Teleological Necessity and *Only*

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Abstract. According to von Fintel and Iatridou (2005a) teleological sufficiency statements, i.e. sentences of the form "In order for p, only have to q", pose a problem of compositionality: it is not clear how to account for their intuitive meaning in terms of a standard theory of *only* and the meaning of the embedding sentence "In order for p, have to q". Therefore von Fintel and Iatridou resort to a non-standard analysis of *only.* The aim of this paper is to show that this is not necessary.

1 Introduction

Intuitively (1) means that going to Haarlemmerstraat is a way of getting German bread which is comparatively or unexpectedly easy for a means of getting German bread, or, in other words, that going to Haarlemmerstraat is sufficient for achieving the given goal, for reasons of which I will speak of a teleological sufficiency statement (TSS).

(1) In order to get German bread, you only have to go to [Haarlemmerstraat]$_F$.
In order for p, only have to q.

The question to be asked then is how this meaning can be derived from the meaning of *only* paired with the meaning of the embedding sentence (2), the so-called prejacent, a teleological necessity statement (TNS)?

(2) In order to get German bread, you have to go to Haarlemmerstraat.
In order for p, have to q.

A naive application of a standard account of the meaning contribution of *only* seems incapable of answering this question. Recall that, according to Horn's influential approach, a sentence like (3a) semantically means (3b) and either strongly presupposes (3c) (Horn 1969) or weakly presupposes (3d) (Horn 1996).

(3) a. Only [Hans]$_F$ came.
b. Nobody other than Hans came.
$\forall x \in \text{Alt(Hans)}\ (\neg \text{came}(x))$

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c. Hans came.
came(Hans)

d. Somebody came.
$\exists x\ (\text{came}(x))$

If we naively apply the same idea to TSSs, we would get that (1) semantically means (4a) and either strongly presupposes (4b) or weakly presupposes (4c).

(4) a. In order to get German bread, you don't have to go anywhere else than to HS.
$\forall q \in \text{Alt(HS)}\ \neg\text{Nec}(\text{GB}, q)$

b. In order to get German bread, you have to go to Haarlemmerstraat.
$\text{Nec}(\text{GB}, \text{HS})$

c. There is something that you have to do in order to get German bread.
$\exists q\ (\text{Nec}(\text{GB}, q))$

Yet as von Fintel and Iatridou (2005a) notice, the naive approach faces what they call the *prejacent problem*; if other ways of getting German bread exist, the strong presupposition in (4b) is false, although intuitively (1) does not seem to suffer from a presupposition failure in such cases. The strong presupposition therefore seems too strong for TSSs. Yet a weak presupposition (4c) seems too weak. The presupposition that something is necessary for getting German bread, together with the semantic meaning (4a) does not capture our meaning intuition that (1) says that going to Haarlemmerstraat is *sufficient* for getting German bread. Suppose that, if you bring your purse, German bread is to be had in Leidsestraat (LS) and Utrechtsestraat (US), but not in Haarlemmerstraat (HS). Then (4a) is true, because for a set of alternative $\text{Alt(HS)} = \{\text{LS}, \text{US}\}$ we get that $\forall x \in \text{Alt(HS)}\ \neg\text{Nec}(\text{GB}, x)$ is true; all alternatives to going to Haarlemmerstraat are not necessary for getting German bread. As bringing your purse is necessary, we do not infer from the weak presupposition and the semantics that going to Haarlemmerstraat is sufficient for getting German bread and so a weak presupposition seems too weak to account for intuitions. So neither a strong nor a weak presupposition seems appropriate in a naive application of an established approach of the meaning of *only* to account for intuitions.

2 Previous Analyses

2.1 Modal Split

In order to solve the prejacent problem von Fintel and Iatridou (2005a) suggest a modal-split analysis of *only*. In analogy to languages like French where a TSS such as (1) is expressed by a separate negation and an exceptive quantifier ($\exists x \in \text{Alt}(X)$) as in (5), von Fintel and Iatridou suggest to regard *only* as analogously comprising these two elements.

(5) tu n' as qu' à aller à HS.
you not have except-to go to HS
"You only have to go to HS."

It is then argued that the prejacent problem can be solved if the necessity modal in (1) takes intermediate scope in between negation and the exceptive quantifier, again in analogy to the French example. The proposed semantic meaning of a TSS with modal-split *only* is then the following:

$$\begin{aligned} \text{`In order for } p\text{, only have to } q\text{.'} &\approx \neg \Box_p \; \exists q' \in \mathrm{Alt}(q) \; q' \text{ is true} \\ &\approx \neg\forall w \; (w \in p \rightarrow \exists q' \in \mathrm{Alt}(q) \; w \in q') \\ &\approx \exists w \; (w \in p \wedge \forall q' \in \mathrm{Alt}(q) \; w \notin q') \end{aligned} \tag{2.1}$$

Part of the prejacent problem is solved, because according to (2.1) sentence (1) is no longer predicted true in case there are two alternatives to going to Haarlemmerstraat where German bread can be bought. Yet in order to account for the meaning component of (1) that German bread is on sale in Haarlemmerstraat, it has to be made sure that the witness of (2.1) is actually a world where we went to Haarlemmerstraat. This can be derived if we assume that the set of considered means $\mathrm{Alt}(q) \cup \{q\}$ exhausts the goal-worlds. This exhaustifity requirement is fulfilled, according to von Fintel and Iatridou, by a weak presupposition which is of the form (2.2).

$$\Box_p \; \exists q' \in \mathrm{Alt}(q) \cup \{q\} \;\; q' \text{ is true} \tag{2.2}$$

Taken together (2.1) and (2.2) let us derive the overall meaning of a TSS in (2.3).

$$\exists w \in W \;\; (w \in p \wedge w \in q \wedge \forall q' \in \mathrm{Alt}(q) \; w \notin q') \tag{2.3}$$

Although this analysis overcomes the noted prejacent problem, it still suffers from some insufficiencies. It is not only that the only genuine argument for modal split of *only* is that it helps solve the prejacent problem, and that therefore, if possible, a non-split treatment of *only* would clearly be preferred, but it is also that (2.3) is too weak to account for sufficiency and that the scalar meaning component, q's relative ease for achieving p, are not captured. These latter two points of criticism have been taken up by Huitink (2005) and Krasikova and Zhechev (2005) respectively and form the basis of their alternative accounts.

2.2 Modal Concord

Huitink (2005) notices that von Fintel and Iatridou's prediction (2.3) does not capture the transitivity of TSSs. Intuitively, the following argument is clearly valid, but this intuition is not borne out in (2.3):

In order to pass logic, you only have to be able to do derivations.
In order to be able to do derivations, you only have to know the rules of thumb.
∴ In order to pass logic, you only have to know the rules of thumb.

At the heart of Huitink's criticism lies the realization that the existential in (2.3) is too weak to capture sufficiency. Von Fintel and Iatridou (2005a) intended to parry Huitink's charge by pointing out the difference between (6a) and (6b).

(6) a. In order to find out what Morris is working on, you only have to go to the SC.
b. You only have to go to the SC, and you'll find out what Morris is working on.

Whereas (6a) does not mean that it is a direct and immediate result of going to the SC that the addressee finds out about Morris' work, this is the intuitive meaning of (6b). Hence, so the conclusion of von Fintel and Iatridou, TSSs express something short of sufficiency. Yet although this indeed seems to be the case, the worry remains that von Fintel and Iatridou's analysis falls *too* short of sufficiency. The problem clearly surfaces in the erroneous predictions about sentences such as (7).

(7) In order for this fair coin to come up heads, you only have to toss it.

For all we know about fair coins, (7) should be false, but is rendered true by the analysis of von Fintel and Iatridou in (2.3).

In the light of the shortcomings of von Fintel and Iatridou's analysis Huitink proceeds to propose an alternative account of TSSs. She proposes to see a modal concord phenomenon in *only have to* constructions. *only* is considered a universal modal quantifier alongside of *have to*. Since intuitively in (1) only one universal modal quantifier seems to be operative, Huitink suggests to analyze *only have to* as a modal concord phenomenon where *only* simply reverses the relation in (2.4) to yield (2.5).

$$\text{`In order for } p \text{, have to } q\text{.'} \quad \approx \quad \forall w\ (w \in p \rightarrow w \in q) \tag{2.4}$$
$$\text{`In order for } p \text{, only have to } q\text{.'} \quad \approx \quad \forall w\ (w \in q \rightarrow w \in p) \tag{2.5}$$

This analysis can account for the transitivity of TSSs, as desired. But again it relies on a non-standard treatment of *only*, may even seem *ad hoc* from a distance and clearly raises the question whether it is not actually too strong. It is not the case that (1) means that in all worlds where one goes to Haarlemmerstraat automatically or immediately German bread is obtained. So it seems that an appropriate intermediate notion of sufficiency has to be met to account for the meaning of (1) situated in between the too weak notion of von Fintel and Iatridou and the too strong notion of Huitink.

2.3 Scalar Only

Both von Fintel and Iatridou and Huitink pay attention to, but do not focus on the intuitive meaning aspect of (1) that going to Haarlemmerstraat is comparatively easy. Krasikova and Zhechev (2005) put this intuition center stage and suggest a scalar analysis of TSSs. Accordingly, (1) is said to mean (2.6) semantically and to weakly presuppose (2.7).

$$\forall q' \in \text{Alt}(q)\ (q' > q \rightarrow q' \text{ is not necessary for } p) \tag{2.6}$$

All ways more effortful than q are not necessary for p.

$$\exists q' \in \text{Alt}(q)\ (q' \text{ is necessary for } p) \tag{2.7}$$

There is something which is necessary for p.

Effort of a proposition is defined in terms of *probability degrees*: More effortful ways are less probable. $D(p) \in [0, 1]$ is the probability degree of proposition p. With this (2.6) can be rephrased as (2.8).

$$\forall q' \in \text{Alt}(q)\ (D(q') < D(q) \rightarrow q' \text{ is not necessary for } p) \tag{2.8}$$

In order to derive the sufficiency of q for p which is intuitively expressed by (1) and not to succumb to the prejacent problem, probability degrees are themselves considered necessary or sufficient for a proposition p. A probability degree d is necessary (sufficient) for p iff there is a proposition q such that q is necessary (sufficient) for p and $D(q) = d$. Necessity and sufficiency then interrelate in various ways via probability degrees, e.g. as in (2.9).

$$d \text{ is sufficient for } p \text{ iff } \forall d' < d\ (d' \text{ is not necessary for } p) \tag{2.9}$$

There is no proposition less likely / more effortful than degree d necessary for p.

According to the authors (2.8) and (2.9) together yield that some proposition q' with $D(q') = D(q)$ is sufficient for p. By a strengthening implicature, this q' is identified with q and the sufficiency of q for p is ensured.

It needs to be noted on the side that the inference from (2.8) and (2.9) to the existence of some proposition q' sufficient for p with $D(q') = D(q)$ is a *non-sequitur*, unless, implausibly, $\text{Alt}(q)$ contains all propositions for each degree $< D(q)$. Disregarding the details of the formalization, it appears that the main point of criticism is that the motivation for talking about probability degrees remains utterly mysterious, although the intuitions about scalar readings are, I claim, basically on the right track.

3 Teleological Necessity

The main thesis of this paper is that to account for the meaning of TSSs a standard theory of the meaning of *only* can be pulled off effortlessly, if only the correct notion of teleological necessity, is supplied. The questions to be addressed in this section are: (i) what is teleological necessity, (ii) what information is conveyed by teleological modals and (iii) what reading of the prejacent TNS may we assume for TSSs?

3.1 Teleological Necessity = Logical Necessity + Dependency

It is clear that a TNS like (2) does not only express q's logical necessity for p. If "In order for p, have to q" was a feasible sentence for all propositions p, q such that p logically entails q, then we'd expect all instantiations where q is a result of p to be legitimate instantiations. But this is not the case. (8) should be true and felicitous if teleological necessity was just logical necessity, but, for all we know about kangaroos, it is marked:

(8) ?In order for Kanga to lose her tail, she has to topple over.

To see what is at stake for a requirement on p, q pairs for instantiation in "In order for p, have to q", the following coin-flip scenario is illuminating.

Coin Flip Scenario Suppose Hans bet on tails and we are about to flip a fair coin.

(9) a. In order for Hans to win, the coin has to come up tails.
b. ?In order for the coin to come up tails, Hans has to win.

Now suppose that the coin was flipped, and it came up heads.

(10) a If the coin had come up tails, Hans had won.
b ?If Hans had won, the coin would have come up tails.

The parallel between (9) and (10) suggests that the same notion of dependency between events is needed for feasibility of TNSs that informs our intuitive judgements about counterfactuals. Having no intention to model these here, I will just assume the correct dependencies to be given. It is then required for pragmatic felicity of "In order for p, have to q" that p *depends* on q. Leaving p's dependence on q implicitly understood, we can define the notion of teleological necessity $\mathrm{Nec}(p, q)$ simply as logical necessity: $\mathrm{Nec}(p, q)$ is true in w, $w \in \mathrm{Nec}(p, q)$, if all p-worlds that are contextually accessible from w are q-worlds. There is moreover serious reason for hope that a suitable rendering of dependency will account for temporal matters naturally.

3.2 Information Conveyed by Teleological Modals

To say that $\mathrm{Nec}(p, q)$ is true in a world if all contextually accessible p-worlds are q-worlds, leaves open the question what kind of accessibility relation teleological modals require. According to von Fintel and Iatridou's (2005a) analysis of TNSs in terms of Kratzer's (1991) theory of modality, $\mathrm{Nec}(p, q)$ is true in a world w relative to a circumstantial modal base $f(w)$ if all worlds in $f(w)$ where p is true are q-worlds. As circumstantial modality seems to be an appropriate candidate for our running example (2) and most others, I will follow von Fintel and Iatridou here.

In restricting ourselves to circumstantial modality we restrict ourselves to cases where TNSs and TSSs are used for predictions about future courses of events. A teleological modal informs us about how the future will evolve. It reduces epistemic uncertainty about what the state of affairs is at present by telling us that the real world w faces a particular future, i.e. is associated with a modal base $f(w)$. If we separate epistemic and circumstantial modality in this way, we may assume that for a contextually given set of alternatives Q and the set of possible worlds W, the modal base $f(w)$ of each $w \in W$ is partitioned by Q

into singleton sets, i.e. we assume that for each $w \in W$ there is a bijection $f_w : Q \rightarrow f(w)$. The idea is that for a given conceivable possible world w there will be just one way w will develop if $q \in Q$ takes place. For epistemic uncertainty how the future will develop under $q \in Q$, we feature worlds w, w' with $f(w) \neq f(w')$.

It is here that we have to solve a problem that we came across earlier. In section 2.2 we saw that von Fintel and Iatridou's analysis of TSSs appeared too weak, while Huitink's amendment appeared too strong. The root of the problem is that our analysis of teleological modality has to leave room for a remote chance of sheer luck in achieving p without q and a remote chance of bad luck in not achieving p despite q. One way of dealing with this problem is to assume a restriction to normal courses of events. Another possibility is to think of $f(w)$ as the state of affairs right after $q \in Q$ has become true. As the slack that we want to incorporate into the model stems from nature's mysterious ways, what is at stake in $w' \in f(w)$ is not whether p is true or false, but whether the proposition p^*_δ is, a proposition that says that it is within the hands of the addressee to bring about p with a sufficiently high probability δ. Notice that in some cases δ might just be 1 and there is nothing further that the agent has to do to achieve p. The coin flip scenario (9a) is an example of such a situation. In other examples, however, amongst which (2), the slack parameters are needed to account for normal courses of events and normal behaviour of goal-oriented agents. We thus define:

$$w \in \text{Nec}(p, q) \text{ iff } \forall w' \in f(w)\ (w' \in p^*_\delta \rightarrow w' \in q) \tag{3.1}$$

3.3 Kinds of Teleological Necessity

In this section I will argue that the meaning of a TNS is context-dependent in interesting ways. $\text{Nec}(p, q)$ might be the basic case, but the presence of scalar *only* forces a particular reading of the prejacent TNS in TSSs, which is however also available outside of TSSs, if only the circumstances are appropriate. Eventually I will propose that in TSSs the underlying prejacent TNS gets a scalar 'at least'-reading.

Here is an example situation which provides evidence that a TNS may be pragmatically enriched to include further contextually salient goals in addition to the mentioned.

Shanghai Scenario A customer of a travel agency declares his wish to fly to Shanghai. There are three airways available. A and B fly to Shanghai, C heads for Tokyo. Assume that B and C are comfortable to travel with, unlike A.

(11) In order to fly comfortably, you have to fly with B.

The travel agent may say (11) in this situation without running risk of untruthfulness, because it is understood that the contextually salient goal to fly to Shanghai is implicitly assumed. The case suggests that for contextually salient goals r a TNS may be pragmatically enriched from $\text{Nec}(p, q)$ to $\text{Nec}(p \wedge r, q)$.

This context dependence may also be made responsible for scalar readings of teleological necessity. In a situation where it is mutually known that the addressee wants to minimize his effort in achieving a certain goal, we might assume that the further wish to be economical creeps into the reading of teleological necessity, just as other additional salient goals do. By way of illustration, suppose that we consider three locations where German bread might possibly be obtained: Leidsestraat (LS), Haarlemmerstraat (US) and Utrechtsestraat (US) with a preference order, based on walking distance, for instance, LS $<^{\mathrm{E}}$ HS $<^{\mathrm{E}}$ US, i.e. LS preferred over HS etc. Now it seems that (2) may be said truly and felicitously even if German bread is available in Utrechtsestraat if only the effort scale is sufficiently salient in the discourse. This clearly speaks for a *scalar reading* of TNSs.

Of course, the minimization of effort cannot be accounted for simply by adding a further proposition r to yield $\mathrm{Nec}(p \wedge r, q)$, as was the case with example (11). Minimization of effort in realizing p requires comparison with other possible ways of realizing p. This can be achieved, for example, in a Kratzerian vein by taking into account an additional ordering source $g(w)$. Let $\mathrm{Nec}_{\mathrm{Sc}}(p, q)$ be the proposition expressed by a TNS under its scalar reading and let $\mathrm{Nec}_{\mathrm{Sc}}(p, q)$ be true in w relative to a circumstantial modal base $f(w)$ and ordering source $g(w)$, which now takes care of the additional wish to minimize effort, if all the $g(w)$-best worlds in $f(w)$ where p is true are q-worlds. The $g(w)$-best worlds are minimal worlds according to the ordering $\prec$ defined as usual: $v \prec u$ iff $\{p \in g(w) \mid u \in p\} \subset \{p \in g(w) \mid v \in p\}$.

Let $\langle Q, \leq^{\mathrm{E}} \rangle$ be a preference order on the set of possible means. Barring clear intuitions about effort-incomparable alternatives, I will assume throughout the paper that all preference orders are linear, but not necessarily strict. I will furthermore assume that Q is finite. $g(w)$ is meant to capture the goal of minimizing effort in achieving p. That means that $g(w)$ will contain the proposition p^*_δ and each proposition $q^\uparrow$ for all $q \in Q$ where $q^\uparrow$ is true in a world w if $w \in q_w$ and $q_w \leq^{\mathrm{E}} q$. This yields:

$$w \in \mathrm{Nec}_{\mathrm{Sc}}(p, q) \text{ iff } \forall u \in f(w)\ ((u \in p^*_\delta \wedge \neg \exists v \in f(w)\ (v \prec u)) \rightarrow u \in q) \tag{3.2}$$

It is clear from the way $g(w)$ is defined here that if a world u makes p^*_δ true, then any world v for which $v \prec u$ holds has to make p^*_δ true as well. Furthermore v has to make strictly more propositions from the set $\{q^\uparrow \mid q \in Q\}$ true which just means that if $v \in q_v$ and $u \in q_u$, then $q_v <^{\mathrm{E}} q_u$. Based on the assumption that each $f(w)$ is partitioned by Q, this suggests that we can consider an easier alternative ordering $<^{\mathrm{E}}$ between worlds $u, v \in f(w)$ defined as $v <^{\mathrm{E}} u$ iff $v \in q_v$ and $u \in q_u$ and $q_v <^{\mathrm{E}} q_u$. With this it is easily seen that (3.2) is equivalent to (3.3).

$$w \in \mathrm{Nec}_{\mathrm{Sc}}(p, q) \text{ iff } \forall u \in f(w)\ ((u \in p^*_\delta \wedge \neg \exists v \in f(w)\ (v \in p^*_\delta \wedge v <^{\mathrm{E}} u)) \rightarrow u \in q) \tag{3.3}$$

Although not crucial, it pays to assume a scalar 'at least'-reading of TNSs in TSSs, because this way fewer amendments to the theory of *only* by means of which I want to compute the meaning of TSSs in the next section have to be made. As a suggestive example of what a scalar 'at least'-reading is and as evidence that such readings can be justified for TNSs also outside of TSSs, consider again the German bread scenario with alternatives LS $<^{\mathrm{E}}$ HS $<^{\mathrm{E}}$ US. What (12) now seems to be saying is that there is no German bread at Leidsestraat, for sure, and that the addressee has to go to Haarlemmerstraat *at least*.

(12) In order to get German bread, you have to go to HS, if not even to US.

In order to model the scalar 'at least'-reading, let $q^{\downarrow}$ be a proposition that says that q or more is the case: $w \in q^{\downarrow}$ iff $w \in q_w$ and $q_w >^{\mathrm{E}} q$ or $q_w = q$ for some $q_w \in Q$. Then let $\mathrm{Nec'}_{\mathrm{Sc}}(p,q)$ be the proposition expressed by a TNS under its scalar 'at least'-reading.

$$w \in \mathrm{Nec'}_{\mathrm{Sc}}(p,q) \text{ iff } \forall u \in f(w) \; ((u \in p^*_\delta \wedge \neg\exists v \in f(w) \; (v \in p^*_\delta \wedge v <^{\mathrm{E}} u)) \rightarrow u \in q^{\downarrow}) \quad (3.4)$$

Given a set Q of alternatives, define $\mathrm{Alt}(q) = Q \setminus \{q\}$ for each $q \in Q$. If we further define what it means for a $q \in Q$ to enable p in a world w: $w \in \mathrm{Enable}(p,q)$ iff there is a $w' \in f(w)$ such that $w' \in q$ and $w' \in p^*_\delta$, then it can be proved[1] that (3.4) has a much more intelligible equivalent in (3.5) which I will be using hereafter.

$$w \in \mathrm{Nec'}_{\mathrm{Sc}}(p,q) \text{ iff } \forall q' \in \mathit{Alt}(q) \; (q' \leq^{\mathrm{E}} q \rightarrow w \notin \mathrm{Enable}(p,q')) \quad (3.5)$$

4 Teleological Sufficiency

In the beginning we saw that an analysis of a TSS into semantic component (4.1) and pragmatic component (4.2) was subject to the prejacent problem: a TSS can be true and felicitous even if there are more ways of achieving p than just q. Weakening the pragmatic component came at the price of loosing q's sufficiency for p.

$$\{w \in W \mid \forall q' \in \mathrm{Alt}(q) \; w \notin \mathrm{Nec}(p,q')\} \quad (4.1)$$
$$\mathrm{Nec}(p,q) \quad (4.2)$$

To overcome this problem, I suggest similarly to Krasikova and Zhechev that *only* in teleological sufficiency statements is scalar. Instead of excluding all of the alternatives we only exclude more relevant alternatives. What is more relevant in turn is based on an underlying effort or preference ordering of the considered alternatives. The presence of scalar *only* hands down scalarity to the underlying notion of teleological necessity and justifies an 'at least'-reading. Taken together, I suggest that a TSS comprises (4.3) as its semantic and (4.4) as its pragmatic component.

$$\left\{w \in W \mid \forall q' \in \mathrm{Alt}(q) \; (q <^{\mathrm{E}} q' \rightarrow w \notin \mathrm{Nec'}_{\mathrm{Sc}}(p,q'))\right\} \quad (4.3)$$
$$\mathrm{Nec'}_{\mathrm{Sc}}(p,q) \quad (4.4)$$

I will show presently how the analysis in (4.3) and (4.4) can be derived from a recent independent account of the meaning of *only*. I tend to believe, however, that nothing

[1] Let $w \in \mathrm{Nec'}_{\mathrm{Sc}}(p,q)$ and assume that (3.4) is true but (3.5) is false. Hence there is a $q' \in \mathrm{Alt}(q)$ with $q' \leq^{\mathrm{E}} q$ and $w \in \mathrm{Enable}(p,q')$. As Q is finite, let q' be $\leq^{\mathrm{E}}$-least with these properties. From $w \in \mathrm{Enable}(p,q')$ we know that there is a $u \in f(w)$ with $u \in q'$ and $u \in p^*_\delta$. Since q' is least, we can conclude from (3.4) that $u \in q^{\downarrow}$ which contradicts $u \in p'$, as $q' \neq q$ and $q' \leq^{\mathrm{E}} q$.
Now let $w \in \mathrm{Nec'}_{\mathrm{Sc}}(p,q)$ and assume that (3.5) is true but (3.4) is false. Then there is a world $u \in f(w)$ such that $u \in p^*_\delta$, there is no $v \in f(w)$ with $v \in p^*_\delta$ and $v <^{\mathrm{E}} u$, but $u \notin q^{\downarrow}$. If $u \notin q^{\downarrow}$, then $u \in q_u$ with $q_u \in \mathrm{Alt}(q)$ and $q_u \leq^{\mathrm{E}} q$. From (3.5) we then derive that $w \notin \mathrm{Enable}(p,q_u)$. But this means that $u \notin p^*_\delta$, as u is the only world in $f(w)$ which makes q_u true. □

hinges crucially on the precise theory of *only* that is used to calculate the meaning of a TSS as in (4.3) and (4.4), as long as it can handle scalar readings. It is therefore in order to elaborate informally first how this analysis overcomes the problems that we want it to. In particular, we want to see that the prejacent problem of von Fintel and Iatridou is avoided and that our intuitions about sufficiency are met.

If we apply (4.3) and (4.4) to our main example (1), we would like to see what the predictions are in case there are less, equally and more preferred alternatives to going to Haarlemmerstraat. So assume that $Q = \{\text{LS}, \text{NDS}, \text{HS}, \text{US}\}$, where NDS is short for Nieuwe Doelenstraat and preferences are: LS $<^{\text{E}}$ NDS $=^{\text{E}}$ HS $<^{\text{E}}$ US. With this:

> From (4.3) we get that $\neg\text{Nec}'_{\text{Sc}}(\text{GB}, \text{US})$ which means that there is some $q \in \text{Alt}(\text{US})$ with $q \leq^{\text{E}} \text{US}$ such that $\text{Enable}(\text{GB}, q)$ is true. (4.4) yields that $\text{Nec}'_{\text{Sc}}(\text{GB}, \text{HS})$, so that all $q \in \text{Alt}(\text{HS})$ with $q \leq^{\text{E}} \text{HS}$ do not enable GB. Together, $\text{Enable}(\text{GB}, \text{HS})$ must be true.

Notice that the prejacent problem does not arise. Given the analysis in (4.3) and (4.4), (1) may be true and felicitous, even if there are alternative successful means of getting German bread, as long as these are not preferred to going to Haarlemmerstraat. Also, our intuitions about sufficiency are met: going to Haarlemmerstraat turned out to be a means of getting German bread. Moreover, it might be said that (4.3) alone vindicates our intuitions about sufficiency. Von Fintel and Iatridou (2005a) ascribe to Beck and Rullmann (1999) the observation that "q being sufficient for p" has a natural paraphrase in "for p, it's not necessary to do more than q". The very same intuition most certainly also motivated Krasikova and Zhechev to relate sufficiency and necessity of probability degrees as in (2.9).

The question remains, whether the meaning intuitions in (4.3) and (4.4) can be accounted for with a standard theory of *only* in a straight-forward manner. In what follows I will shortly show that van Rooij and Schulz's (2006a) recent background-alternatives approach to the meaning of *only* does the trick nearly effortlessly. Given a sentence "Only $B(F)$", with B a background predicate and F the focus applying to it, the basic idea of this approach is to assimilate the workings of *only* to exhaustification and to say that the meaning of "Only $B(F)$" is the meaning of $B(F)$ interpreted in worlds that are minimal with respect to the extension of the background predicate. A world v is more minimal with respect to background B than world w, $v <_B w$, if v is exactly like w, except that $B[v] \subset B[w]$, i.e. the extension of the background predicate in v is included in the extension of the background predicate in w. With this, van Rooij and Schulz compute the overall meaning impact of a sentence "Only $B(F)$" as (4.5) and identify (4.6) as its semantic component.

$$\text{ONLY}(F, B) = \{w \in W \mid w \in B(F) \wedge \neg\exists v \in W \; (v \in B(F) \wedge v <_B w)\} \tag{4.5}$$

$$\textit{only}(F, B) = \{v \in W \mid \exists w \in \text{ONLY}(F, B) \; v \leq_B w)\} \tag{4.6}$$

For the calculation of our example (1) once again assume that $Q = \{\text{LS}, \text{NDS}, \text{HS}, \text{US}\}$ and that LS $<^{\text{E}}$ NDS $=^{\text{E}}$ HS $<^{\text{E}}$ US. We are interested in the case where the background predicate B is $\text{Nec}'_{\text{Sc}}(\text{GB}, \cdot)$ and where the extension of the background predicate is $B[w] = \{q \in Q \mid w \in B(q)\}$. Clearly, the relevant possibilities to be considered are the sixteen possible distributions of truth-values of $\text{Enable}(\text{GB}, q)$ for $q \in Q$:

	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}	w_{11}	w_{12}	w_{13}	w_{14}	w_{15}	w_{16}
LS	√	√	√	√	√	√	√	√	–	–	–	–	–	–	–	–
NDS	√	√	√	√	–	–	–	–	√	√	√	√	–	–	–	–
HS	√	√	–	–	√	√	–	–	√	√	–	–	√	√	–	–
US	√	–	√	–	√	–	√	–	√	–	√	–	√	–	√	–

Unfortunately, if we rely on the pure extensional ordering $<_B$ defined above we do not make the right predictions. In particular, with $<_B$ we get as the semantic meaning of (1) that *only*(HS, B) $= \{w_1, \ldots, w_{10}, w_{13}, w_{14}\}$. But for (4.3) to be vindicated, we want w_{11} and w_{12} to be in *only*(HS, B) as well. The reason why w_{11} and w_{12} are not in *only*(HS, B) under the ordering $<_B$ is that worlds w_{11} and w_{12} are not comparable with worlds w_{13} and w_{14}, in turn because the propositions $\text{Nec}'_{\text{Sc}}(\text{GB}, \text{NDS})$ and $\text{Nec}'_{\text{Sc}}(\text{GB}, \text{HS})$ do not entail one another.

Fortunately, the problem already has an established solution. To account for context-sensitivity of exhaustification, as needed for scalar reasoning, domain restriction and answers to mention-some questions, van Rooij and Schulz (2006b) suggest to consider not a pure entailment-based, but a relevance-based ordering on worlds $<^{\text{r}}_B$. The very same idea, of course, then applies to their theory of *only*. In our present example, a non-strict linear order on Q gave us, so conceived, a mention-some case in the middle of a scale: options NDS and HS are equally preferred and therefore $\text{Nec}'_{\text{Sc}}(\text{GB}, \text{NDS})$ and $\text{Nec}'_{\text{Sc}}(\text{GB}, \text{HS})$ should be equally good propositions for any natural measure of relevance. Consider for instance the addressee's decision problem where to go to get German bread with possible actions Q. Prior to inquiry assume that all possibilities are equiprobable. Van Rooij (2004) suggests to measure the relevance of a proposition P as the change in utility value, i.e. the expected utility of the best action, that learning P brings about. With this the relevance order $<^{\text{r}}$ on propositions is straight-forward:[2] $\text{Nec}'_{\text{Sc}}(\text{GB}, \text{LS}) <^{\text{r}} \text{Nec}'_{\text{Sc}}(\text{GB}, \text{NDS}) =^{\text{r}} \text{Nec}'_{\text{Sc}}(\text{GB}, \text{HS}) <^{\text{r}} \text{Nec}'_{\text{Sc}}(\text{GB}, \text{US})$. Based on $<^{\text{r}}$, define a relevance order on worlds $<^{\text{r}}_B$ as usual:

$$v <^{\text{r}}_B w \text{ iff } \{u \in W \mid B[v] \subseteq B(u)\} <^{r} \{u \in W \mid B[w] \subseteq B(u)\} \tag{4.7}$$

This yields: $w_1 =^{\text{r}}_B \ldots =^{\text{r}}_B w_{10} <^{\text{r}}_B w_{11} =^{\text{r}}_B \ldots =^{\text{r}}_B w_{14} <^{\text{r}}_B w_{15} =^{\text{r}}_B w_{16}$ and if we now use $<^{\text{r}}_B$ instead of $<_B$ in the calculation of (4.5) and (4.6) we get: ONLY(HS, B) $= \{w_{13}, w_{14}\}$ and *only*(HS, B) $= \{w_1, \ldots, w_{14}\}$. This is the correct prediction. Proposition $\{w_1, \ldots, w_{14}\}$ is identified as the semantic meaning of (1) and this corresponds to (4.3). The overall meaning of (1) is predicted to be $\{w_{13}, w_{14}\} = \{w_1, \ldots, w_{14}\} \cap \text{Nec}'_{\text{Sc}}(\text{GB}, \text{HS})$ as desired.

5 Conclusion

The main aim of this paper has been to substantiate the idea that a standard account of the meaning contribution of *only* to TNSs is all that it takes to explain our intuitions

[2] It is here that the assumption of an 'at least'-reading pays off. Had I not assumed an 'at least'-reading, I would have had to invest more effort and ink into the justification of this relevance ordering.

about TSSs. The present proposal indeed did not suffer from the prejacent problem, which previous analyses were chiefly concerned with, and moreover managed to provide an adequate analysis of sufficiency as expressed in TSSs.

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