Hierarchical structure and local contexts[1]

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Abstract. We use antecedent-final conditionals to formulate a challenge to parsing-based theories of local contexts, and associated theories of presupposition projection and triviality, like the one given in Schlenker 2009. We show that a theory like Schlenker's predicts that the local context for the antecedent of an antecedent-final conditional will entail the negation of the conditional's consequent. It thus predicts that presuppositions triggered in the antecedent of antecedent-final conditionals will be filtered if the negation of the consequent entails the presupposition. But this is wrong: *John isn't in Paris, if he regrets being in France* intuitively presupposes that John is in France, contrary to this prediction. Likewise, parsing-based approaches to triviality predict that material entailed by the negation of the consequent will be felt to be redundant in the antecedent of the conditional. But this is wrong: *John isn't in Paris, if he's in France and Mary is with him* is intuitively felicitous, contrary to this prediction. Importantly, given that the material in question appears in sentence-final position in antecedent-final conditionals, both incremental (left-to-right) and symmetric versions of parsing-based theories of local contexts make the same problematic predictions here. In Mandelkern and Romoli 2017, we discuss one solution to this problem, given within a broadly parsing-based pragmatic approach. In this paper, we explore an alternate direction: incorporating attention to hierarchical structure into the calculation of local contexts. We sketch several possible implementations and point to some of the possibilities and challenges for a hierarchical approach to local contexts.

Keywords: presupposition projection, conditionals, parsing, linear order, hierarchical order, local contexts, triviality, incrementality.

1. Introduction

Schlenker (2008, 2009), building on previous observations by Soames (1989) and Heim (1990), questions the explanatory power of traditional dynamic approaches to presupposition projection, posing an explanatory challenge for any theory of presupposition projection as follows:

> **Explanatory Challenge for Presupposition Projection**:
> Find an algorithm that predicts how any operator transmits presuppositions once that operator's syntax and classical semantics have been specified.
> (Schlenker 2009)

This challenge has sparked a debate which has led to a variety of new theories, both static

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(Schlenker 2009; George 2008; Fox 2008, 2012; Chemla 2010) and dynamic (Chierchia 2009; Rothschild 2008, 2011).

One aspect of this debate is whether the algorithm for predicting presupposition projection should be based on parsing, a process which takes as input a string of linguistic items, and thus will be sensitive to the linear order of the elements of the sentence in question; or on the compositional calculation of meanings, a process which takes as input a syntactic structure, and thus is sensitive to the hierarchical structure of the sentence. This debate, in turn, bears on the more general question whether presupposition calculation should be thought of as a pragmatic post-compositional phenomenon, in the sense of Chierchia et al. 2012, or as part of compositional semantics, as in more traditional dynamic approaches like that of Heim 1983.

In this paper, we will explore antecedent-final conditionals. We will argue that antecedent-final conditionals with presupposition triggers in the antecedent present a challenge to parsing-based accounts of presupposition projection, as well as to theories of triviality that build on those accounts. We will focus in particular on the predictions of Schlenker (2009), who uses a parsing-based approach to reconstruct the notion of a local context, and then builds theories of presupposition projection and triviality on top of his theory of local contexts in a straightforward way.[2]

To briefly sketch the problem: the parsing-based approaches to presupposition projection which we will consider come in both symmetric and asymmetric versions. Both versions, however, predict that presuppositions triggered in the antecedent of antecedent-final conditionals will be filtered (i.e. will not project) if the negation of the consequent entails the presupposition. But this is the wrong prediction; for instance, (1) presupposes that John is in France, contrary to this prediction.

(1) John isn't in Paris, if he regrets being in France.

Likewise, parsing-based approaches to triviality predict that material entailed by the negation of the consequent of an antecedent-final conditional will be redundant in the antecedent of the conditional. But, again, this is wrong; for instance, (2) is felicitous, contrary to these predictions.

(2) John isn't in Paris, if he's in France and Mary is with him.

In Mandelkern and Romoli 2017, we lay out a solution to this problem which allows us to maintain a parsing-based pragmatic approach with the caveat that, in calculating local contexts, we take into account material presupposed by the surrounding strings; we show that, together with a semantics for the conditional on which the conditional presupposes the antecedent to be compatible with the context set, this approach avoids the present problem. This approach

[2]As we discuss in Mandelkern and Romoli 2017, however, the problems extend to other parsing-based accounts, including those which make use of a trivalent valuation instead of local contexts (e.g. Fox 2008, 2012) as well as pragmatic parsing-based theories like Schlenker 2008.

requires a substantial shift in the formulation of the symmetric algorithm for calculating local contexts, however.

In this paper, we will take these puzzles in a different direction. In particular, we explore whether these puzzles motivate an approach to local contexts which takes account of hierarchical structure, rather than linear order. We will discuss two ways this might go. The first derives local contexts from an algorithm much like Schlenker's, but which is built on hierarchical structures rather than strings. The second builds on more traditional approaches in dynamic semantics, augmenting these approaches with hierarchical constraints. Our discussion will be somewhat inconclusive: we believe that both approaches have merits which make them worth careful exploration, but both also face substantial challenges.

The remainder of the paper is organized as follows. In the rest of this introduction, we introduce Schlenker (2009)'s algorithm for computing local contexts. In Section 2, we lay out the problem for presupposition projection from antecedent-final conditionals, and in Section 3, the problem for triviality. In Section 4, we discuss our first pass at a hierarchical approach to local contexts, building on Schlenker's system. In Section 5, we discuss our second pass at a hierarchical approach, an attempt to incorporate attention to hierarchical structure into traditional dynamic systems. We conclude in Section 6.

1.1. A parsing-based theory of local contexts and presupposition projection

Schlenker (2009) addresses the explanatory challenge for presupposition projection by using a parsing-based algorithm to reconstruct the notion of a local context in a static, bivalent semantics.[3] In this section, we summarize Schlenker's theory of local contexts and presupposition projection; those familiar with the theory should skip to the next section.

The basic intuition motivating Schlenker, which is similar to the intuition motivating trivalent theories of presuppositions (Peters 1979; Beaver and Krahmer 2001; George 2008; Fox 2008, 2012), is that as we evaluate a sentence against some contextual information, we try to minimize our effort by evaluating the sentence only in those worlds of the context that "matter" for the evaluation. Further, we assume (at least initially) that the interpreter evaluates expressions of a sentence proceeding left-to-right. Before evaluating an expression, the interpreter will choose the smallest domain she needs to take into consideration in evaluating such expression. This smallest domain is the local context for the expression.

Thus, for example, as we evaluate a conditional like *If A then* B_p (where B_p is a sentence B which presupposes $[\![\mathsf{P}]\!]$), as we proceed left-to-right, we will evaluate the consequent only in those worlds of the context in which the antecedent is true.[4] This is because we know that in

[3] Schlenker's approach is parsing-based in the sense we gave above: its input is a string, rather than a syntactic structure. We remain neutral on the connection of a theory like his to theories of parsing in general.

[4] We use sans serif capital letters as sentence variables, and italics to set off a linguistic example in running text. We move freely between talking of presuppositions as sentences and as propositions. Where P is a linguistic item, $[\![\mathsf{P}]\!]^c$ is the meaning (intension) of P at context C (a non-empty set of possible worlds); we often omit reference to the context for readability. We use 'C' throughout to refer to the global context, and sometimes use 'C' as a

those worlds in which the antecedent is false, the sentence as a whole is true irrespective of the value of the consequent, and thus we can ignore those worlds (assuming here that *If ... then* expresses the material conditional; we revisit this assumption in Mandelkern and Romoli 2017). But we cannot ignore any worlds where $[\![\mathsf{A}]\!]$ is true, since we must check whether the consequent is true at those worlds to see whether the sentence as a whole is true. This means that the local context for B in *If A then* B_p is $C \cap [\![\mathsf{A}]\!]$.

We can then formulate a theory of presupposition in this framework as follows: we say that a sentence S is assertable in a context C only if, for every expression B_p in S, $[\![\mathsf{P}]\!]$ is entailed by B_p's local context in S. We then say that a sentence presupposes anything that is entailed by every context where it can be asserted. This means that the predicted presupposition of *If A then* B_p is $A \rightarrow P$: in other words, *If A then* B_p is assertable at C only if $A \rightarrow P$ holds at every world in C.[5] This approach correctly predicts that a sentence like (4) presupposes only the tautology that if John used to smoke he used to smoke:

(3) If John used to smoke, he stopped smoking.

But—as Schlenker (2008, 2009) and Chierchia (2009), building on Heim 1990; Soames 1979 and others, discuss—antecedent-final conditionals pose a problem for the asymmetry encoded in this algorithm. (4), like (3), appears to have only a trivial presupposition, but this is not predicted by the incremental left-to-right algorithm, which only considers material to the left of the presupposition trigger.

(4) John stopped smoking, if he used to.

Intuitively, we would like material on the right of the presupposition trigger to count in this case. In response to these data, Schlenker (2009) proposes a symmetric version of his algorithm, which works on the entire sentence, rather than proceeding left-to-right: it considers both material on the left and the right of the expression to be evaluated. The result is that the symmetric local context for B in a conditional with the form B_p*, if A* is $C \cap [\![\mathsf{A}]\!]$; thus we predict that a conditional like (4) has no presupposition, as desired.

Schlenker makes these intuitive ideas precise as follows. First, the incremental, left-to-right version:

corresponding linguistic item whose intension is the global context.

[5]With $\rightarrow$ standing for the material conditional. Notice that for some cases, the predicted conditional presuppositions of conditionals appear too weak. This is the so-called Proviso Problem (Geurts 1996 and much subsequent work; see Schlenker 2011 among others for recent discussion). This problem is orthogonal to the one we discuss here, however. Although the problem we raise for presupposition projection, like the Proviso Problem, stems from a gap between the observed projection and what is predicted, there is a crucial structural difference: in Proviso cases, the gap is between observed presuppositions with the form $[\![\mathsf{P}]\!]$, and predicted presuppositions with the form $[\![\mathsf{A} \rightarrow \mathsf{P}]\!]$. It is possible that a principled story can be told about how we move from the latter to the former (and indeed just such a story has been told in the literature; see Mandelkern 2016 for citations and criticism). By contrast, in the cases we raise here, the gap is between observed presuppositions with the form $[\![\mathsf{P}]\!]$, and a predicted trivial presupposition—i.e. a presupposition of $\top$. It is much harder in this case to see how a strengthening story would help: there is no obvious principled way to get from $\top$ to $[\![\mathsf{P}]\!]$.

Definition 1.1. Local Contexts, Incremental Version:[6]
The *incremental local context* of expression E in syntactic environment $\mathsf{a\_b}$ and global context C is the strongest $[\![\mathsf{Y}]\!]$ s.t. for all sentences D and good finals b', $\mathsf{a}(\mathsf{Y}\wedge\mathsf{D})\mathsf{b}'\leftrightarrow_c\mathsf{aDb}'$.

In addition to this incremental algorithm, Schlenker (2009) also defines a symmetric version, which applies as a dispreferred rescue strategy:

Definition 1.2. Local Contexts, Symmetric Version:[7]
The *symmetric local context* of expression E in syntactic environment $\mathsf{a\_b}$ and global context C is the strongest $[\![\mathsf{Y}]\!]$ s.t. for all sentences D: $\mathbf{a}(\mathsf{Y}\wedge\mathsf{D})\mathbf{b}\leftrightarrow_c\mathbf{a}\mathsf{D}\mathbf{b}$, where **a** and **b** are derived from a and b by removing any presupposition material.

This symmetric algorithm is like the incremental version except for two features. First, it takes into account all material in the sentence, regardless of whether it precedes or follows the expression to be evaluated: this is what makes it symmetric. Second, it ignores presuppositions in the surrounding material. The reason for this second feature is that, as Rothschild (2008) and Beaver (2008) point out, without it, the symmetric algorithm incorrectly predicts that on a symmetric parse, presuppositions can cancel each other out. Thus we would predict e.g. that a sentence like (5), with the form A_p *and* B_p, should not presuppose p.

(5) The King of France is bald and the King of France is tall.

But this is wrong; to see that (5) presupposes that there is a king of France, note that this inference projects when (5) is embedded in the antecedent of a conditional, as in (6):

(6) If the King of France is bald and the King of France is tall, there will be no diplomatic incident.

Analogous data can be generated with disjunction (see Rothschild 2008). This problem is avoided by the algorithm given above, according to which we ignore the presuppositional material of a and b when calculating the local context of the constituent between a and b.

Notice that if we are evaluating an expression D which appears sentence-final, the symmetric and incremental local context of D are identical. This is important for our purposes: it follows that for the data we are concerned with in this paper—the antecedents of antecedent-final conditionals—the incremental and symmetric versions of the algorithm will make the same predictions.

[6] We restrict our attention here to a propositional fragment; for a general version, see Schlenker 2009. The good finals of an expression are all strings that can grammatically follow that expression. '$\leftrightarrow_C$' is material equivalence *modulo* a context C.

[7] This formulation assumes that it is possible to "delete" a sentence's presuppositions from the sentence. It is not obvious to us that this is possible, but we set aside this issue here. See Mandelkern and Romoli 2017 for further discussion.

2. The problem for presupposition projection

To work up to our puzzle, consider first a conditional with a presupposition trigger in the antecedent, as in (7).

(7) If A_p then B.

Here the incremental and symmetric algorithms for calculating local contexts make different predictions, since the trigger appears sentence-initial. The incremental algorithm predicts that (7) presupposes P. The symmetric one, on the other hand, takes into consideration the material following A_p in evaluating it. $[\![\mathsf{B}]\!]$-worlds would make the whole sentence true regardless of the value of the antecedent; thus we only need to consider $[\![\neg\mathsf{B}]\!]$-worlds in evaluating A_p.[8] In particular we must consider every $[\![\neg\mathsf{B}]\!]$-world in the context. Thus the symmetric local context of A_p in (7) is $C \cap [\![\neg\mathsf{B}]\!]$, and so the predicted presupposition of the symmetric algorithm is $\neg\mathsf{B} \rightarrow \mathsf{P}$.

Schlenker (2009); Chemla and Schlenker (2012) and Rothschild (2011) discuss whether the prediction of the symmetric algorithm for (7) is correct. But this discussion is complicated by the fact that the symmetric algorithm is taken to be a dispreferred interpretive strategy, making it hard to see how to evaluate this prediction.

We can avoid this complication, however, by considering the antecedent-final counterpart of (7), in (8).

(8) B, if A_p.

Here the incremental and the symmetric algorithms make the same predictions, since in both versions of the algorithm the material on the left of the trigger is taken into account, and there is no material to the right of the trigger in this case. This allows us to avoid difficult questions about the relation between an incremental and symmetric algorithm,[9] and directly evaluate the plausibility of a parsing-based algorithm of either form.

Both algorithms predict that at the point at which we process A, we only need to consider $[\![\neg\mathsf{B}]\!]$-worlds of C, because $[\![\mathsf{B}]\!]$-worlds would make the sentence true regardless of the value of the antecedent. Therefore the incremental and symmetric local context for A in (8) is $C \cap [\![\neg\mathsf{B}]\!]$. Thus the predicted presupposition of (8), for both the incremental and symmetric approach, is $\neg\mathsf{B} \rightarrow \mathsf{P}$.

But this prediction is problematic. It follows from this prediction that if the negation of the consequent of an antecedent-final conditional entails the presupposition of the antecedent, the sentence will be presuppositionless. Schematically, a case like (9), where $[\![\mathsf{P}^+]\!]$ entails $[\![\mathsf{P}]\!]$, is thus predicted to presuppose nothing.

[8] We sometimes use '$\neg$' and other logical connectives as abbreviations for the corresponding natural language conectives. We leave our derivations of local contexts at the present level of informality; the reader can check them for herself, or refer to Schlenker 2009.

[9] On which see Schlenker 2008, 2009; Chemla and Schlenker 2012 and Rothschild 2011.

(9) $\neg \mathsf{P}^{+}$, if A_p.

This prediction, however, does not match intuitions. To see this, consider first the conditionals in (10a), (11a), and (12a). They appear to presuppose that John is in France, that he is sick, and that he is a linguist, respectively, as predicted by the incremental parsing approach.

(10) a. If John regrets being in France, he isn't in Paris.
b. John isn't in Paris, if he regrets being in France.

(11) a. If John's wife is happy that he is sick, he doesn't have cancer.
b. John doesn't have cancer, if his wife is happy that he is sick.

(12) a. If John is happy he is a linguist, he isn't a semanticist.
b. John isn't a semanticist, if he is happy that he is a linguist.

Consider now the corresponding antecedent-final conditionals in (10b), (11b), and (12b), which have the form of (9). Intuitively these have the same presuppositions as the antecedent-initial versions. The problem is that the symmetric and incremental versions of the algorithm both predict that (10b), (11b), and (12b) have no presuppositions.[10]

Both the symmetric and incremental parsing-based algorithms given in Schlenker 2009 thus apparently make the wrong predictions for antecedent-final conditionals with a presupposition trigger in the antecedent: they predict that, when the conditional has the form of (9), its presupposition will be filtered, whereas the presupposition in fact projects.

3. The problem with triviality

The parsing-based theory of local contexts can be straightforwardly extended to a theory which predicts when a sentence strikes us as trivial or redundant. We show in this section that the problem raised in the last section extends to this theory.

Reconstructing the notion of local context allows Schlenker (2009) to connect his theory to a general theory of triviality, a theory with roots in Stalnaker 1978 (see also Singh 2007; Fox 2008; Chierchia 2009; Mayr and Romoli 2016 among others).[11] Given the account of local contexts sketched above, we say that a sentence S is infelicitous if, for any part E of S, $[\![\mathsf{E}]\!]$ is entailed or contradicted by its local context.

This approach correctly predicts that a sentence like (13) should be infelicitous, since it has a part, namely *he is in France*, whose content is entailed in its local context (whether we calculate it incrementally or symmetrically):

[10] In other words, that all three have trivial presuppositions: respectively, that if John is in Paris, then he is in France; that if John has cancer, then he is sick; and that if John is a semanticist, then he is a linguist.

[11] A theory of triviality can also be formulated in terms of equivalence to simplifications of the sentence, in the sense of Katzir 2007, to which one can add an incremental component (see Mayr and Romoli 2016; Meyer 2013 and Katzir and Singh 2013 for discussion). The problems discussed here extend to this approach as well.

(13) #If John is in Paris, he is in France and Mary is with him.

Similarly, this approach predicts that (14) should not be assertable, given that *he is in Paris* is contradictory in its local context.

(14) #If John isn't in France, he is in Paris and Mary is with him.

So far so good. Now consider the predictions of the parsing-based algorithm for antecedent-final conditionals. Recall in particular that the local context of the antecedent of an antecedent-final conditional like *B, if A* is predicted by both the incremental and symmetric algorithms to be $C \cap [\![\neg \mathsf{B}]\!]$. The theory of triviality under discussion thus predicts that if $[\![\mathsf{A}]\!]$ is entailed or contradicted by $C \cap [\![\neg \mathsf{B}]\!]$, the sentence should not be assertable. Both the symmetric and incremental algorithms thus predict that a sentence with the form

(15) $\neg \mathsf{P}^{+}$, if P and Q.

will be infelicitous, since P will be redundant. But this is wrong. To see this, consider first the antecedent-initial conditionals in (16a) and (17a).

(16) a. If John is in France and Mary is with him, then he's not in Paris.
b. John isn't in Paris, if he is in France and Mary is with him.

(17) a. If John is sick and his wife is happy that he is sick, then he doesn't have cancer.
b. John doesn't have cancer, if he is sick and his wife is happy that he is sick.

We judge these conditionals to be perfectly felicitous. Now consider the antecedent-final versions, in (16b) and (17b). We judge these versions to be equally felicitous. However, the parsing-based theory of triviality (on both its incremental and symmetric versions) wrongly predicts that the antecedent-final versions will be infelicitous, since both have material that is locally redundant (*he is in France* and *he is sick*, respectively).

4. Hierarchical transparency

Antecedent-final conditionals thus present a puzzle for parsing-based approaches to local contexts. In Mandelkern and Romoli 2017, we present a solution to this puzzle which stays largely within the bounds of the parsing-based framework. Here we will explore two alternate solutions, both of which reject parsing-based approaches in favor of approaches which track hierarchical structure rather than linear order. As we will discuss, while both approaches show promise in relation to our data and others discussed below, both also face serious challenges that remain open at this stage.

The first solution, which we call a *hierarchical transparency* approach, retains the basic idea of Schlenker's algorithm: namely, that the local context for an expression in a certain environment is the strongest meaning which *adds nothing* to that environment; i.e. the strongest meaning which is *transparent* in that environment. Crucially, we depart from Schlenker, however, in implementing this idea with an algorithm that takes into account hierarchical structure, rather than linear order.

Before sketching the algorithm and how it might help with our case, let us quickly review some further data which will provide independent evidence for the hierarchical transparency approach. The first come from Ingason 2016, which explores triviality judgments regarding relative clauses in head-final languages, in particular Korean and Japanese. In brief, Ingason shows that triviality judgments track hierarchical structure, *not* linear order. To see the point, consider first the contrast between (18a) and (18b). (18a) is felicitous, while (18b) is infelicitous. This is just as predicted by the theory of triviality introduced above, since the local context for *is a man* will entail *is a man* in (18b), but not (18a).

(18) a. John met a man who is an uncle.
b. #John met an uncle who is a man.

These sentences are in English, a head-initial language, where hierarchical structure and linear order of relative clauses correspond. It turns out that when we look at head-final languages like Korean and Japanese, however, where hierarchical structure comes apart from linear order, judgments about triviality track hierarchical structure, *not* linear order. Here is Ingason's data from Korean:

(19) a. Mary-nun [[accesi-in] sengin namca-lul] mannassta.
Mary-TOP [[mister-ADN] adult male-ACC] met.
'Mary met an adult man who is a mister/uncle.'
b. #Mary-nun [[sengin namjcaa-in] acessi-lul] mannassta.
Mary-TOP [[adult male-ADN] mister-ACC] met.
'Mary met a mister/uncle who is an adult male.'

A theory of triviality based on linear order, like the one introduced above, will wrongly predict that (19b) is felicitous, since *uncle* cannot be part of the local context of *adult male*, as it follows *adult male* in the linear order of the sentence. By contrast to the predictions of a theory like that, these data seem to show that triviality judgments track hierarchical order in some sense, rather than linear order.

The second data point we will introduce here concerns presupposition projection, and comes from Chung 2017. Chung notes that Korean is a SOV language, and thus that the attitude verb generally follows its complement clause in terms of linear order. If the calculation of local contexts were sensitive to linear order, then, the local contexts for the complements of attitude verbs would be given by the global context, just as for unembedded material. But this is not what happens; presuppositions rather project just as they do in English, where the complement of an attitude verb follows the verb. For instance, (20) is not felt to presuppose that Mary used to smoke, contrary to what we would predict if the local context for the second attitude ascription was calculated based on linear order:

(20) John-un Mary-ka kotunghakkyo ttay tampay-lul pi-ess-ess-tako
John-TOP Mary-NOM high school time cigarette-ACC smoke-PERF?-PAST-COMP

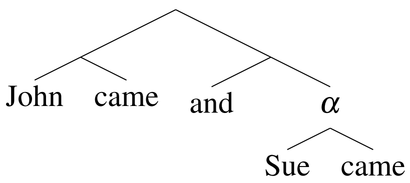
mit-ø-ko, (John-un) Mary-ka cikum-to keysokhayse tambay-lul
believe-PRES-CONJ John-TOP Mary-NOM now-also continuously cigarette-ACC
pi-n-tako mit-nun-ta.
smoke-PRES-COMP believe-PRES-DECL.
'John believes that Mary smoked in high school, and he believes that she continues to smoke.'

This suggests that, just as in the case of triviality judgments, our calculation of local contexts needs to track hierarchical structure, not linear order. We will sketch an approach which modifies Schlenker's algorithm so that it takes into account hierarchical structures, rather than linear order.[12] We will show how this kind of approach answers to the motivations just sketched, and then explore whether it also affords a solution to our puzzle from antecedent-final conditionals.

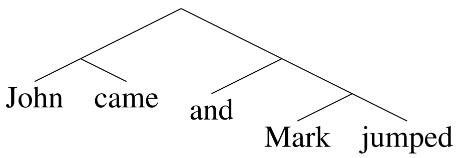
The idea is simple: to derive the local context for an expression, we look at that expression's place in its LF, and we look at what we could add to that place in the LF, so that however the LF is completed, the LF's denotation remains the same. There are different ways to flesh out what we mean by 'however the LF is completed'. We will interpret this as meaning however we replace the material in that expression, or material which is structurally "below" it, in the sense of being asymmetrically c-commanded by it. This seems to us like a reasonable way of fleshing out the relevant notion, though it is worth noting that the basic idea could be implemented in a variety of other ways which are well worth exploring.

More formally, for any LF L and node α in L, let us define a *good-completion* of L at α as any well-formed LF which is identical to L except that any clause dominated or asymmetrically c-commanded by α may be replaced by new material.[13] For any sub-tree Y, let a *Y-good-completion* of L at α be any good completion of L at α such that α is replaced by a subtree beginning with *[Y [and _* . Thus for instance (22) is a good-completion of (21) at α, and (23) is a [John [came_-good-completion of (21) at α.

(21)



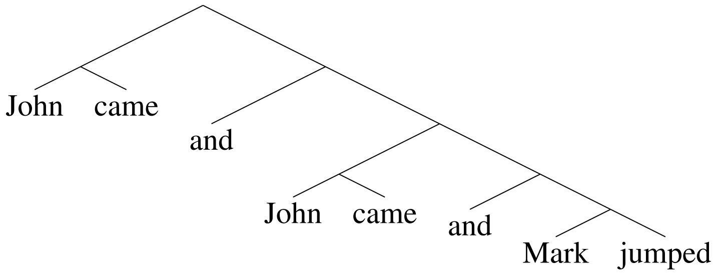
(22)



[12]We'll focus only on the incremental version, since in the symmetric version, the predictions will be essentially equivalent to Schlenker's approach.

[13]Why asymmetric c-command, instead of c-command? Consider an attitude ascription with the form *[John [believes [A]]]*. If we formulated our definition in terms of c-command, rather than asymmetric c-command, we would predict that in calculating the local context for A, we would have to ignore *believes*. This would yield the wrong results.

(23)

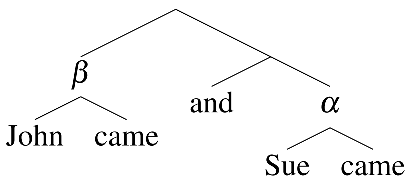


Now we are in a position to state the hierarchical transparency algorithm:[14]

Definition 4.1. Hierarchical Transparent Local Contexts:
The local context of expression E in LF L and global context C is the strongest $[\![Y]\!]$ s.t., where α is the lowest node which dominates a full clause containing E, for all good-completions D of L at α, and for all Y-good-completions D^Y of L at α, $[\![D]\!] \cap C = [\![D^Y]\!] \cap C$.[15]

The idea, again, is similar to Schlenker's algorithm, except that the local context here is calculated by finding the strongest thing that we can add to the LF of the expression in question while preserving contextual equivalence, *no matter how that LF is completed*—rather than the strongest thing we can add to the linguistic string, no matter how it is completed. Let's note, first of all, the overlap with Schlenker's algorithm. Assuming that conjunction has the straightforward hierarchical syntax illustrated in (21), then it is easy to verify that the local context for A in A *and* B in global context C is just C; and the local context for B is $C \cap [\![\mathsf{A}]\!]$. Thus for instance consider again (21), repeated here.

(21)



In calculating the local context for *John came*, we first find the lowest node dominating a full clause containing *John came*. We assume that this counts as a full clause itself, and so the lowest such node will be β. In considering good-completions at β, we can ignore everything below β (*John* and *came*), as well as everything β asymmetrically c-commands (*Sue*, *came*). Then the question will be: what is the strongest thing we can conjoin just below β such that it will not change the meaning of the whole LF, no matter how the rest is filled in? Since all we know about the rest of the LF is that it will have an *and* in it, the answer is clearly: the

[14] We assume now that our denotation function is defined on LFs.

[15] Why the reference to 'full clause'? Consider the question of what the local context for *John came* is in (21). Since *John came* asymmetrically c-commands *Sue came*, the latter will, correctly, be predicted not to be entailed by the local context of the former. But now consider what the local context for the first *came* is in (21). Since *came* does *not* asymmetrically c-command *Sue came*, then, if we did not have reference to a 'full clause' in our definition, we would wrongly predict that the local context for *came* does entail that Sue came. What a 'full clause' amounts to is something that of course needs to be spelled out precisely, but something we will remain vague about; we return to this briefly below.

global context. By contrast, in calculating the local context for *Sue came*, we will consider good-completions at α. Since α does not asymmetrically c-command anything in this LF, we will only look at good-completions that vary in the material α dominates, namely *Sue came*. What is the strongest thing that we can conjoin just under α that will be guaranteed to preserve the meaning of the LF? Clearly it is the conjunction of the global context with *John came*.

Likewise, the local context for A in *A or B* in global context C is just C; and the local context for B is $C \cap [\![\neg \mathsf{A}]\!]$. Likewise, finally, the local context for A in *Not A* in global context C is just C. These predictions are all identical to those of Schlenker's asymmetric algorithm (and, therefore, to the standard predictions of traditional dynamic theories).[16]

Things get more interesting, however, when we look at head-final or SOV languages like Korean. Assuming that the clausal part of the relative clause is asymmetrically c-commanded by its head noun, then, in our framework, the content of its head noun will always form part of the content of the local context for the relative clause, *whatever the relative linear order of the head and the relative clause*. That is, take a sentence like *John met an uncle who is a man*. We assume this sentence has an LF with a structure along the lines of *[John [met [an [uncle [who*$_1$ *[t*$_1$ *is a man]]]]]]*. In this structure, t_1 *is a man* does not c-command *an uncle*. This means that in calculating the local context for t_1 *is a man*, we will take into account *an uncle*, and thus we predict that the local context for t_1 *is a man* entails t_1 *is an uncle*, and therefore t_1 *is a man*. Crucially, in the hierarchical transparency account—unlike in Schlenker's parsing-based algorithm—this holds *whatever the linear order* of the relative clause and its head, provided that the hierarchical order is preserved. Similar considerations show that—since the complements of attitude predicates do not asymmetrically c-command the predicate—we predict that the local context under an attitude predicate is the set of attitude worlds, whether or not the attitude predicate precedes its complement, as in English, or follows it, as in Korean.

The hierarchical transparency approach to local contexts (or something roughly along these lines) seems to us to be the right way to preserve the explanatory and predictive virtues of Schlenker's algorithm, while respecting the fact that presupposition and triviality seem to be calculated in a way which depends on hierarchical structure, rather than linear order. But does it help with our problematic data involving antecedent-final conditionals? This depends crucially on the syntax of the conditional, both antecedent-initial and antecedent-final.

Start with antecedent-initial conditionals. We must suppose, first, that the antecedent asymmetrically c-commands the consequent; this would fall out, e.g., if the syntax of the conditional is roughly as in (24), where $\Box$ is the conditional's (possibly covert) modal.

(24) If A $\Box$ B

[16] It is worth noting here that we can also capture symmetric filtering for connectives in this algorithm if we assume non-standard syntactic structure in those cases. We could, of course, also assume that a secondary, symmetric algorithm comes into play in those cases, as Schlenker does; but the present approach gives us flexibility to explore the possibility that there is only one algorithm, and that variations in syntax account for right-to-left filtering.

Second, we must suppose, crucially, that for the purpose of our algorithm, the largest 'full clause' containing A is the whole antecedent *If A*, not A on its own. This assumption is crucial to ensure that the consequent is ignored in calculating the local context for the antecedent; otherwise, in calculating the local context for A, we would not be able to ignore the consequent, since it is not asymmetrically c-commanded by A, and we would predict that the local context for the antecedent entails the negation of the consequent.

Given these assumptions, the local context for the antecedent *If A* will not entail the negation of the consequent, since the antecedent asymmetrically c-commands B, and so we will ignore that part of the LF in searching for the strongest transparent restriction for the antecedent. Instead, the strongest transparent restriction will just be the global context. By contrast, the consequent B does not asymmetrically c-command anything, and so we will ignore nothing when calculating the strongest transparent restriction for B, predicting that the local context is the global context intersected with $[\![\mathsf{A}]\!]$.

If we assume that antecedent-final conditionals are generated from the same LF as antecedent-initial conditionals, and simply linearized in a different way from antecedent-initial conditionals, this approach would make the correct predictions about the local contexts for the antecedents of both antecedent-initial and antecedent-final conditionals, thus solving our puzzle.

But this approach raises a number of serious questions. First, this approach assumes that the smallest 'full clause' that includes A in the sense relevant to our algorithm is *If A*, rather than just A; whereas the largest full clause containing B is B alone. It is not clear to us how to spell out these assumptions in a principled way. One way to do so would be to stipulate that the relevant notion is in part a semantic one, so that what counts as a full clause containing E in an LF *L* is the largest part of *L* whose denotation is equivalent to the smallest full clause containing E. Then, if we assume that *if* is semantically null (which would be natural in the kind of restrictor approach to the syntax of the conditional we are assuming here), it will fall out that the relevant clause to consider when evaluating the local context for A will be *If A*, rather than just A alone. By contrast, in evaluating the local context for B, we obviously will not take into account $\Box$, since $[\![\Box\mathsf{B}]\!]$ is certainly not the same as $[\![\mathsf{B}]\!]$. There is much more to explore as to whether these assumptions are plausible in other environments, and why things would work this way.

Second, there are binding data which suggest that antecedent-final conditionals are not generated from structures like (24). For instance, the infelicity of the co-indexed variant in (25) suggests that the the subject of the consequent of antecedent-final conditionals c-commands the subject of the antecedent, contrary to the picture we have assumed (see Bhatt and Pancheva 2006):

(25) He$_{[1^*/2]}$ isn't at home, if John$_1$ is with Susie.

The plausibility of the hierarchical transparent approach will turn on whether appropriate syntactic assumptions can thus be fleshed out. This is a topic which we leave for future work. Let us note here, however, that, even if it does not solve the present problems, we might still opt for the hierarchical transparent approach on the basis of evidence of the kind discussed above, from Ingason (2016) and Chung (2017), and then supplement that approach with the solution to our problem given in Mandelkern and Romoli 2017.

5. Dynamic semantics

In this section we explore a second strategy for incorporating hierarchical structure into the calculation of local contexts, investigating how we could couple traditional dynamic semantics with a structure-based order constraint.

Traditional dynamic semantics along the lines of Heim 1983 avoids our problems from antecedent-final conditionals. This is because in such a system, as Chemla and Schlenker (2012) put it, the 'left-right asymmetries reach down to the lexical representations of logical operators.' And once the lexical meaning of a conditional operator is stipulated, it doesn't matter whether the antecedent appears sentence-finally or sentence-initially. In other words, given the way asymmetry is encoded in dynamic semantics, what matters is what is encountered first in semantic composition, rather than in linear order. And for both the antecedent-initial and antecedent-final cases, the denotation of *if* composes first with the antecedent and then with the consequent of the conditional. If *if* is treated as a (Curried) two-place sentential operator, as in Heim's system, once we define a context-change potential for *if* which makes the right predictions for an antecedent-initial conditional, it will make the same correct predictions for the antecedent-final counterpart.

This approach, however, fails to address the explanatory challenge summarized at the outset. We can briefly illustrate the problem as follows: there is nothing in the system that prevents us from defining a meaning for *if* which is (in a sense we can make precise) truth-conditionally equivalent to the one Heim proposes, but which makes the wrong predictions about presupposition projection for both antecedent-initial and antecedent-final conditionals. Heim's entry for the conditional is $c[\textit{If A, then B}] = c \setminus c[\mathsf{A}][\neg\mathsf{B}]$. A truth-conditionally equivalent entry would run $c[\textit{If A, then B}] = c \setminus c[\neg\mathsf{B}][\mathsf{A}]$. But this latter entry wrongly predicts that the negation of the consequent is taken into account in evaluating the presuppositions of the antecedent. The explanatory challenge for a theory like Heim's is how to rule out the latter entry in a principled way.

Constrained dynamic approaches (Rothschild 2008, 2011; Schlenker 2009; Chierchia 2009) aim to solve the explanatory problem by giving a principled way to determine CCPs for connectives. Rothschild (2008, 2011) in particular argues that the explanatory problem can be met by constraining possible CCPs according to their truth-conditional adequacy. While this does not uniquely yield a CCP for a given connective, it yields a limited range of CCPs. Rothschild then argues that this range represents admissible interpretations of a given connective. In order to account for an asymmetric bias in evaluating presuppositions, insofar as there is one, Rothschild proposes adding a (possibly defeasible) order constraint along the following lines: in determining the CCP for a formula $\psi * \varphi$, we do not allow any instance of the CCP for ψ to operate on a formula that contains φ.

A key question here is what is meant by a formula with the form $\psi * \varphi$: is the order of this schema meant to mirror linear order, or structural order? If the former, then Rothschild's system will fail to rule out the incorrect alternate CCP for the conditional just sketched. Indeed, Rothschild's system would make just the wrong prediction here: it would predict a strong, if perhaps defeasible, preference for that alternate CCP, where the negation of the consequent is entailed in the local context of the antecedent. A better option, then, is to interpret the order adverted to in Rothschild's order constraint in terms of hierarchical structure, rather than linear order. But it is tricky to spell out exactly how this is meant to go.

A natural first thought is that a sentence of natural language is mapped to $\psi * \varphi$, in the sense relevant for Rothschild's order constraint, just in case ψ asymmetrically c-commands φ. This would suffice to predict the ordinary asymmetric entries for conjunction and disjunction, since the first conjunct/disjunct asymmetrically c-commands the second, under standard syntactic assumptions; and it seems to capture Ingason's and Chung's data in a straightforward way. But does it help us? Only if both antecedent-initial and antecedent-final conditionals are such that the antecedent asymmetrically c-commands the consequent. This is the same assumption that we had to make in spelling out the hierarchical transparent approach in the last section. As we saw there, however, it is not obvious that this assumption is tenable in light of binding data from antecedent-final conditionals; much more work would have to be done to justify it.

A second approach would take the opposite tack: on this approach, a sentence of natural language is mapped to $\psi * \varphi$, in the sense relevant for Rothschild's order constraint, just in case φ asymmetrically c-commands ψ. If we go this way, then we need to say that the consequent of conditionals asymmetrically c-commands the antecedent in both antecedent-final and antecedent-initial conditionals. It is not clear to us whether this is plausible on general syntactic grounds. A simpler problem, however is that this approach yields the wrong results for conjunction and disjunction: since the first conjunct/disjunct asymmetrically c-commands the second, this approach will predict that the preferred interpretation of conjunction and disjunction will involve right-to-left filtering. While it seems to us open that the preferred interpretation of both conjunction and disjunction is symmetric, or that the preferred interpretation of both involves left-to-right filtering, it does not seem open to us that the preferred interpretation involves right-to-left filtering.[17] This approach also does not seem to account for Ingason's and Chung's data.

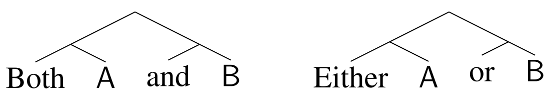
An alternative constraint, more semantic and less syntactic in spirit, builds on Chierchia (2009). The idea is to say that a sentence containing an operator $*$ gets mapped to $\psi * \varphi$ just in case $[\![*]\!]$ first takes $[\![\psi]\!]$ as an argument, yielding a function which then takes $[\![\varphi]\!]$ as an argument.[18] Now, if we assume that *if* denotes an operator which first combines with the meaning of the antecedent, yielding a new function which combines with the meaning of the consequent, then this way of mapping sentences into Rothschild's order constraint will ensure that the antecedent will always provide the local context for the consequent, but not vice versa, whether the antecedent is preposed or postposed, and whatever the underlying syntax turns out to be.

[17] Note that replacing 'asymmetrically c-commands' with 'c-commands' in either case does not help with the problems just sketched.

[18] This corresponds roughly to the relation Chierchia calls 'f-command'.

On first glance, the present approach faces the same objection as the last approach considered: again, if, as is standard, we assume that conjunction and disjunction denote functions which first combine with the right conjunct/disjunct, then this approach will wrongly predict exclusive right-to-left filtering for conjunction and disjunction.[19]

The present approach, however, unlike the last one considered, has a bit of room for maneuver in response to this issue. In particular, we can follow Chierchia (2009), who proposes a revisionary solution to this problem, based on two ingredients. First, we assume that conjunctions and disjunctions always contain either *both* or *either*, which can be overt or covert, and which, crucially, form a constituent with the first conjunct/disjunct, as in (26).

(26)


Second, the meaning of the two connectives is associated with *both* and *either*, respectively; *and* and *or* will be semantically vacuous. If we accept these two assumptions, the predictions of the hierarchical order account are now the expected ones: we will have left-to-right filtering for conjunction and disjunction, not right-to-left filtering. This is a substantial revisionary assumption about the syntax and semantics of connectives, however; the plausibility of this approach will depend on the plausibility of this assumption.

Another challenge for this solution is to explain cases of symmetric filtering with disjunction. A possible response would be to claim that a disjunction can involve an ambiguity as to whether the meaning of the connective is associated with *either* or it is associated with *or* when there is right-to-left filtering. The key question, again, is whether either structure is plausible on broader syntactic considerations.

A final challenge for this solution is whether it can be extended to account for the data we discussed in the last section involving triviality and presupposition projection in head-final and SOV languages. It is not at present clear to us how to do so.

6. Conclusion

We have used antecedent-final conditionals to formulate a problem for parsing-based theories of local contexts. Those theories—both in their incremental and the symmetric variants—predict that the negation of the consequent of antecedent-final conditionals will be entailed by the local context for the antecedent. Data from presupposition projection and triviality judgments, however, show that this is wrong.

In Mandelkern and Romoli 2017, we laid out one solution to this problem broadly within a parsing-based approach to local contexts. In this paper, we have explored two alternate solutions. The first builds on Schlenker's idea that a local context is the strongest trivial restriction in a given environment. Rather than taking the environment to be a linear string as Schlenker does, we explored an account which takes the environment to be an LF. The resulting theory

[19] See George 2008; Chierchia 2009 for discussion of this problem.

nicely accounts for a range of data which appear to show that the calculation of local contexts must be hierarchical. It helps with our problem only under certain assumptions about the syntax of the conditional, however—assumptions which raise a number of substantial questions which are beyond the scope of this paper.

The second solution builds on traditional dynamic semantic accounts along the lines of Heim 1983. As we discussed at the outset, this style of dynamic semantics has come under attack for being insufficiently explanatory. In recent years, however, more explanatory theories have been proposed which, like dynamic semantics, base the calculation of local contexts on compositional structure. We explored three ways in which hierarchical order could be used to constrain possible dynamic semantic entries according to the order of functional application. One way nicely accounts for Ingason's and Chung's data, but requires the same type of controversial assumption about the syntax of conditionals as the hierarchical transparency approach. The second and third approaches account for our data in a fairly straightforward way, but it is not clear they can account for Ingason's and Chung's data; and they face serious challenges in accounting for other connectives. We discussed a response on behalf of the third approach, based on Chierchia 2009, which avoids this objection by making certain revisionary assumptions about the syntax and semantics of other connectives—assumptions which, again, raise a number of substantial questions.

There have been various arguments in the recent literature that hierarchical order should play a direct role in the calculation of local contexts. It is not clear to us whether our data involving antecedent-final conditionals should be accounted for in this way, but, regardless of how those data are ultimately accounted for, we hope to have sketched several promising directions for incorporating hierarchical structure into the calculation of local contexts, along with some of the challenges those approaches face.

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