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A Minimally Sufficient Analysis of Sufficiency
Modal Constructions

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A minimally sufficient analysis of sufficiency modal constructions [*]

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Abstract

A well-known compositionality problem involves the interaction between *only* and goal-oriented modality: *only* can weaken a necessity statement and a necessity modal can suspend a characteristic inference associated with *only*, the inference to the prejacent. Existing proposals resort to non-standard assumptions either about *only* or what it combines with. We show that a standard analysis of *only* and a plausible analysis of goal-oriented modality can account for the compositionality problem.

1 The prejacent problem

The *sufficiency modal construction*, exemplified in (1), gives rise to a puzzle that von Fintel & Iatridou [16] (vF&I) dubbed "the prejacent problem". This problem involves the compositional interaction between *only* and goal-oriented (aka teleological) modality, and can be appreciated by comparing (1) with (2), where (2) corresponds to the prejacent of *only* in (1).

(1)   To get good chocolate, you only have to go [to Trader Joe's]$_F$.

(2)   To get good chocolate, you have to go to Trader Joe's.

Only appears to weaken the necessity statement in its scope: while (2) implies that there is only one way to get good chocolate, (1) is compatible with there being other ways, but implies that those ways are more involved, in some sense, than going to Trader Joe's. A necessity modal under *only*, in turn, can suspend the inference to the prejacent that is characteristic of *only*: while (3) commits the speaker to (4), (1) does not commit the speaker to (2).

(3)   You only have to go [to Trader Joe's]$_F$ today.

(4)   You have to go to Trader Joe's today.

This inferential pattern thus provides a challenge to a uniform analysis of *only* and raises the question of what its presuppositional content is.

An adequate analysis of sufficiency modal constructions should satisfy certain desiderata. The analysis should determine an interpretation for *only* in the construction and say how that interpretation relates to its interpretation elsewhere. Ideally, *only* would receive the same interpretation everywhere. It must also capture two implications of (1). One, which we refer to as the *actual means implication*, is that going to Trader Joe's is actually a way of getting chocolate. The other, which we refer to as the *scalar implication*, is the implication, pointed

out by Krasikova & Zechev [12] as part of their critique of vF&I's non-scalar analysis, that lower ranked alternatives to the modal prejacent, such as going to a store that is closer, are *not* actual means to this goal. If your corner store is closer than Trade Joe's and both have good chocolate, (1) cannot be truly and felicitously uttered; instead, (5) has to be used.

(5)   To get good chocolate, you only have to go to your corner store.

None of the existing analyses of sufficiency modal constructions [16, 10, 12, 8, 11, 1, 2] fully meet these desiderata. Those that build scalarity into the meaning of the construction nevertheless resort to non-standard and, we argue, analytically problematic assumptions either about the compositional make-up of *only* and/or its prejacent, or about *only*'s presuppositional content. This paper demonstrates that a preference-based analysis of goal-oriented modals, coupled with a standard scalar analysis of *only*, provides a compositional account that derives the interpretive behavior of the sufficiency modal construction.

2   Analysis

Descriptively, the sufficiency modal construction consists of *only* and a necessity clause composed of a modalized sentence with a necessity modal modified by a purpose clause. The analytical question is whether these two components suffice for a compositional analysis. On the face of it, the existence of the prejacent problem indicates that the compositional structure is more complex. Complicating the compositional structure has been the approach taken by all previous accounts except for Franke's [8]. We pursue an analysis in which the compositional structure of the construction reflects its grammatical structure. Our main claim is that the interpretive properties of the construction are due (a) to the contextual alternatives activated by *only* and (b) the contextual resolution of the parameters of the modal in the prejacent of *only*. We first discuss the interpretation of goal-oriented modality, then the interpretation of *only* and the effect it has on the interpretation of the necessity clause in its scope.

2.1   Goal-oriented modality

Consider the exchange in (6), where a goal-oriented necessity clause is used in response to an assertion about a search for good chocolate. Intuitively, B's response in (6) provides the factual information that Trader Joe's carries good chocolate and that it's the only (relevant) shop that does. More directly tied to its semantic content, it is used by B to communicate that going to Trader Joe's is necessary for acquiring good chocolate (in an optimal way).

(6) A : I am looking for some good chocolate (to serve at the dinner).
        B : You have to go to Trader Joe's.

On the standard analysis of modality due to Kratzer [13], the interpretation of the modal in (6) is determined by two contextual parameters, a modal base f and an ordering source g. We assume the analysis of goal-oriented modality in [4], which is based on a preferential ordering source (in line with [8]). In (6) it would consist of the goals of the addressee, including a goal to get good chocolate, inferred to motivate A's search.[1] The modal base is circumstantial, containing all the relevant facts, including, among others, the addressee's location and which stores do and do not carry good chocolate. (6) is then true in a world w iff in all worlds that agree with w on the relevant facts and which best satisfy A's goals at w, A goes to Trader Joe's.

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[1]We will use the term 'goal' to refer to [4]'s notion of effective preference.

(2) has the same context-dependent truth conditions as (6). In order to incorporate the compositional contribution of the purpose clause, we assume that purpose clauses, like *if*-clauses, are modifiers of the modal, but operate on its ordering source parameter in the way specified in (7).

(7)   A modal $\mathcal{M}_{f,g}$ modified by a purpose clause with content p is $\mathcal{M}^p_{f,g^+}$, where for any w,
       $g^+(w) = \{p \wedge r \mid r \in g(w)\}$

As long as g is non-empty and, for a world w, p is consistent with $g(w)$, which we can assume for the cases at hand, p will be true in all the f-g^+-best worlds relative to w.

The semantic content of (2) is that, relative to a world of evaluation, the f-g^+-best worlds, which are worlds in which you get good chocolate, are worlds in which you go to Trader Joe's. That in those worlds you get good chocolate *by* going to Trader Joe's and that, in the world of evaluation Trader Joe's carries good chocolate are pragmatic inferences. (See discussion in [14, 5] on how goal-oriented modal statements can convey factual information and the role of pragmatic reasoning in linking the prejacent to the stated goal as a way/means of achieving it.) The actual means implication is thus derived as an implication of goal-oriented necessity claims, generated on the basis of their semantic content and pragmatic reasoning.

2.2   Goal-oriented modality under *only*

We now turn to goal-oriented necessity clauses embedded under *only*. The null hypothesis is that 'To p, you only have to q' has the logical form in (8).

(8) $ONLY(\square^p_{f,g}(q))$

Consider first a context in which graduate students applying for reimbursement for domestic travel need to obtain their advisor's signature, whereas international travel requires also signatures from the DGS and the chair. You ask about reimbursement for domestic travel, and receive the reply in (9).

(9)   To apply for reimbursement, you only have to get the [advisor's]$_F$ signature.

(9) implies that your advisor's signature is required but no other signatures are. In this case, the alternatives are ranked by entailment and Horn's [9] account of the presupposition of *only* goes through without generating the prejacent problem. Assuming Rooth's [15] analysis, *only* is a propositional operator that brings into the semantic composition a contextually determined set of alternatives, based on the focus alternatives of the focused expression, including the prejacent proposition. *Only* presupposes that the prejacent alternative is true, and asserts that all the stronger alternatives are false.

Sufficiency modal constructions like (1) differ from (9) in that the alternatives are not ranked by strength. Accounting for them, therefore, requires moving away from entailment-based accounts of *only* to a more general scalar analysis (with entailment as a special case). Coppock & Beaver [6], building on Beaver & Clark [3], provide such an analysis. On their analysis, *only*'s semantics involves two operators, MIN and MAX, defined in (10). The presuppositional content of *only* is specified in terms of MIN and thus involves restricted existential quantification over alternatives. The assertive content of *only* is specified in terms of MAX. The inference to the prejacent arises from the combined effect of presupposition and assertion.

(10)   a.   MIN$(p, Alt) = \lambda w.\exists p' \in Alt(p)\,[p'(w) \wedge p \leq p']$
       b.   MAX$(p, Alt) = \lambda w.\forall p' \in Alt(p)[p'(w) \rightarrow p' \leq p]$

In (1), we can then take the focus alternatives to be stores that might, given the common ground between the interlocutors, carry chocolate, ordered, as assumed in the literature, by how easy they are to get to. Supposing the stores are your corner store, Trader Joe's, some other stores further away, and the distant chocolaterie *Coco*, the alternatives operated on by *only* would be as in (11), generated from the focus alternatives and inheriting their ordering. Due to the context dependence of the modal these alternatives are not propositions, but functions from contexts to propositions. What propositions they determine depends on how the global context resolves their pronoun-like parameters f and g^+.

(11) $\square_{f,g^+}^{\text{choco}}(\text{you go to corner store}) < \square_{f,g^+}^{\text{choco}}(\text{you go to TJ}) < \ \ldots \ < \square_{f,g^+}^{\text{choco}}(\text{you go to Coco})$

Under what conditions could any of the necessities in (11) be true in a world in which multiple stores carry good chocolate? Our key assumption is that the ordering source g^+ in sufficiency modal constructions encodes a preference to minimize the cost of goal realization. Such an ordering source generally leads to a smaller domain of quantification than is involved in bare necessity statements like (2), and thus allows for a necessity to be true in a world in which multiple ways of achieving the goal exist. In any such world, only one of the alternative necessities will be true, namely the one in which the modal prejacent describes the least effortful way of getting chocolate, thus deriving the scalarity inference. Given that the contextual salience of a preference for cost minimization is a hallmark of the sufficiency modal construction, which singles out one way of achieving a goal as contrasting with higher ranked alternatives, this is a natural construal for the ordering source.

We model the preference for cost minimization by having the ordering source include propositions that the agent incurs no more than d-amount of cost, for different d's. This ensures that the ordering source contains propositions that stand in an entailment relation. On the resulting ordering on worlds, a world w_1 in which, for example, you get good chocolate incurring no more than d_1 amount of cost is better than a world w_2 in which you do so incurring no more than d_2 amount of cost, for $d_1 < d_2$, because w_1, in which you incur no more than d_1, and hence also no more than d_2 cost, verifies more propositions in the ordering source than w_2.

Under these assumptions, the presupposition in (12-a) is that the f-g^+-best worlds are ones in which you go to Trader Joe's or further and incur at least the amount d_{TJ} of cost associated with going to Trader Joe's. The assertion (12-b) is that the f-g^+-best worlds are ones in which you go no further than Trader Joe's and incur at most d_{TJ} cost. The combined presuppositional and assertive content is, therefore, that the f-g^+-best worlds are ones in which you go to Trader Joe's and incur d_{TJ}-cost, which is precisely the content our analysis assigns to *only*'s prejacent. As mentioned above, the conveyed content of (1) is then that in the best worlds, you get good chocolate incurring d_{TJ}-cost by going to Trader Joe's.

(12) a. P: $\lambda w.\exists p' \in Alt(\square_{f,g^+}^{\text{choco}}(\text{you go to TJ}))\,[p'(w) \wedge \square_{f,g^+}^{\text{choco}}(\text{you go to TJ}) \leq p']$
      b. A: $\lambda w.\forall p' \in Alt(\square_{f,g^+}^{\text{choco}}(\text{you go to TJ}))[p'(w) \rightarrow p' \leq \square_{f,g^+}^{\text{choco}}(\text{you go to TJ})]$

(12) gives rise to the inference to the prejacent of *only*. Our main claim is that this is the correct result and straightforwardly explains the prejacent problem in terms of context equivocation (shifts in context between the premises and conclusions of an argument). Absent explicit modification, a natural context for a necessity clause like (2), unlike for a sufficiency modal construction, does not involve ranked alternative ways to achieve a goal, and hence determines an ordering source that does not encode cost minimization. This results in a larger domain of quantification and given the existence of multiple means, there is diversity across the worlds in the domain as to how the goal is achieved, falsifying the necessity clause.

   This way of linking minimal sufficiency inferences to scalar alternatives and the ordering source has two further advantages. We correctly predict that necessity clauses can, in the right context, give rise to minimal sufficiency inferences in the absence of *only*. The implication in (13) is that flying across Europe is the least I have to do to see a Picasso.[2]

(13)   To see a Picasso, you only have to drive downtown. I have to fly across Europe.

Cases like (13) provide empirical support for attributing the weakening of necessity brought about by *only* to a narrowed domain of universal quantification for the modal, as on our analysis (and Franke's), and against analyses that associate a possibility interpretation with sufficiency modal constructions, such as those of vF&I or Alonso-Ovalle & Hirsch (AO&H). For the former, bare necessity clauses are never predicted to have minimal sufficiency readings. For the latter, since nothing negates the necessity of higher alternatives, nothing ensures that the modal prejacent is in fact a way of achieving the goal.
   We also capture the fact, pointed out in [11] (and echoed by [7]), that a scalar element in a goal-oriented necessity clause can lead to minimal sufficiency inferences without *only*, as seen in the implication of (14).

(14)   To avoid evening rush hour without driving in the dark, you have to leave at 4pm.
         ↝ *4pm is the latest you can leave and still avoid rush hour and driving in the dark*

A context invoking alternative means, ranked by some measure of cost, can determine an ordering source that encodes cost minimization, giving rise to the minimal sufficiency interpretation.

3   Comparison with previous proposals

vF&I decompose *only* into NEGATION + EXCEPT, and allow for split scope, with the modal taking scope between them.[3] The logical form of (1) is (15). EXCEPT has an existential presupposition, triggered under the modal in (15). (1) presupposes that in every world in which you get good chocolate you go to some (potentially different) store. The assertive content is (16), which, combined with the presupposition, yields goal-oriented possibility, as in (17).

(15) $\neg\Box^{choco}(\text{EXCEPT}(\text{TJ}) \lambda x. \text{ you go to } x))$

(16) $\neg\Box^{choco}(\exists x \neq \text{TJ} : \text{you go to } x)$

(17) $\Diamond^{choco}(\text{you go to TJ})$

As discussed above and in [12], this analysis does not meet the scalarity desideratum. The decomposition and split scoping of *only* is, furthermore, problematic. AO&H show that outside of the construction, the presupposition associated with *only* (via EXCEPT) is too weak, and that *only* has no negative component in languages where it is monomorphemic. [4] Finally, Huitink points out in [10] that a possibility semantics fails to account for valid transitivity inferences.
   For AO&H [1], *only* presupposes its prejacent, which optionally contains a covert scalar operator AT LEAST. AT LEAST presupposes that its own prejacent is the lowest alternative, on an effort-based ranking, and asserts that one of the alternatives is true. The presuppostional

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[2]Although both sentences imply minimal sufficiency, only the first has an easiness implication. This implication is due to *only*, but neither our account nor any of the alternatives explains why.

[3]In French, Greek and other languages, the translational equivalent of the sufficiency modal construction contains all three components on the surface.

[4]There is also no structural evidence for a bimorphemic analysis of *only*.

and assertive content amounts to a possibiliy claim as in vF&I, and is thus subject to some of the same objections. Furthermore, (18) shows that overt *at least* is illicit in the construction, weakening the case for a covert operator with presumably the same semantics.

(18)   #To get good chocolate, you only have to go at least to Trader Joe's.

Krasikova & Zhechev [12] recognize the essential scalarity of the construction, but their account uses a special-purpose compositional analysis of *only*, and moreover derives very weak semantics, relegating what appears to be core semantic content to implicatures. *Only* takes a measure function, the modal prejacent, and the modal (modified by the purpose clause) as separate arguments, so *only* has no prejacent. The modal prejacent is mapped to a degree of likelihood, taken to correlate with difficulty.[5] (1) presupposes that in the closest worlds to the world of evaluation[6] in which the stated goal is achieved, you do something, and asserts that what you do is at least as likely (easy) as going to Trader Joe's. The combined content is that in the closest goal-worlds you do something at least as likely (easy) as going to Trader Joe's. A quantity implicature then excludes more likely (easier) alternatives, generating the content that in the closest goal-worlds, you do something with the same degree of likelihood as going to Trader Joe's. That what you do *is* go to Trader Joe's is claimed to be a relevance implicature.

Franke's [8] analysis meets the three desiderata and we rely on many of its insights. His key assumptions are that goal-oriented necessity clauses have scalar and non-scalar interpretations, and that on the scalar one they involve an ordering source that encodes cost minimization. For instance, (2) is claimed to allow an interpretation like (19-a) or (19-b).

(19)   a.   To get good chocolate, you have to go to Trader Joe's, if not even to Choco.
         b.   To get good chocolate, you have to go to Trader Joe's or further away.

He assumes further that *only* selects for the scalar interpretation,[7] and presupposes its prejacent. The presupposition of (1) then amounts to a disjunction of necessities only one of which is true in any given world, avoiding the prejacent problem. Goal-oriented clauses, however, do not generally have scalar, *at least*-type readings without overt modification. The contrast in felicity between (20-a) and (20-b) shows that necessities like (2) cannot actually be interpreted like (19-a) or (19-b). Moreover, as seen in (21), *only* is incompatible with overtly marked weak prejacents, undermining the hypothesis that *only* selects for scalar prejacents.

(20)   a.   To see a Picasso, you have to go at least to Chicago, but I'm not sure how far.
         b. #To see a Picasso, you have to go to Chicago, but I'm not sure how far.

(21)   a. #To get good chocolate, you only have to go to Trader Joe's if not even to Choco.
         b. #To get good chocolate, you only have to go to Trader Joe's or further away.

Franke recognizes that goal-oriented necessity is context-dependent and that, in combination with *only*, it involves a particular contextual resolution of the ordering source, namely one that encodes cost minimization. He does not, however, connect this context dependence to the prejacent problem. What our analysis capitalizes on is that *only* requires a context that fixes the ordering source parameter of the modal in such a way that leads to the inference to the prejacent of *only*. The prejacent problem then emerges as a mirage.

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[5]The idea being that more difficult things are less likely to happen. We think that introducing likelihood into the semantics is mistaken, since the likelihood inferences expected on this analysis are unattested.

[6]A similarity-based analysis to the modality problematically equates (2) with *if you were to get good chocolate, you would go to Trader Joe's.*

[7]This achieves the same weakening of the prejacent of *only* as AO&H's AT LEAST operator without stipulating a silent operator.

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