems to be more than that if we think of evidence as something that we can still learn. Locality can be conceptualized as a rationality constraint against unlearning: we do not “unlearn” evidence (i.e., give up what constitutes the information state), but we can learn it. In this way, we can check whether the prejacent would be, say, true if we learned some evidence.

This brings us to the second constraint, Totality. The intuition behind it is that we cannot work under the assumption that we will always learn more—we also need to consider just the evidence that we have full access to. In terms of the previous analogy, we need to be able to assume that our information state is in a sense evidentially complete.

(8) \[ \exists w' \in f(B^w_j) : B^w_j = MB(w') \] (there is a world \( w' \) in the chosen part of the belief state and the worlds compatible with the evidence in \( w' \) encompass the belief state)

This constraint uses a function over the belief state that picks out the salient part of it. The main purpose of this is to ensure that existential belief predicates are not vacuous with respect to Totality, but the two existential statements can make a claim about the same world-entities.

To see what the two constraints achieve, consider Figure 1.

![Figure 1: Some situations](image)

The modal base function \( i \) that is used in both schemas maps one world onto the belief state and the other one onto itself. This means that the evidence that it maps onto is at both worlds such that John (the agent) does not unlearn any of the pieces of evidence that constitute his belief state. Locality is therefore uniformly satisfied. The world on the right-hand side is the world where the agent learns more evidence, whereas the world on the left-hand side can be used to satisfy Totality.

It helps to examine Figure 1a to see that embedded universal modal force creates a very strong statement. In particular, it makes \( D_j \square_i p \) as strong as \( B_j \square_i p \). Totality ensures that there is a world, such as the one on the left, at which the agent does not learn any new evidence. Formally, the modal base function maps that world onto the belief state. This same world (via \( f \)) is such that the prejacent \( p \) is true in all the worlds compatible with the agent’s evidence from it. This, however, means then that the prejacent is true throughout the agent’s belief state.\(^{10}\)

\(^{10}\)Notice that if instead of \( \square_i p \) we had \( \neg \Diamond_i p \), we would still be looking at a universal statement, but about \( \neg p \). Hence the argument is completely parallel. See Močnik (2019) for formal details.
The situation in Figure 1b shows that embedded existential modals preserve the distinction between the two attitudes. The requirement made by an embedded existential is that there be some worlds in the worlds compatible with the attitude holder’s evidence. So if we look at the world on the left-hand side, it makes this statement true. However, the situation does not make true a universal attitude over the existential modal, since on the right-hand side, where the agent learns some evidence, \( \neg \mathcal{P} \) holds.

I will not go through the cases of negated attitudes, but suffice it to say that the relationships are reversed, as illustrated in Figure 2 below.

4. Deriving oddnesses using blind scalar implicatures

Our goal is to explain the distribution of stars (oddnesses) in Figure 2, where arrows represent contextual entailments among sentences, abbreviated schematically. The bracketed star on \( \neg \mathcal{B} \mathcal{J} \square \mathcal{I} \mathcal{P} \) marks the fact observed in (5) that oddness is sensitive to how negation is spelled out.

![Figure 2: Contextual entailments from §3](image)

The main idea of this section is that the source of oddness in sentences with embedded epistemic modals is the same as that observed in sentences like (9), where blind scalar implicatures are said to trigger a contextual contradiction.

(9) *Some Italians come from a warm country.* Magri (2009, 2011)

4.1. Blind scalar implicatures

The sentence in (9) intuitively strikes us as odd because it conveys that not all Italians are from Italy. This intuition is captured by the reasoning, going back to Hawkins (1991), that (9) triggers the scalar implicature *Not all Italians come from a warm country*, which clashes with our world knowledge. Magri (2009, 2011) uses a system of blind exhaustification that creates this inference and makes it obligatory.

LFS contain at every scope site a silent exhaustivity operator (like an only) that combines with a free variable \( \mathcal{R} \) and a prejacent, as in Figure 3. The free variable ranges over the scalar\(^{11}\)

\(^{11}\)‘The set Alt(\( \varphi \)) of scalar alternatives of the prejacent LF \( \varphi \) consists of those LFs that can be obtained from the target LF \( \varphi \) by replacing one or more scalar items in \( \varphi \) with their Horn-mates.’ (Magri, 2011: p. 7)
alternatives that are contextually relevant for the prejacent. In particular, the prejacent itself is postulated to be relevant (uncancellable) as well as anything contextually equivalent to it. In Figure 3, for example, the denotation of $\mathcal{R}$ will contain the prejacent (Some Italians. . .) and the alternative All Italians. . ., since they entail each other contextually.

The exhaustivity operator is said to not see the contents of this free variable. It only looks at all the scalar alternatives and negates (excludes\textsuperscript{12}) the ones that it consistently can. Crucially, the notion of consistency that the operator uses is not contextual but semantic – it is blind to pragmatic information such as Italians being people that come from Italy. So as far as it is concerned, it is consistent to “say” Some Italians come from a warm country and not all Italians do.

![Figure 3: LF of (9), drawn with only the matrix exhaust](image)

The way this works more concretely is in (10). The set $\text{Excl}(\varphi)$ contains the set of excludable alternatives, i.e. scalar alternatives of $\varphi$ that can be (semantically) consistently negated with $\varphi$. Note, for example, that $\varphi$ is not an excludable alternative to itself, so even though it is relevant, it will never be negated. In practice, it will be up to $\mathcal{R}$ to have the final say in which semantically-consistent-with-$\varphi$ scalar-to-$\varphi$ alternatives are negated. For example, when only the prejacent is relevant, the effect of the exhaustivity operator is not visible.

\begin{equation}
\text{Exh}_{\mathcal{R}}(\varphi) = \varphi \land \bigwedge_{\psi \in \mathcal{R} \cap \text{Excl}(\varphi)} \neg \psi \quad (\text{Magri, 2011: p. 9})
\end{equation}

The background assumption is that when exhaustification produces something trivial (a contradiction or a tautology), this triviality is the source of oddness and unacceptability. We will use this strategy to explain why oddness arises with embedded epistemic modals.

4.2. Blindness with modals and attitudes

We saw that some and all are scalar alternatives (along with possibly other expressions, such as most). Let’s assume the same kind of competition between epistemic modals and (separately) between doxastic attitudes (dopuščati and misliti). I will make the following two assumptions about the exhaustivity operator: it is sensitive to the requirement that belief states and modal bases do not denote empty sets, but it is blind to pragmatic principles like Locality and Totality, discussed in §3. For the sake of simplicity, I will in what follows ignore any exhaustivity operators within the complement of the attitude verb.

\textsuperscript{12}The set $\text{Excl}(\varphi)$ of alternatives excludable w.r.t. the prejacent $\varphi$ consists of those scalar alternatives $\psi \in \text{Alt}(\varphi)$ such that $\psi$ can be negated consistently with $\varphi$.’ (Magri, 2011: p. 8)
Consider first ‘John thinks it must be raining’ ($B_J \Box p$) from (1a). The attitude verb and the modal are stronger than their respective scalar alternatives, so the combination yields the semantically strongest expression in \{$D_J \Diamond i p, B_J \Diamond i p, D_J \Box i p, B_J \Box i p$\}. Since there is nothing to consistently exclude, the enriched meaning is simply the prejacent, as in Figure 4, line 1.

By contrast, ‘John allows that it must be raining’ ($D_J \Box i p$) from (1b) is semantically weaker than $B_J \Box i p$, so $B_J \Box i p$ can be excluded and in fact must be because it is relevant. Assuming what we did about epistemic modal bases in §3, the modal base function $i$ pragmatically strengthens $D_J \Box i p$, making it contextually equivalent to $B_J \Box i p$. The enriched meaning in Figure 4, line 2, is contextually contradictory. (Excluding also $B_J \Diamond i p$ does not remedy this.)

<table>
<thead>
<tr>
<th>$\varphi$</th>
<th>$\text{Excl}(\varphi)$</th>
<th>$\mathcal{R}_{\text{min}}(\varphi)$</th>
<th>$\text{Excl}(\varphi) \cap \mathcal{R}_{\text{min}}$</th>
<th>$\text{Exh}<em>{\mathcal{R}</em>{\text{min}}}(\varphi)$</th>
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<tr>
<td>$B \Box p$</td>
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<td>${D \Box p, B \Box p}$</td>
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<td>$B \Box p$</td>
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<td>$D \Box p$</td>
<td>${B \Diamond p, B \Box p}$</td>
<td>${D \Box p, B \Box p}$</td>
<td>${B \Box p}$</td>
<td>$D \Box p \land \neg B \Box p \iff_c \bot$</td>
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<td>$B \Diamond p$</td>
<td>${D \Box p, B \Box p}$</td>
<td>${B \Diamond p}$</td>
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<td>$B \Diamond p$</td>
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<tr>
<td>$D \Diamond p$</td>
<td>${B \Diamond p, D \Box p, B \Box p}$</td>
<td>${D \Diamond p}$</td>
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<td>$D \Diamond p$</td>
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Figure 4: Computing the minimally enriched meanings (omitting the subscripts)

While the enriched meanings in lines 3 and 4 in Figure 4 are simply the prejacents, this need not be so. The enriched meanings in (11) can be used to convey that John is unopinionated with respect to $p$.

(11) a. $\text{Exh}_{\mathcal{R}_1}(B_J \Diamond i p) = B_J \Diamond i p \land \neg D_J \Box i p \land \neg B_J \Box i p$

b. $\text{Exh}_{\mathcal{R}_1}(D_J \Diamond i p) = D_J \Diamond i p \land \neg D_J \Box i p \land \neg B_J \Box i p$

c. $\text{Exh}_{\mathcal{R}_2}(D_J \Diamond i p) = D_J \Diamond i p \land \neg B_J \Diamond i p$

Negated attitude verbs from §2.2 are more complex to analyse due to the embedded exhaustivity operator between negation and the attitude verb. For example, ‘John doesn’t think that Bob might be behind his back’ from (5d) has the LF: $\text{Exh}_{\mathcal{R}'}(\neg \text{Exh}_{\mathcal{R}'}(B_J \Diamond i p))$. This example appears as $\chi$ in Figure 5, line 3, where $\mathcal{R}'$ is replaced by a subscript spelling out its value from Figure 4, line 3, column 2. The result in Figure 5, line 3, column 3 tells us that the effect of the two exhaustivity operators can be vacuous. Similarly to what we discussed for (11), $\mathcal{R}$ can contain for example $\{\neg \text{Exh}_{\{B \Diamond p\}}(B \Diamond p), \neg \text{Exh}_{\{D \Diamond p\}}(D \Diamond p)\}$ to yield $\neg B \Diamond p \land \neg (D \Diamond p \land \neg B \Diamond p)$, which is just $\neg B \Diamond p \land D \Diamond p$.

<table>
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<tr>
<th>$\chi$</th>
<th>$\mathcal{R}'_{\text{min}}$</th>
<th>$\text{Exh}<em>{\mathcal{R}'</em>{\text{min}}}(\chi)$</th>
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<tr>
<td>$\neg \text{Exh}_{{D \Box p, B \Box p}}(B \Box p)$</td>
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<td>$\neg (D \Box p \land \neg B \Box p) \iff_c \top$</td>
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<td>cf. $\neg B \Box p$</td>
<td>${\neg B \Box p, \neg D \Box p}$</td>
<td>$\neg B \Box p \land D \Box p \iff_c \bot$</td>
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Figure 5: Computing the minimally enriched meanings (omitting the subscripts)

The main appeal of Magri’s system is that it allows us to run pragmatics locally and capture (with the caveat below) the intuition that ‘John doesn’t allow for the possibility that Bob must
be behind his back’ in (5g) is odd because it is odd on a local level (cf. *D□p). The embedded exhaustivity operator yields a contextual contradiction (Figure 4, line 2), while the negation over it creates a contextual tautology. The caveat is that our rich scalar alternatives allow for a potential escape strategy: it should be possible to escape the tautology during the main-clause exhaustification, by conjoining it with something contingent from the excludable alternatives. To my knowledge this has not been discussed with the more traditional examples, so it is an open question whether this option is generally blocked.

The presence of a local exhaustivity operator is the only option within this system to generate the oddness of (5g). The LF $Ex_{\text{R}}(\neg D□p)$ does not generate a contextual contradiction because $\neg B□p$ is semantically weaker than $\neg D□p$, and therefore not excludable.

Some flexibility would, however, be useful with negated universal doxastics. While It’s not the case that John thinks that Bob must be behind his back from (5c) was acceptable, the corresponding sentence with doesn’t think from (5b) was degraded. The two seem to correspond to the LFs in lines 1 and 5 from Figure 5, respectively. Are there exceptions to having the exhaustivity operator at every scope site?

Magri notes the following contrast, suggesting that the difference lies in there being “no space” for an embedded exhaustivity operator in (12b).

(12) Situation: In this department, all professors get together at the end of the semester and decide on a grade to assign to all of their students.
   a. It is false that this year all professors assigned an A.
   b. #This year, not all professors assigned an A. (Magri, 2011: p. 38)

While this seems less plausible for main clause verbs (especially non-neg-raising ones), other factors such as prosodity can shape the LF and could therefore in theory play a role with exhaustification as well. Consider for example (13), read with a “B accent” (rise-fall-rise, cf. All politicians aren’t corrupt), which triggers a wide-scope negation (Büring, 1997). A possible explanation for its oddness is that it lacks, like (12b), an embedded exhaustivity operator.

(13) *All Italians don’t come from a warm country. (rise-fall-rise interpretation)

5. Conclusion

I discussed the limited distribution of epistemic modals under dopuščati (‘allow for the possibility’), an existential doxastic attitude verb from Slovenian. To explain the oddness of embedding a universal epistemic force, I drew on Močnik (2019) to revise the contribution of epistemic modals. The core idea explored in this paper was that sentences like *Dopuščam, da mora deževati (‘I allow for the possibility that it must be raining’) share their source of oddness with the more well-known *Some Italians come from a warm country (Magri, 2009, 2011).
References


