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Restriction in Doubly-Modal Disjunctions*

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Abstract Within a disjunction $\ulcorner\phi$ or $\psi\urcorner$, the right disjunct ψ is typically evaluated on the supposition of $\neg\phi$. This observation is central to recent dynamic and information-sensitive analyses of disjunction. However, in *doubly-modal disjunctions* (DMDs) – expressions of the form $\ulcorner\triangle_1\phi$ or $\triangle_2\psi\urcorner$ where $\triangle_1, \triangle_2 \in \{\Diamond, \Box\}$, the second disjunct is often (though not always) interpreted relative to the negation of the left modal's *prejacent*, i.e., $\neg\phi$, instead of $\neg\triangle_1\phi$. In this paper, we critically evaluate two extant accounts of prejacent restriction in DMDs due to Klinedinst & Rothschild (2012) and Meyer (2015), arguing that neither account is predictive. Drawing on Singh's (2007; 2008) approach to the proviso problem, we then argue that prejacent restriction in DMDs arises from speakers locally updating with the negation of a formal alternative to the left disjunct. The alternatives available for update are, we argue, constrained both by structural similarity and relevance.

Keywords: disjunction; formal alternatives; accommodation; QUD

1 Introduction

As Karttunen (1974) observed, the existence presupposition of the right disjunct in (1) is filtered by the negation of its left disjunct.

(1) Either France doesn't have a king, or the king is in exile.

Many dynamic theories capture these filtering facts by giving disjunction an entry where the left disjunct is evaluated in a "local context," consisting of the global context updated with the negation of the right disjunct:

(2) $c[\phi \text{ or } \psi] = c[\phi] \cup c[\neg\phi][\psi]$

More recently, Klinedinst & Rothschild (2012) (K&R) have proposed a static implementation of this semantics where a disjunction $\ulcorner\phi$ or $\psi\urcorner$ is true relative to a world w and information state s if and only if the left disjunct ϕ is true relative to w and

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s, or the right disjunct ψ is true relative to w and the restricted information state $s[\neg\phi] = s \cap [\![\neg\phi]\!]$.[1]

(3) $[\![\phi \text{ or } \psi]\!]^{w,s} = 1 \Leftrightarrow [\![\phi]\!]^{w,s} = 1 \vee [\![\psi]\!]^{w,s[\neg\phi]} = 1$

In addition to capturing facts about filtering, this dynamic entry for disjunction also correctly predicts some patterns of domain restriction exhibited by modals embedded in disjunctions. While Disjunctive Syllogism (DS) is generally a good inference pattern for non-modal sentences, it fails in (4).[2] If the domain of the modal in the right disjunct is restricted to worlds where the left disjunct is false, this failure is easily explained: the second premise with an unrestricted domain doesn't ensure the falsity of the right disjunct in the first premise, which has a restricted domain.

(4) John is away at a conference, or he must be on campus. $p \vee \Box q$
John might not be on campus. $\neg\Box q$
$\not\Rightarrow$ John is away at a conference. p

Following Yalcin (2007), K&R assume that epistemic modals have a domain semantics, meaning that they quantify over the information state s:[3]

(5) $[\![\text{must } \phi]\!]^{w,s} = 1 \Leftrightarrow \forall w' \in s : [\![\phi]\!]^{w',s} = 1$

Combining these two assumptions, we predict that, in a sentence $\ulcorner\phi$ or must $\psi\urcorner$, the modal quantifies over an information state restricted to the $\neg\phi$-worlds.

(6) $[\![\phi \text{ or must } \psi]\!]^{w,s} = 1 \Leftrightarrow [\![\phi]\!]^{w,s} = 1 \vee \forall w' \in s[\neg\phi] : [\![\psi]\!]^{w',s} = 1$

Given this entry, it's easy to see that the instance of DS in (4) fails.[4] Moreover, since K&R assume that non-modal sentences are not sensitive to the information state parameter in the index of evaluation, DS remains valid for non-modal disjunctions.

1.1 The prejacent problem

Despite these advantages, K&R's information-sensitive semantics (3) and its dynamic predecessor (2) make incorrect predictions about the meaning of *doubly-modal*

1 A similar approach is the bounded semantics proposed by Mandelkern (2019, 2024). Mandelkern's theory closely parallels K&R's but instead assumes classical semantics for modals with definedness conditions concerning restriction from the local context.

2 DS is the inference from $\{\phi \vee \psi, \neg\psi\}$ to ϕ. This observation is discussed by both Klinedinst & Rothschild (2012) and Dorr & Hawthorne (2013). Plausibly, it is valid for non-modal sentences and licenses *or-to-if* inference to *if* $\neg\psi$ *then* ϕ.

3 As Yalcin (2007) notes, there are several ways to model the update effect of epistemic modals in domain semantics. However, if we assume that asserting $\Diamond\phi$ simply checks whether s is compatible with ϕ, returning s if it is, and the absurd context otherwise, domain semantics can be thought of as a static version of update semantics.

4 Likewise, we can obtain the same failure of DS by combining (2) with Veltman's (1996) update semantics for epistemic modals.

disjunctions (DMDs). In a DMD, like (7), we intuitively want the *prejacent* of the modal in the left disjunct to restrict the domain of the modal in the right disjunct.[5]

(7) John must have failed his exam, or he would be happy. $\Box\phi$ or WOLL ψ
$\rightsquigarrow$ If John passed his exam, he would be happy. $\neg\phi \to$ WOLL ψ
$\not\rightsquigarrow$ If John might have passed his exam, he would be happy. $\Diamond\neg\phi \to$ WOLL ψ

However, given the entry in (3), K&R's semantics predicts that (7) should have the following truth-conditions:

(8) $[\![\Box\phi \text{ or WOLL } \psi]\!]^{w,s} = 1 \Leftrightarrow [\![\Box\phi]\!]^{w,s} = 1 \vee [\![\text{WOLL } \psi]\!]^{w,s[\Diamond\neg\phi]} = 1$

Given the meaning in (8), we merely have to learn that it's possible John passed to infer that he's happy. This is clearly an absurd prediction. It shows that, in DMDs, the second disjunct sometimes must be evaluated relative to an information state updated with the prejacent of the first disjunct's modal rather than the entire expression – call this the *prejacent problem*.

The prejacent problem, moreover, isn't unique to epistemic modality. The same problem also arises with root modals. For example, given the context in (9), (9a) entails (9b) but does not entail (9c).

(9) **Context:** John has an A in his philosophy class. He has a final paper due at the end of the term. If John doesn't write the final paper, he will get a C.

a. John has to write a paper, or he will get a C.[6]

b. $\rightsquigarrow$ If John doesn't write a paper, he will get a C.

c. $\not\rightsquigarrow$ If John doesn't have to write a paper, he will get a C.

Given the context, (9c) is clearly false – if writing the paper was not required, then John would receive his current grade, an A. If (9c) were the correct paraphrase of the right disjunct, we would expect the whole disjunction to be infelicitous. As K&R note, there's a striking similarity between root DMDs and anankastic conditionals (2012: fn. 30). DMDs with root modals pose a compositional problem that mirrors the one posed by anankastic conditionals (Sæbø 2001; von Fintel & Iatridou 2005).

(10) a. If you want to go to Harlem, you have to take the A train.

b. $\approx$ To go to Harlem, you have to take the A train.

The most salient reading of (10a) is one where the consequent is restricted by the *complement* of the attitude verb in the antecedent, as in (10b), rather than the entire attitude verb. Indeed, many root DMDs resemble anankastic disjunctions.

5 Following Abusch (1985, 1997), we assume *will* and *would* share a common modal morpheme called WOLL which combines with tense to give the meanings of *will* and *would*.

6 Some of the speakers we've consulted prefer *would* over *will* in this disjunction, but the restriction on the modal is the same in either case.

Moreover, disjunctions of other intensional operators generate problems anologous to the prejacent problem. McHugh (2024) observes that the same phenomenon occurs in disjunctions of conditionals. For example, in (11a), the conditional in the right disjunct is restricted by the negation of the *antecedent* of the conditional in the left disjunct, while in (11b) the conditional in the right disjunct is restricted by the negation of the *consequent* of the conditional in the left disjunct.

(11) a. If there's no bathroom in this house, I'll go home, or if it's in a funny place, I'll ask the host for directions.

b. If Alice comes, Charlie will come, or if Alice comes, Dan will come.

However, given K&R's analysis of disjunction, we expect that, in (11a) and (11b), the right disjunct is evaluated relative to an information state updated with the negation of the entire conditional in the left disjunct as in (12).

(12) $[\![(\phi > \psi) \text{ or } (\phi > \chi)]\!]^{w,s} = 1 \Leftrightarrow [\![(\phi > \psi)]\!]^{w,s} = 1 \vee [\![(\phi > \chi)]\!]^{w,s[\neg(\phi > \psi)]} = 1$

Given the fact that indicative conditionals are scopeless with respect to negation, the entry in (12) is equivalent to the entry in (13).

Scopelessness. $\neg(\phi > \psi) \Leftrightarrow (\phi > \neg\psi)$

(13) $[\![(\phi > \psi) \text{ or } (\phi > \chi)]\!]^{w,s} = 1 \Leftrightarrow [\![(\phi > \psi)]\!]^{w,s} = 1 \vee [\![(\phi > \chi)]\!]^{w,s[\phi > \neg\psi]} = 1$

Given Scopelessness, K&R's semantics straightforwardly derives the correct meaning of (11b) – the right disjunct of (11b) is predicted to be true just in case Dan comes to the party given that Alice comes and Charlie does not. However, examples like (11a) prove far more problematic for K&R's semantics. Given Scopelessness, the right disjunct is predicted to be true just in case I won't go home if there's no bathroom, which is, again, a clearly absurd prediction.

1.2 Overview

We are not the first to notice the problem posed by prejacent restriction in DMDs. In §2, we discuss two extant approaches to the problem due to Klinedinst & Rothschild (2012) and Meyer (2015). While K&R's and Meyer's implementations have different empirical drawbacks, they share a common problem: neither theory is predictive. Neither theory tells us *when* restriction by the prejacent arises. In §3, drawing on Singh's (2007; 2008) approach to the proviso problem, we argue that prejacent restriction in DMDs arises from updating the local context with the negation of a proposition structurally-derived from the left disjunct. Following Singh, we argue that the formal alternatives available for local context update in DMDs are constrained both by structural similarity and relevance.

Finally, we should flag at the outset that DMDs typically license conjunctive strengthening. As Meyer (2015) observes, $\ulcorner\Box\phi$ or WOLL $\psi\urcorner$ is usually strengthened to $\ulcorner\Box\phi$ and if $\neg\phi$, WOLL $\psi\urcorner$ as in (14).

(14) John must have failed his exam, or he would be happy.
$\rightsquigarrow$ John must have failed his exam, and if he hadn't, he would be happy.

Indeed, in our presentation of the data, we often take the conjunctive readings of DMDs for granted to probe intuitions about domain restrictions. Like Meyer, we view the derivation of the conjunctive reading and the conditional interpretation of the right disjunct as separable issues. While we won't attempt to derive the conjunctive reading in this paper, our proposal is consistent with a derivation based on scalar strengthening similar to the one proposed by Meyer (2015).

2 Previous accounts

There are two extant proposals about how to accommodate the prejacent restriction in DMDs – one due to Klinedinst & Rothschild (2012), the other due to Meyer (2015). In this section, we highlight some shortcomings of both proposals.

2.1 Klinedinst & Rothschild (2012)

K&R briefly acknowledge the prejacent problem. As a response, they propose that the restriction on the right disjunct can optionally come from a *subclause* of the first disjunct. This allows ϕ to restrict the right disjunct even when the left disjunct is $\Box\phi$. However, there are two problems with this simple fix.

Problem #1: too few options for restriction. First, as Cariani (2017) points out, K&R's fix doesn't generalize to disjunctions with logically complex disjuncts. Given a sentence of the form $\ulcorner(\Diamond\phi$ or $\Diamond\psi)$ or WOLL$\chi\urcorner$, Cariani points out that WOLL is often restricted to the $(\neg\phi\wedge\neg\psi)$-worlds; for example, in (15), *will* is restricted to worlds where Jones isn't eating lunch and isn't teaching.

(15) Jones might be eating lunch, or he might be teaching, or he'll be in his office.
$\rightsquigarrow$ If Jones isn't eating lunch and isn't teaching, he'll be in his office.

However, $\ulcorner\phi$ or $\psi\urcorner$ is not a sub-clause of $\ulcorner\Diamond\phi$ or $\Diamond\psi\urcorner$; so, K&R's simple fix does not predict that the most natural reading of (15) should even be available.

Problem #2: not predictive. Second, K&R offer no principled way for determining when to restrict by a subclause rather than the full clause (as they themselves concede.) This is a problem because, in most contexts, only one of the two restrictions is available. For example, in K&R's example (16), (16b) is seemingly the only possible interpretation the disjunction can receive.

(16) John must pay alimony, or he will be arrested.

a. $\not\rightsquigarrow$ If John isn't required to pay alimony, he will be arrested.

b. $\rightsquigarrow$ If John doesn't pay alimony, he will be arrested.

An example like (16) might be explained by appeal to world knowledge – given our knowledge of laws, we know (16a) is very unlikely to be true, whereas (16b) is very likely to be true. However, most speakers find it's impossible to even access the reading in (16a), suggesting that K&R cannot explain the obligatory nature of prejacent restriction in (16) via post-semantic pragmatic reasoning.

2.2 Meyer (2015)

Meyer (2015) proposes that DMDs always contain a subtractive pro-form *else* or its covert counterpart pro_{else}:[7]

(17) John must have failed his exam, or **else** he would be happy.

Meyer's key idea is that, in sentences like (17), *else* functions as a propositional anaphor, which subtracts the worlds where its antecedent proposition is true from the set of accessible worlds $R(w)$ for the modal.

(18) $[\![R \text{ else}_k]\!]^{g,w} = R(w) - g(k)$

This set of worlds $R(w) - g(k)$ then serves as WOLL's domain, leading to the conditional interpretation of (17). To avoid the prejacent problem, Meyer proposes *else* and pro_{else}'s antecedent can be any "salient tree," where a salient tree is defined similarly to the formal alternatives for implicature described by Katzir (2007).

(19) SALIENT TREES. If ϕ can be derived from a given constituent ψ by deletion or lexical replacement of terminal nodes, then ϕ is salient.

If we combine these pieces, Meyer's account predicts that, when ϕ is salient, $\triangle_2$ is restricted to the accessible $\neg\phi$-worlds in $\ulcorner\triangle_1\phi$ or $\triangle_2\psi\urcorner$ where $\triangle_1.\triangle_2 \in \{\Diamond, \Box\}$.

In some respects, Meyer's account improves on K&R's suggestion. Given her syntactic algorithm, Meyer avoids our first critique of K&R; returning to Cariani's example, $\ulcorner\phi$ or $\psi\urcorner$ can be derived from $\ulcorner\Diamond\phi$ or $\Diamond\psi\urcorner$ by deletion. However, our second objection seems to remain. Meyer's account isn't predictive either. In many contexts, restriction by a salient tree isn't *an* option – it's the *only* option. However, Meyer's proposal also face new problems unique to her covert-*else* analysis.

7 In the nominal domain, its standard common to treat *else* as a subtractive pro-form to capture how it composes with quantificational DPs (Culicover & Jackendoff 1995).

Problem #1: too many options for restriction. Whereas K&R's theory *undergenerates* possible readings of DMDs with logically-complex disjuncts, Meyer's theory *overgenerates* possible readings. Let's focus on a relatively simple example: $\ulcorner \Diamond\phi$ or $\textsc{woll}\chi\urcorner$. Given Meyer's Katzir-inspired algorithm, we predict that WOLL in the aforementioned sentence can be restricted by any of the following "salient trees": $\Box\phi$, $\Diamond\phi$. and ϕ. However, restriction by $\Box\phi$ appears to be unattested; for example, while we can make (20a) and (20b) salient by modulating the QUD, it seems impossible for (20) to ever have the meaning in (20c) (even if the QUD concerns whether taking semantics is a requirement.)

(20) Either John may take semantics, or he'll have to take logic.

a. $\rightsquigarrow$ If John doesn't take semantics, he'll have to take logic.

b. $\rightsquigarrow$ If John isn't permitted to take semantics, he'll have to take logic.

c. $\not\rightsquigarrow$ If John isn't required to take semantics, he'll have to take logic.

To avoid overgeneration of the kind seen in (20), Meyer could posit that, whereas the alternatives for scalar implicature are those obtainable by deletion and lexical replacement of terminal nodes, the alternatives relevant for determining restriction in DMDs are only those obtainable by deletion of terminal nodes:[8]

(21) SALIENT SIMPLIFICATIONS. If ϕ can be derived from a given constituent ψ by the deletion of terminal nodes, ϕ is salient.

If we do not consider alternatives derivable by lexical replacement, then $\Box\phi$ will never be a salient tree for $\Diamond\phi$. Ignoring the fact that this response lacks any independent motivation, the deletion alternatives alone still leave us with too many unattested restrictions. Let's return to Cariani's example: $\ulcorner(\Diamond\phi$ or $\Diamond\psi)$ or $\textsc{woll}\chi\urcorner$. This disjunction's left disjunct has seven simplification alternatives (excluding itself):

$$\Diamond\phi \vee \psi, \phi \vee \Diamond\psi, \phi \vee \psi, \Diamond\phi, \Diamond\psi, \phi, \psi$$

However, many of these simplifications can seemingly never restrict the right disjunct. For example, (22) never licenses inferences to (22a) or (22b). In every context, these inferences are too strong.

(22) Jones might be eating lunch, or he might be teaching, or he'll be in his office.

a. $\not\rightsquigarrow$ If Jones isn't eating lunch, he'll be in his office.

b. $\not\rightsquigarrow$ If Jones isn't teaching, he'll be in his office.

8 Sauerland (2004) and Katzir (2007) both highlight several reasons why the alternatives for scalar implicature must be those obtainable both by deletion and lexical replacement.

Moreover, this can not explained by the fact that a disjunction is weaker than its disjuncts, because a conjunctive left disjunct gives rise to the same problem. While each conjunct is weaker than the conjunction, we can't restrict the right-embedded modal by the individual conjuncts.

In sum, while the idea that DMDs are sensitive to formal alternatives is plausible and allows Meyer to avoid Cariani's criticism of K&R's proposal, we need some mechanism to rule out the many alternatives that threaten to license unattested restrictions.[9]

Problem #2: symmetric restriction. Meyer's proposal hardwires asymmetry into the meaning of DMDs. However, there's good reason to think that symmetric restriction is also possible – for example, (23a) gives rise to symmetric restriction.

(23) **Context:** Mary is taking a grad semantics seminar where she has to write one long research paper or two short squibs.

a. Mary has to write a research paper, or she has to write two squibs.

b. $\rightsquigarrow$ If Mary doesn't write a research paper, she has to write two squibs.

c. $\rightsquigarrow$ If Mary doesn't write two squibs, she has to write a research paper.

However, since *else* is only grammatical in a right disjunct, it's unclear how Meyer's theory can accommodate cases like (23a). In contrast, we can easily amend K&R's semantics to make it symmetric:

(24) $[\![\phi \text{ or } \psi]\!]^{w,s} = 1 \Leftrightarrow [\![\phi]\!]^{w,s[\neg\psi]} = 1 \vee [\![\psi]\!]^{w,s[\neg\phi]} = 1$

Examples, like (23a), still pose a problem for K&R because we want symmetric restriction by the prejacents – not symmetric restriction by modals.

2.3 Taking stock

In this section, we discussed two extant proposals for capturing prejacent restriction in DMDs. As we saw, both theories fall short of fully explaining the data. In particular, K&R's approach undergenerates possible readings of DMDs, while Meyer's approach overgenerates possible readings. We also argued that, unlike K&R's semantics, Meyer's covert *else* analysis cannot be straightforwardly extended to cases of symmetric restriction. However, these accounts both share a major limitation: they're not predictive. Neither account tells us when the right disjunct should be restricted by a part of the left disjunct rather than the entire left disjunct.

9 We could employ "pruning" of the kind often posited for the formal alternatives relevant to scalar implicature and which we'll employ later (Fox & Katzir 2011; Crnič, Chemla & Fox 2015). However, since pruning is attributed to contextual factors, we would expect that, in some contexts, (22) would entail (22a) and (22b); yet, we don't find such contexts.

3 Local context update is alternative-sensitive

According to the satisfaction theory of presupposition, the use of a presupposition trigger is felicitous only if its local context entails the presupposition. For example, in a disjunction, the satisfaction theory predicts that a presupposition trigger in the right disjunct must be entailed by the global context set updated with the negation of the left disjunct. However, the satisfaction theory runs into a well-known problem: hearers accommodate presuppositions stronger than those predicted by the satisfaction theory. Geurts (1996, 1998) dubbed this the "proviso problem." Geurts observed that, given the satisfaction theory's treatment of conditionals, the conditional (25a) should presuppose the material conditional in (25c), but speakers typically accommodate the stronger presupposition (25b).

(25) a. If Theo hates sonnets, the his wife hates them too.
b. $\rightsquigarrow$ Theo has a wife.
c. $\rightsquigarrow$ Theo hates sonnets $\supset$ Theo has a wife.

Likewise, given the dynamic entry for disjunction in (2), the satisfaction theory predicts that the disjunction in (26a) should presuppose the material conditional in (26c), but speakers usually accommodate the stronger presupposition (26b).

(26) a. Either Theo doesn't hate sonnets, or he and his wife both hate sonnets.
b. $\rightsquigarrow$ Theo has a wife.
c. $\rightsquigarrow$ Theo hates sonnets $\supset$ Theo has a wife.

The prejacent problem for DMDs is closely related to the proviso problem. For example, the satisfaction theory predicts that (27a) should lead to presupposition failure, because, given an entry for disjunction like (2), (27a) presupposes the material conditional in (27c) rather than the one in (27d).

(27) a. John must not have a daughter, or his daughter would have come.
b. $\not\rightsquigarrow$ John has a daughter.
c. $\not\rightsquigarrow$ John might have a daughter. $\supset$ John has a daughter.
d. $\rightsquigarrow$ John has a daughter. $\supset$ John has a daughter.

In other words, the satisfaction theory predicts that the local context of the right disjunct in (27a) is simply the global context c restricted to the worlds where John might have a daughter. However, this means that the right disjunct's local context will fail to entail the presupposition that John has a daughter, leading to presupposition failure; however, presupposition failure in (27a) is not attested.

In short, the proviso problem concerns which of a set of propositions $\mathscr{H}$ can be *globally* accommodated, i.e., can update the common ground. Geurts's data show that speakers globally accommodate propositions stronger than the presuppositions predicted by the satisfaction theory. In contrast, the prejacent problem concerns which of a set of propositions $\mathscr{H}$ can update the *local* context in a disjunction. The data we've discussed show that, in disjunctions, the local context is often updated by propositions stronger than the update predicted by the satisfaction theory. More concretely, we can tweak K&R's view along the following lines: instead of evaluating the right disjunct relative to an information state updated with the left disjunct, a speaker can evaluate the right disjunct with respect to certain alternatives derived from the left disjunct.[10]

(28) $[\![\phi \text{ or } \psi]\!]^{w,s} = 1 \Leftrightarrow [\![\phi]\!]^{w,s} = 1 \vee [\![\psi]\!]^{w,s[\neg p]} = 1$ for some $p \in \mathscr{H}(\phi)$

In this respect, the theory on offer is very similar to the one offered by Klinedinst & Rothschild (2012) and Meyer (2015). However, drawing on Singh (2007, 2008), we will sketch a predictive account of restriction in DMDs. In particular, we posit that what updates the local context of the right disjunct is the negation of the relevant formal alternative closest in structural complexity to the left disjunct. When the original disjunction is a relevant alternative, its negation will be the update; when it's not available, prejacent restriction could arise.

3.1 Singh's solution to the proviso problem

Our solution to the prejacent problem is inspired by Singh's (2007; 2008) solution to the proviso problem based on formal alternatives. Singh posits that hearers entertain the following set of structurally-derived options for accommodation:

(29) For a sentence ϕ, the set of possible accommodations is $\mathscr{H} = \{\pi(\psi) : \psi \in \mathscr{A}(\phi)\}$ where $\mathscr{A}(\phi)$ are the formal alternatives to ϕ and $\pi(\cdot)$ is a function mapping a sentence to its presuppositions.

For example, given a sentence $\ulcorner \phi$ or $\psi_p \urcorner$ where the right disjunct presupposes p, a speaker entertains the following possible accommodations $\{\neg\phi \supset p, p\}$ associated with the formal alternatives $\{\phi \text{ or } \psi_p, \phi, \psi_p\}$. To rule out unattested accommodations, Singh proposes two independently-motivated constraints on $\mathscr{H}$.

First, Singh (2007, 2008) highlights several cases in which (29) is too permissive. For example, when a conditional is embedded under a factive attitude verb like *know*, as in (30a), the conditional presupposition in (30c) is what hearers accommodate, not the unconditional presupposition in (30b).

10 It's easy to slightly tweak (28) to allow for the possibility of symmetric restriction:

(i) $[\![\phi \text{ or } \psi]\!]^{w,s} = [\![\phi]\!]^{w,s[\neg q]} = 1 \vee [\![\psi]\!]^{w,s[\neg p]} = 1$ for $p \in \mathscr{H}(\phi)$ and $q \in \mathscr{H}(\psi)$.

This allows us to accommodate the symmetric cases that proved problematic for Meyer.

(30) a. Mary knows that if John flies to Toronto, he has a sister.
b. $\not\rightsquigarrow$ John has a sister.
c. $\rightsquigarrow$ John flies to Toronto. $\supset$ John has a sister.

However, given the definition in (29), the unconditional presupposition in (30b) should be a proposition that hearers can accommodate; however, accommodation of (30b) is unattested. Singh (2008) solves this by proposing a theory based on "interacting alternatives" where the alternatives available for accommodation are constrained by the scalar alternatives for implicature; roughly, Singh proposes that an implicature blocks repairs inconsistent with that implicature. For example, (30a) generates an ignorance implicature, i.e., that Mary doesn't know whether John has a sister, which blocks accommodation of (30b).

More concretely, Singh proposes that, given a sentence ϕ, the candidate repairs a hearer can accommodate are determined by $\mathscr{H}$, ϕ's possible accommodations, and $\mathscr{N}$, ϕ's possible implicatures.

(31) For a sentence ϕ, its possible implicatures are $\mathscr{N} = \{\neg\psi : \psi \in \mathscr{A}(\phi)\}$

We then take the intersection of all the subsets of $\mathscr{H} \cup \mathscr{N}$ that are maximally consistent with ϕ, what Fox (2007) calls the "innocently excluable" alternatives.

(32) Let $\mathscr{H}^*$ be the intersection of all subsets of $\mathscr{H} \cup \mathscr{N}$ which are maximally consistent with ϕ and its presuppositions $\pi(\phi)$.

The set $\mathscr{H}^*$, the set of accommodations for ϕ which do not conflict with any scalar implicatures of ϕ, corresponds to the actually attested accommodations.

Second, Singh (2008) observes that his account is also sometimes too restrictive. For example, his account predicts that (33a) should only license ignorance inferences, because the unconditional presupposition in (33a) should be impossible to accommodate because the proposition that Mary is cheating on John is included in $\mathscr{H}$ (via the factive presupposition of *know*) while its negation is included in $\mathscr{N}$.[11]

(33) a. If John flies to Toronto, he'll know Mary is cheating on him.
b. $\rightsquigarrow$Mary is cheating on John.
c. $\not\rightsquigarrow$ John flies to Toronto $\supset$ Mary is cheating on John.

However, as Singh observes, relevance appears to modulate the acceptability of accommodating an unconditional presupposition. For example, Singh observes that, in (34), only the ignorance implicature is available – accommodating the unconditional inference is impossible.

(34) A: Where are we?
B: Well, if we're on Rte. 183, I know we're just outside Lockhart.

11 This type of example is due to Soames (1982).

Drawing on work concerning the role of relevance in constraining alternatives for scalar implicature (Katzir 2007; Fox & Katzir 2011), Singh tweaks his account by restricting the formal alternatives to those that are relevant to the Question Under Discussion (QUD) (Roberts 2012).

(35) $\mathscr{A}_R(\phi) = \mathscr{A}(\phi) \cap R$

We will assume that ϕ is relevant only if it is a complete or partial answer to the QUD. Assuming, for simplicity, a partitional semantics for questions (Groenendijk & Stokhof 1984), we can define the set of relevant propositions R_Q as the set of all partial and complete answers to Q:

(36) $R_Q := \{Z \mid \exists X, Y \in Q : X \cup Y = Z \wedge Z \neq W\}$

For example, given a question with three answers like (37a), the relevant propositions R_Q consists of all the answers that eliminate one or two cells of Q.[12]

(37) a. $Q = \{A, B, C\}$
b. $R_Q = \{A, B, C, A \cup B, A \cup C, B \cup C\}$

This allows Singh to solve the problem posed by sentences like (33a) which generate the formal alternatives in (38a). However, when $\psi \notin R_Q$, i.e., the complement of the attitude verb in (33a) is not relevant to the QUD, the symmetry between $K_j\psi$ and $\neg\psi$ is broken, allowing us to include $\pi(K_j\psi) \in \mathscr{H}^*$ as desired.

(38) a. $\mathscr{A} = \{\text{if } \phi,\ K_j\psi, \phi, \neg\phi, K_j\psi, \neg K_j\psi, \psi, \neg\psi\}$
b. $\mathscr{A}_R = \{\text{if } \phi,\ K_j\psi, \phi, \neg\phi, K_j\psi, \neg K_j\psi\}$
c. $\mathscr{H}^* = \{\text{if } \phi,\ K_j\psi, K_j\psi, \neg K_j\psi\}$

Hence, when ψ is irrelevant, Singh's theory predicts that (33a) should permit the accommodation of (33b).

However, there's an over-generation problem that plagues Singh's original proposal; in particular, Singh's original proposal predicts, modulo relevance, that, given a conditional $\ulcorner$if $\neg\phi$, then $\psi_p\urcorner$, a hearer can accommodate $\neg\phi \supset p$, $\phi \supset p$, or p. However, when presented with a conditional $\ulcorner$if $\neg\phi$, then $\psi_p\urcorner$, hearers never accommodate $\phi \supset p$. This problem is related to Romoli's (2013)'s objection to breaking symmetry by structural complexity: Katzir's algorithm predicts that scalar items under negation generate symmetric alternatives, meaning it fails to capture implicatures like (39).

(39) John didn't eat all of the cookies.
$\rightsquigarrow$ John ate some of the cookies.

12 Note: since we're assuming questions are partitional, $A \cup B \cup C = W$ – i.e., it's true in all possible worlds; hence, $A \cup B \cup C \notin R_Q$.

Given Singh's original proposal, a left disjunct containing negation generates symmetric alternatives for accommodation, blocking the possibility of accommodation.

With respect to this problem of symmetry breaking, we find Haslinger & Schmitt's (2025) recent approach promising. It derives scalar alternatives not from "complexity *per se*, but similarity to the prejacent." From their perspective, when faced with a set of symmetric alternatives $\{\neg\exists, \exists\}$, the reason why $\neg\exists$ is an available alternative and contributes to the attested $\exists$-implicature is that the $\neg\exists$ alternative is closer than $\exists$ to the original prejacent (for exh or *only*), $\neg\forall$.

3.2 Proposal

We believe that the updates on the local context in DMDs are derived from formal alternatives to the disjuncts constrained by relevance. However, unlike Singh, we take inspiration from the approach of Haslinger & Schmitt (2025) and appeal to the notion of structural similarity.[13]

More concretely, we can capture this idea using a *selection function* $\texttt{sel} : \mathscr{P}(W) \times \mathscr{P}(\mathscr{P}(W)) \to \mathscr{P}(\mathscr{P}(W))$ which takes a proposition and a set of propositions (corresponding to a set of formal alternatives) and outputs a set of propositions:

(40) $\mathscr{H}(\phi) = \{\psi : \psi \in \texttt{sel}(\phi, \mathscr{A}_R(\phi))\}$

Given ϕ and a set $\mathscr{A}_R(\phi)$, the selection function $\texttt{sel}$ outputs the member of the latter (**Inclusion**) closest in structural complexity to ϕ. Intuitively, the closest alternative is the alternative derived from ϕ via the fewest number of deletions and lexical replacements. If the default restriction ϕ is relevant, it will be selected (**Centering**) (Stalnaker 1968), as nothing can be structurally closer to it than itself.[14] If ϕ is not relevant, the structurally closest relevant alternative will be selected.

- **Inclusion:** $\texttt{sel}(\phi, \mathscr{A}_R(\phi)) \in \mathscr{A}_R(\phi)$
- **Centering:** If $\phi \in \mathscr{A}_R(\phi)$, $\texttt{sel}(\phi, \mathscr{A}_R(\phi)) = \phi$.

The use of structural similarity helps avoid an immediate worry about left disjuncts involving negation. Given a disjunction $\ulcorner\neg\phi$ or $\psi\urcorner$, the two alternatives $\neg\phi$ and ϕ

13 The two applications of the notion of structural similarity are for quite different purposes, and the possible connections and differences merit further study. We want to note that we use the notion in order to pick a single proposition for restriction, while they allow multiple propositions to be maximally similar to a prejacent and thus all become part of the available alternatives that the exhaustivity operator to generate implicatures.

14 Strictly speaking, complexity ordering is based on the syntactic objects the propositional alternatives are interpreted from. We assume that the propositions inherit the structural ordering. Thanks to Aron Hirsch for urging us to clarify on this point.

would both be relevant alternatives whose negation we could in principle accommodate. However, $\neg\phi$ will be structurally more similar to $\neg\phi$ than the alternative ϕ, and so $\neg\neg\phi$ becomes the restriction. This just replicates the result from Haslinger & Schmitt (2025) in a different use case. And this is a generally good result. In (41), we intuitively can only restrict the modal with $\neg\neg$**bathroom** $\Leftrightarrow$ **bathroom**.

(41) There is no bathroom in this house, or it must be in a funny place.

As we will see later, the use of selection function helps up make principled predictions about which proposition contributes to the restriction on the right disjunct, when the left disjunct is complex.

Given a DMD $\ulcorner\triangle_1\phi$ or $\triangle_2\psi\urcorner$ where $\triangle_1, \triangle_2 \in \{\Diamond, \Box\}$, $\triangle_2$, the selection function-based derivation of possible update in (40) predicts that restriction by $\neg\phi$ is only licensed when $\triangle_1\phi \notin R$ – i.e., when $\triangle_1\phi$ is irrelevant but ϕ is relevant.[15] We believe that this is a desirable prediction. As we'll show in §3.2.1, like global context update in the proviso problem, the availability of prejacent restriction in DMDs is modulated by relevance. In particular, when only the prejacent is relevant, restriction by the prejacent is preferred, while restriction by the entire modalized claim is preferred when the modalized claim itself is relevant.

3.2.1 Relevance constrains prejacent restriction.

In many contexts, like, say, (16), restriction by the prejacent is obligatory, not optional. However, obligatory prejacent restriction can be explained by the following constraint:

> **Relevance Constraint.** For a disjunction $\ulcorner\phi$ or $\psi\urcorner$ given a QUD Q: restriction by $p \in \mathscr{A}(\phi)$ is allowed only if p is relevant to Q, i.e., p is identical to some union of cells of Q.

In other words, a formal alternative p to the left disjunct can restrict the right disjunct's information state only if p is a partial or complete answer to the QUD.

There's compelling empirical evidence for this generalization. First, it accounts for why epistemic modals in DMDs invariably give rise to prejacent restriction. While questions about an epistemic modal's prejacent are natural, questions concerning the status of epistemic modal claims, though possible, are far less natural – e.g., a corpus study by Hacquard & Wellwood (2012) found that, in matrix questions, epistemic *must* only occurred 34 times, while root *must* occurred 243 times.[16] Sec-

15 This is, again, only true if we assume **Inclusion**.

16 They also show that *might* (523), which typically receives an epistemic interpretation, is far less prevalent in matrix questions than *can* (17,971), which typically receives root interpretations.

ond, the generalization predicts that, in DMDs involving root modals, the availability of prejacent restriction should vary with the QUD.

As we will demonstrate, this prediction seems to be borne out for root DMDs. For example, consider two variations on the following context: John's grades are currently in the A-range, but John's grades will drop to a B+ if he fails to write his final paper for the class. First, consider a context like (42) in which the professor has hinted that she's dropping the paper requirement for everyone. The professor has made her decision, but has yet to announce it. When the QUD concerns whether the requirement described by the left disjunct holds, restriction by the entire modal claim is observed.

(42) a. **QUD:** Is there a paper requirement? $\{\Box write, \overline{\Box write}\}$

b. (Either) John has to write a paper, or he will get an A.

c. $\rightsquigarrow$ If John doesn't have to write a paper, he will get an A.

d. $\not\rightsquigarrow$ If John doesn't write a paper, he will get an A.

Now imagine the exact same context, but instead of the professor contemplating whether to scrap the final paper, John is considering blowing off the final paper to party with his friends. When the QUD concerns whether the prejacent of the modal claim in the left disjunct is true, restriction by the prejacent is observed.

(43) a. **QUD:** Will John write a paper? $\{write, \overline{write}\}$

b. (Either) John has to write a paper, or he will get a B+.

c. $\not\rightsquigarrow$ If John doesn't have to write a paper, he will get a B+.

d. $\rightsquigarrow$ If John doesn't write a paper, he will get a B+.

Hence, we see that, when only the prejacent is conversationally relevant, restriction with the prejacent is obligatory.

3.2.2 Putting everything together

The Relevance Constraint allows us to capture the most salient reading of our original example (7), repeated in (44)

(44) John must have failed his exam, or he would be happy.

If we assume, as seems plausible, that the salient QUD in (44) is the polar question in (45a), then the possible sources for local context update (before negation applies) for the right disjunct $\mathscr{H}$ only contains the prejacent of the modal in the left disjunct.

(45) a. **QUD:** Did John pass? $Q = \{pass, fail\}$

b. $\mathscr{A}(\Box\mathbf{fail}) = \{\Box\mathbf{fail}, \Diamond\mathbf{fail}, \mathbf{fail}\}$

c. $\mathscr{H}(\Box\mathbf{fail}) = \mathscr{A}_{R_Q}(\Box\mathbf{fail}) = \{\mathbf{fail}\}$

Thus, given the Relevance Constraint, we predict that the hearer locally accommodates the **fail**-alternative, yielding the following truth-conditions:

(46) $[\![(44)]\!]^{w,s} = 1 \Leftrightarrow [\![\Box fail]\!]^{w,s} = 1 \vee [\![\text{WOLL } happy]\!]^{w,s[\neg\mathbf{fail}]} = 1$

Conversely, the Relevance Constraint also allows us to capture the most salient reading of (42), repeated as (47). As we suggested, in the context given in (42), the QUD corresponds to the polar question in (48a).

(47) John has to write a paper, or he will get an A.

Given this QUD, we can prune all alternatives except for the $\Box$**write**-alternative.

(48) a. **QUD:** Is there a requirement to write a paper? $Q = \{\Box write, \overline{\Box write}\}$

b. $\mathscr{A}(\Box\mathbf{write}) = \{\Box\mathbf{write}, \Diamond\mathbf{write}, \mathbf{write}\}$

c. $\mathscr{H}(\Box\mathbf{write}) = \mathscr{A}_{R_Q}(\Box\mathbf{write}) = \{\Box\mathbf{write}\}$

Thus, given the Relevance Constraint, we predict that the hearer updates the local context with the $\Box$**write**-alternative, yielding the following truth-conditions:

(49) $[\![(44)]\!]^{w,s} = 1 \Leftrightarrow [\![\Box write]\!]^{w,s} = 1 \vee [\![\text{WOLL } get\ a\ C]\!]^{w,s[\neg\Box\mathbf{write}]} = 1$

In relatively simple examples like these, we do not see the interplay between structural similarity and relevance. However, the interplay between the two is key to deriving the behavior of logically-complex DMDs. For example, let's examine how our account derives the attested reading of a variant of Partee's bathroom sentence in (41), where the left disjunct contains a negation. Imagine that you're in a strange house. You're struggling to find the bathroom; in fact, you're starting to worry that there may be no bathroom, and you utter (41). Since relevance is closed under negation, both $\neg$**bathroom** and **bathroom** would be among the relevant alternatives. However, since the former is just the left disjunct, and so is structurally closest to it than the latter, the former will be the proposition whose negation restricts *must*.

(50) a. **QUD:** Is there a bathroom in this house?[17] $\{bathroom, \overline{bathroom}\}$

b. There is no bathroom in this house, or it must be in a funny place. =(41)

c. $\mathscr{A}_{R_Q}(\neg\mathbf{bathroom}) = \{\neg\mathbf{bathroom}, \mathbf{bathroom}\}$

d. $\mathscr{H}(\neg\mathbf{bathroom}) = \{\neg\mathbf{bathroom}\}$ restriction: $\neg\neg\mathbf{bathroom}$

Next, we can show that we derive the attested restrictions in our running example of a logically-complex disjunction (15), repeated here as (51).

17 Given that the first disjunct leaves open the possibility that there's no bathroom in this house, another candidate question *Where is the bathroom?* seems less appropriate given that it presupposes that there is a bathroom.

(51) Jones might be eating lunch, or he might be teaching, or he'll be in his office.
$\rightsquigarrow$ If Jones isn't eating lunch and isn't teaching, he'll be in his office.

If we assume that, in (51), the QUD filters out alternatives irrelevant to the question of what John is doing right now, we are left with one alternative closest in structural complexity to the left disjunct, the ($\mathbf{lunch} \vee \mathbf{teaching}$)-alternative:

(52) a. **QUD:** What is John doing now? $Q = \{lunch, teaching, office\}$

b. $\mathscr{A}_{R_Q}(\Diamond\mathbf{lunch} \vee \Diamond\mathbf{teaching}) =$
$\{\mathbf{lunch} \wedge \mathbf{teaching}, \mathbf{lunch} \vee \mathbf{teaching}, \mathbf{lunch}, \mathbf{teaching}\}$

c. $\mathscr{H}(\Diamond\mathbf{lunch} \vee \Diamond\mathbf{teaching}) = \{\mathbf{lunch} \vee \mathbf{teaching}\}$

In fact, whenever the left disjunct is a disjunction or conjunction, where each disjunct/conjunct has a relevant alternative, the selected alternative that contributes to the restriction will always retain the disjunctive/conjunctive force. We see this as a welcome result.[18]

Finally, we can show that the symmetric version of our entry (see fn.10) predicts the right restriction for the wide-scope free choice case, where symmetric prejacent restriction arises. Here, we take the QUD to be a *wh*-question about what Mary will do. The simplifications of the left disjunct are in $\mathscr{A}(\Box paper) = \{\Box paper, paper\}$, and only *paper* is relevant. So $\mathscr{A}_{R_Q}(\Box paper) = \{paper\}$. Similarly, $\mathscr{A}_{R_Q}(\Box squibs) = \{squibs\}$. By symmetric restriction, the left disjunct will be restricted by $\neg squibs$, while the right disjunct will be restricted by $\neg paper$.

(53) **Context:** Mary is taking a grad semantics seminar where she has to write one long research paper or two short squibs.

a. **QUD:** What will Mary write for the class? $Q = \{paper, squibs\}$

b. Mary has to write a research paper, or she has to write two squibs.

c. $\mathscr{A}_{R_Q}(\Box\mathbf{paper}) = \{\mathbf{paper}\}$, $\mathscr{A}_{R_Q}(\Box\mathbf{squibs}) = \{\mathbf{squibs}\}$

d. $\mathscr{H}(\Box\mathbf{paper}) = \{\mathbf{paper}\}$, $\mathscr{H}(\Box\mathbf{squibs}) = \{\mathbf{squibs}\}$

3.2.3 Extending the account to disjunctions of conditionals.

As we mentioned in §1 that, McHugh (2024) observes that disjunctions of conditionals give rise to an effect similar to prejacent restriction where the antecedent of the left-embedded conditional restricts the domain of the right-embedded conditional. In disjunctions of conditionals, the possibility of antecedent restriction appears subject to something like the Relevance Constraint. For instance, suppose you're (again) in

18 If one disjunct/conjunct is itself not directly relevant, and has no alternative that's relevant either, then by pragmatic consideration it will be infelicitous regardless of its truth condition.

the context where you are wondering if the house even has a bathroom. In such a context, the disjunction of conditionals in (54b) implies (54c) where the antecedent of the left-embedded conditional restricts the right-embedded conditional.

(54) a. **QUD:** Is there a bathroom in this house? $\{bathroom, \overline{bathroom}\}$

b. If there's no bathroom in this house, I'll go home, or if it's in a funny place, I'll ask the host for directions.

c. If there is a bathroom in this house and it's in a funny place, I'll ask the host for directions.

Since the QUD is about the left-embedded conditional's antecedent, the right-embedded conditional is interpreted as restricted by that *antecedent*. Moreover, our account derives antecedent restriction. For example, given the QUD in (54a), we are left with the alternatives in (55b) after pruning.

(55) a. $\mathscr{A}(\neg\textbf{bathroom} > \textbf{go-home}) =$
$\{\neg\textbf{bathroom} > \textbf{go-home}, \neg\textbf{bathroom}, \textbf{bathroom}, \textbf{go-home}\}$

b. $\mathscr{A}_{R_Q}(\neg\textbf{bathroom} > \textbf{go-home}) = \{\neg\textbf{bathroom}, \textbf{bathroom}\}$

c. $\mathscr{H}(\neg\textbf{bathroom} > \textbf{go-home}) = \{\neg\textbf{bathroom}\}$

Of these, the $\neg$**bathroom**-alternative is closest in structural complexity to the left disjunct in (54b), meaning that it's the only source for local context update. And so its negation $\neg\neg$**bathroom** restricts the right-embedded conditional.

4 Conclusion

This paper started with the observation that prejacent restriction in doubly-modal disjunctions (DMDs) pose a non-trivial compositional problem for extant dynamic and information-sensitive theories of disjunction. In §2, we surveyed two approaches to the problem – one due to Klinedinst & Rothschild (2012) allows any sub-clause of the left disjunct to restrict the right disjunct's information state, the other due to Meyer (2015) posits that any formal alternative to the left disjunct can restrict the right disjunct's information state. While K&R's theory undergenerates possible readings of DMDs, Meyer's theory overgenerates possible readings. Moreover, neither theory is predictive – neither theory tells us why prejacent restriction is sometimes obligatory in DMDs, while other times full disjunct restriction is obligatory. In §3, we proposed a novel solution to the prejacent problem. In particular, we argued that, in DMDs, the local context of the right disjunct is updated with the negation of an alternative derived from the left disjunct. Moreover, this alternative is the relevant formal alternative which is structurally most similar to the left disjunct. .

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