Presupposition projection: Global accommodation, local accommodation, and scope ambiguities*

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Abstract

It is commonly assumed that there is a default preference for the presuppositions of embedded constituents to project to the root. Some theories of presupposition, here called 'filtering' theories (e.g., Karttunen and Peters, 1979; Heim, 1983; Beaver and Krahmer, 2001; Schlenker, 2008), have a difficult time making sense of this tendency. Other theories, here called 'default projection' theories (e.g., Gazdar, 1979; van der Sandt, 1992), readily account for the generalization but they fail to account for the fact that presuppositions of embedded constituents sometimes appear at the root in modified form (they are filtered). In fact, as we will see, the 'projection-by-default' generalization is incorrect. We survey various approaches to presupposition projection through the lens of the 'projection-by-default' generalization. We will sketch a possible synthesis of filtering and default projection theories that involves associating sentences with sets of potential presuppositions derived by applying filtering mechanisms on salient alternatives of the uttered sentence. The approach might help us state a more accurate default principle and might allow for the elimination of local accommodation and other cancellation mechanisms.

*Acknowledgments to be added.

1 The projection problem for presuppositions

1.1 A brief introduction

This article is concerned with the projection problem for presuppositions. This is the problem of predicting the presuppositions of complex sentences based on their form and the presuppositions of their parts. At first blush, it might be unclear why presupposition projection is a 'problem.' Suppose that the semantic system has some way of assigning presuppositions to atomic sentences. We might then expect the presuppositions of complex sentences to be derivable from classical assumptions about the semantics of operators, that is, from the run-of-the-mill compositional semantics that we are used to.

To see this, suppose that *the king of France is bald* presupposes that there is a unique king of France and asserts that this individual is bald. We will say more about what this means later, but for the moment, let us assume that presuppositions assigned by the semantics are interpreted by the pragmatics as background assumptions with respect to which asserted information is interpreted. For example, von Fintel (2004b) notes that certain discourse moves exploit this difference between presuppositions and assertions. The hearer can object *Hey wait a minute! I didn't know there's a king of France!* but cannot object *#Hey wait a minute! I didn't know the king of France is bald!* The objection to the presupposition is appropriate because the speaker has incorrectly assumed that the hearer shared the presupposition with them (note the past tense marking and the verb *to know*: *I didn't know that...*). Assertions are intended to be new to the listener, so objecting that you didn't know what the speaker said would be senseless.

Returning to the issue of compositionality, note that the sentence entails both its assertion and its presupposition (presuppositions of atomic sentences are also entailments). From the perspective of classical logic, it is a surprising discovery that when the sentence is negated, for example, the asserted content is denied but the presupposition survives: *the king of France is not bald* 'inherits' the presupposition that there is a unique king of France and denies only that this individual is bald. Assuming that negation returns the complement of the proposition denoted by its argument, one might have expected *the king of France is not bald* to deny the conjunction of the presupposition and assertion of *the king of France is bald*: either there's no king of France or (there is and) he's not bald. Instead, negation only seems to 'see' its complement's asserted content.

The problem with negation is just a special case of a more general prob-

lem. Let S_p^q be a sentence that presupposes p and asserts q. If we assume classical entries for logical operators, and assume that S_p^q can be analyzed as the conjunction of $p \wedge q$, it turns out that we fail to predict the presuppositions that complex sentences containing S_p^q actually come to have. For example, assume that sentences of the form x *loves her* Z presuppose that x has a Z (suppose x is an individual and Z a predicate). Then, given what we know about *if*, *or*, *believe*, *no*, I will leave it to the reader to confirm that classical assumptions fail to derive the presuppositions the sentences in (1) intuitively have (below, indicated with '$\rightsquigarrow$').[1]

(1) a. Either John is lazy or Sandy loves her dog $\rightsquigarrow$ Sandy has a dog
b. If John gets run over by a bull, Sandy loves her dog $\rightsquigarrow$ Sandy has a dog
c. Sue believes that Sandy loves her dog $\rightsquigarrow$ Sandy has a dog and Sue believes it
d. No girl in this room loves her dog $\rightsquigarrow$ every girl in this room has a dog

Things do not become any clearer if we assume a three-valued or partial semantics to incorporate presuppositions. It is sometimes assumed that to make sense of the 'squeamish' feeling we get when a sentence is uttered whose presupposition is not true, such as *the king of France is bald*, we need a semantics that fails to assign true or false to the sentence. In some views the sentence is assumed to not have a truth-value (the semantics is partial), and in some approaches the sentence receives a third value that is neither true nor false (sometimes interpreted as uncertainty).[2] Assume the latter three-valued approach for the moment: suppose that sentences can have the value 0 (false), 1 (true), or # (don't know which). If a presupposition is true,

[1]The quantified sentence has a constituent 'x loves x's dog', which we assume presupposes that x has a dog.

[2]Specifically, the system is sometimes assumed to be underlyingly bivalent, and '#' is interpreted as uncertainty about which of the two classical values the sentence receives (see e.g., Fox, 2008; George, 2008 for discussion). This intuition then allows the three-valued tables motivated by empirical considerations (e.g., Peters, 1979; Beaver and Krahmer, 2001) to be explained in terms of (incremental) reasoning about uncertainty. It's not clear that this interpretation is consistent with Kleene's (1952) interpretation of the third-value. He imagined a computing device mechanically carrying out a procedure with the aim of answering a question. At any given moment, when asked it could give the answer 'yes' (true), 'no' (false), or 'don't know'. Because the problem under consideration might be undecidable, it's not clear that the assumption of underlying bivalence is warranted. See Katzir and Singh (2012) for a different perspective on deriving the basic Kleene (1952) truth-tables, one that employs constraints on lexicalization (Katzir and Singh, 2013a) instead of reasoning about uncertainty.

then if the assertion is also true the sentence is true, and if the assertion is false the sentence is false. However, if the presupposition is not true, the whole sentence receives the third-value: it is neither true nor false. Granting this, what should be the value of $\neg S$, for example (cf. also (1)), when S receives the value #? There is a choice here: the value could be taken from anywhere in the set of truth-values $\{0,1,\#\}$, and nothing in the logic itself forces one answer over the other. The fact that the value is #, that is, that the presupposition of S is inherited by $\neg S$, is as mysterious as it was from the classical perspective.

As we hope to clarify, observations like this seem to call for a dedicated theory of presupposition projection. It is not obvious on the face of it which assumptions need to be given up, nor is it obvious whether the innovations need to come in the semantics, the pragmatics, or elsewhere. We unfortunately do not have introspective access to the inner workings of the mind, and thus the only thing to do is to build theories and hope that the effort leads to insight and understanding. In addition to the challenge of describing the data, there is the more ambitious challenge of finding a set of assumptions that might explain the data in a natural and principled way. The literature on presupposition is rich with empirical observations and theoretical advances. I will not be able to do justice here to all of that work. To keep the discussion focussed, I will try to highlight one central observation that quite neatly divides different approaches to projection, namely, the observation that there is a general tendency for the presuppositions of embedded constituents to project to the root. I will discuss some of the data that support this tendency, as well as some data showing that the tendency is not strict. In fact, we will see that this 'projection-to-the-root-by-default' way of talking is incorrect. We will try to state a more accurate generalization, and in the process will draw some potentially interesting consequences for grammar (syntax/semantics) and for pragmatic principles of language use.

1.2 Atomic sentences

Let's begin with the presuppositions of atomic sentences and work our way to sentences of greater complexity. Following Beaver and Zeevat (2007), we will distinguish between 'semantic presuppositions', which are assigned by the linguistic system, and 'pragmatic presuppositions', the presuppositions of speakers and hearers who use linguistic objects that have semantic presuppositions. Intuitively, a speaker who utters a sentence like *the king of France is bald* is taken to be pragmatically presupposing that there is a (unique) king of France, and pragmatically asserting that the person referred to is

bald. For the moment, we continue to take pragmatic presuppositions to be those assumptions the speaker assumes either are or will be part of the background with respect to which the sentence's asserted content is interpreted (see Stalnaker, 1998, 2002; von Fintel, 2008 for the intricate contextual dynamics that make sense of the 'or will be' disjunct). We also take pragmatic assertions to be information the speaker offers that is in principle open for debate and challenge. We assume that these pragmatic acts link up with the output of the semantic system through Stalnaker's 'Bridge Principle' (modified from the discussion in von Fintel, 2008): If sentence S semantically presupposes p and has asserted content q, S_p^q, then a speaker who uses S_p^q in context c pragmatically presupposes p and pragmatically asserts q. We will have occasion to revisit this assumption in later sections of the paper.

Semantic presuppositions are commonly assumed to be triggered by certain lexical items, called presupposition triggers (though see e.g., Abusch, 2010; Abrusan, 2011 and references therein). The definite article *the* is one such item: under one textbook treatment (Heim and Kratzer, 1998), *the* presupposes that its nominal argument has a contextually unique satisfying element (e.g., a unique king of France in *the king of France*). If the context furnishes such an element a, we say that the presupposition is satisfied, in which case *the N* denotes a.[3] This individual a then serves to saturate the predicate *is bald*, and the sentence is true if a is bald and is false is a is not bald. If there is no unique king of France available in the context, the presupposition is not satisfied. Intuitively something has gone wrong. Certainly no cooperative speaker would utter such a sentence if they had reason to doubt the existence of a king of France. Such an utterance strikes me as ruder than an outright lie. Assertions can and sometimes should be challenged (*no, that's false!*), but it's harder to directly challenge a presupposition, which perhaps reflects the fact that there is a general expectation that a listener will leave presuppositions be.[4]

When a sentence is uttered in a context in which its presupposition is not satisfied, we say that the sentence suffers from 'presupposition failure.' Although there is little doubt that there is a sensation of failure here, there

[3] $[[\textit{the}]] = \lambda f_{et} : \exists!x f(x).\tau y(f(y))$. Here, we use '$\exists!x$' to mean "there is a unique x such that" and we use 'τy' to mean "the unique y such that..." We can read this in English as denoting a partial function which (i) takes elements of type et as input (or, equivalently, predicates), (ii) is defined only if there is a unique individual in the context that satisfies the input predicate, and (iii) returns as output the unique individual that satisfies the predicate (where the function is defined).

[4] Matthewson (2006) provides evidence for cross-linguistic variation concerning the way presuppositions are treated in discourse. For example, St'at'imcets speakers were more accepting of inappropriate presuppositions than English speakers.

is disagreement about the underlying linguistic cause of this failure. As noted earlier, under one perspective the semantics is partial, failing to deliver a truth-value when presuppositions are not satisfied (there is a truth-value 'gap').[5] Under a different perspective, the sentence denotes a third truth-value that is neither true nor false (see note 2).[6] Either way, what these views have in common is that the context needs to satisfy the sentence's semantic presupposition for the sentence to be properly interpretable. We will sometimes omit the qualifiers 'semantic' and 'pragmatic' and talk simply of 'presuppositions'; this is justified by Stalnaker's Bridge, but it is important to keep in mind that there is an intricate architecture assumed here, for we will revisit the bridge principle in later parts of the paper.

The set of presupposition triggers includes elements of various semantic type: the definite article is one, but there are also complement-taking verbs such as *know* and *realize* (e.g., *John knows that he made a mistake* presupposes that John made in a mistake), aspectual verbs like *stop* (e.g., *it stopped raining* presupposes that it was raining at some (salient) time interval before the utterance), anaphoric discourse particles like *too* and *also* (e.g., *JOHN built a garden bed, too* presupposes that some individual other than John built a garden bed), and many more (see e.g., Karttunen, 1973; Gazdar, 1979; Soames, 1989; Beaver, 2001; Beaver and Zeevat, 2007).

1.3 Complex sentences

As we noted earlier, the projection problem gets its bite from the observation that presuppositions interact with embedding operators in unexpected ways. Negative embedding raises several important issues, so let's focus for the moment on this special case. If we negate *the king of France is bald*, the expected reading (from a classical perspective) is the one in (2-b); however, what we spontaneously infer when we hear (2) is paraphrased in (2-a):

(2) The king of France isn't bald

a. There is a king of France x and it's not the case that x is bald

b. it is not the case that (there is a king of France x and x is bald)

[5] Such as in the system of Heim and Kratzer (1998), for example (see note 3). In this system, if any node fails to have a semantic value, so does any node dominating it; that is, undefinedness projects all the way up the tree. Thus, when the DP *the king of France* fails to get a semantic value, so does the sentence containing it.

[6] Under yet a different perspective, a classical bivalent semantics is assumed, and the problem is wholly pragmatic in nature (Chemla, 2009b; Schlenker, 2008).

The reading in (2-b) is available, but it is so marked that it typically can be recovered only with contextual help:

(3) a. The king of France isn't bald...there is no king of France!
b. There is no king of France. Therefore, the king of France isn't bald.

It is clear from online intuitive judgments (e.g., Heim, 1983; van der Sandt, 1992) as well as online processing results (Chemla and Bott, 2013) that the reading in (2-a) is preferred to (2-b). A challenge, of course, is to explain why this preference should exist (e.g., Geurts, 2000).

Note in addition that under the reading in (2-a), not only does the inference to there being a king of France project out of negation, the inference continues to have the character of a pragmatic presupposition. That is, the sentence would be infelicitous if uttered in a context in which the existence of a unique king of France were not taken for granted. Given Stalnaker's Bridge, this suggests that the existence of a king of France is also a semantic presupposition of (2-a). In other words, negation seems to be a 'hole' for presuppositions (Karttunen, 1973): if sentence S presupposes p, then $\neg S$ also presupposes p. However, when negation behaves classically, returning the set-complement of the proposition denoted by its embedded constituent as in (2-b), the sentence (2) has no presupposition at all.

Several questions immediately arise. By what mechanism is the ambiguity in (2) generated? Why is the reading in (2-a) so strongly preferred over the reading in (2-b)? And what are the use conditions that link the semantics and pragmatics so that under the reading in (2-a) the sentence (2) presupposes that there is a king of France, and under the reading in (2-b) there is no presupposition at all? This article surveys approaches to answering these and related questions. We will see that there are non-trivial difficulties no matter what one's approach; more positively, we hope that the survey will highlight what different approaches do well and what they don't, with the further hope that an eventual satisfactory synthesis will be found. We explore such a possibility in section 4.

2 Ambiguity and presupposition projection

2.1 Lexical ambiguity + extensions to other operators

Karttunen and Peters (1979) proposed that negation itself might be ambiguous. Specifically, they proposed an analysis of operators under which an operator encodes not only a normal truth-conditional component of meaning, intended to specify the projection of asserted content, but that operators also encode a 'heritage' function which specifies how presuppositions of embedded constituents affect higher clauses. As above, let S_p^q be a sentence that presupposes p and asserts q. In Karttunen and Peters's (1979) treatment of negation, the word *not* is ambiguous. Under one of the entries, the one in (2-a), *not* S_p^q asserts $\neg q$ ($\neg$ is classical negation) and presupposes p: $[\textit{not}\ [S_p^q]]_p^{\neg q}$. Under the other entry, the one in (2-b), *not* S_p^q presupposes nothing at all and asserts $\neg(p \wedge q)$: $[\textit{not}\ [S_p^q]]_{\mathcal{W}}^{\neg(p \wedge q)}$ (here $\mathcal{W}$ is the set of all worlds, and thus the presupposition has no information). Karttunen and Peters (1979) note that this second negation is typically associated with the prosody of metalinguistic negation (note the marked pronunciation of (2-b)).

There are several reasons to doubt an analysis in terms of lexical ambiguity. First, as far as I know, these two negations are not realized by different morphemes in any language. Second, there need not be marked accent in generating the reading in (2-b); there is none in (3-b), for example. Third, we find a similar pattern with other embedding operators: the presupposition of an embedded constituent typically projects to the root (cf. the (a) sentences in (4)-(6)), but can be prevented from doing so in certain contexts (cf. the (b) sentences in (4)-(6)):

(4) a. If John is from Toronto, the king of France is bald
    b. If there is a king of France, the king of France is bald

(5) a. John is from Toronto and the king of France is bald
    b. There is a king of France and the king of France is bald

(6) a. Either John is from Toronto or the king of France is bald
    b. Either there is no king of France or the king of France is bald

We would not wish to multiply ambiguities in the heritage functions of *if, and, or*, and so on. Nevertheless, we find – just as with negation – that the embedded presupposition sometimes projects to the root, and sometimes does not. Furthermore, when the presupposition does not project, there are

clear interfering factors: in (4-b) and (6-b) there is a constituent which suggests that the speaker is ignorant about whether there is a king of France: *if there is a king of France* in (4-b) and *either there is no king of France* in (6-b). And in (5-b) the first conjunct *there is a king of France* plainly asserts that there is one. In the negative sentences in (3), the existence of a king of France is asserted to be false. These considerations might be reason enough to cancel the presupposition. Asserting that something is true at the same time as presupposing it seems self-defeating. So is asserting that something is false and presupposing that it is true. And so is presupposing that something is true and implying that you don't know whether it is true. It is unclear why presuppositions give way to these other inferences when they come into tension, but it seems clear than in absence of such self-defeating acts, the embedded presupposition seems to want to be inherited globally by the entire sentence.

2.2 A generalization about the presuppositions of complex sentences

A surprisingly simple generalization is suggested by the above considerations: presuppositions project through operators by default, but this default can be overridden under threat of pragmatic inappropriateness. Clearly, positing ambiguities in lexical heritage functions would miss this generalization, which we state here for ease of later reference:

(7) Default projection generalization

a. Heritage functions are holes: The heritage functions of operators are generally 'holes' for presuppositions, letting through the presuppositions of their constituent sentences (this is the 'cumulative hypothesis' of Langendoen and Savin, 1971).

b. Pragmatically motivated cancellation: Presuppositions of embedded constituents get cancelled to avoid self-defeating or otherwise inappropriate speech acts, such as the ones enumerated above; in such contexts, the presupposition is assimilated into the asserted component of its triggering constituent.

The rest of this paper examines this generalization: the extent to which it's a true generalization about natural language, and the way it fits into theories of presupposition projection.

Call any approach that aims to directly capture this generalization a 'default projection' approach. The theory that perhaps comes closest to mak-

ing sense of this generalization is Gazdar's (1979), which we will discuss in section 3.2.1. We will also see that other approaches, such as DRT approaches (e.g., van der Sandt, 1992), also capture the generalization quite naturally. However, default projection approaches face significant difficulties elsewhere, some of which we identify shortly. In particular, they have a hard time making sense of systematic violations of (7): sometimes, the presuppositions of complex sentences neither project to the root nor get cancelled, but show up in modified form at the root.

Another strategy overcomes this difficulty by taking off from a very different place: it takes operators like *or, and, if* to be 'filters', such that the presuppositions of embedded constituents do not generally project to the root unmodified. Call such approaches 'filtering' approaches. As we hope to clarify, filtering approaches have a hard time making sense of (7) because the presuppositions of embedded constituents will typically have been filtered away at the root, and the information about the presuppositions of embedded constituents is lost in matrix position. Filtering theories include Karttunen and Peters (1979), as well as much of the literature that followed (e.g., Heim, 1983; Chierchia, 1995; Beaver, 2001; Chemla, 2009b; Schlenker, 2008; Fox, 2008, 2012).

In section 4, we will explore a possible synthesis of these competing frameworks. The direction is similar to that proposed in Soames (1982), although I have the benefit of several decades of important work on the topic that wasn't available at the time.

3 Capturing the generalization with different theories of projection

3.1 Filtering + accommodation mechanisms

The Karttunen and Peters (1979) approach assumes that pragmatic presuppositions are computed by the joint contribution of two cognitive systems: (i) the heritage function encoded in the semantics of operators, and (ii) pragmatic principles of conversational reasoning. As noted above, these authors propose that binary operators encode heritage functions that are 'filters,' that is, they modify the presupposition of at least one of their arguments. The approach thus has to explain away apparent hole-like behaviour as a consequence of pragmatic reasoning. In this approach to conditionals, for example, (4-b) is taken to be representative and (4-a) is in need of explanation. Specifically, *if* is assumed to be a filter in its semantics: *if A, then* S_p seman-

tically presupposes $A \rightarrow p$. Thus, (4-b) is correctly predicted to not have any presupposition, but (4-a) is incorrectly predicted to semantically presuppose that if John is from Toronto, there is a king of France. A speaker who asserts (4-a) rightly expects that the listener will share their presupposition that there is a king of France whether or not John flies to Toronto.

To make sense of this inference, Karttunen and Peters (1979) suggest that principles of conversational reasoning can modify the output of the semantics to generate attested pragmatic presuppositions. Under this approach, Stalnaker's Bridge would have to be revised: pragmatic presuppositions are a function of semantic presuppositions, but may be different from them. If the approach is on the right track, which in this respect is shared with other filtering theories with otherwise quite different assumptions (e.g., Heim, 1983; Beaver and Krahmer, 2001; Schlenker, 2008), it teaches us that the linguistic classification of operators as holes or filters is potentially confounded by context-dependent pragmatic reasoning. We will discuss some of the pragmatic principles that may be needed in section 4. Here, I would like to briefly mention three conceptual issues that might be raised against the approach. I will dismiss two of them here, perhaps too quickly, but I hope the discussion will nevertheless be instructive.

First, the lexical ambiguity in negation is still troublesome. It turns out, however, that this stipulation can be eliminated in favour of a general mechanism for assimilating presuppositions into assertions. That is, several mechanisms in the filtering framework have been proposed for 'shutting off' presupposition projection and treating embedded presuppositions as though they were part of the asserted content of their triggering constituent. These include the 'local accommodation' operation of Heim (1983) and the 'floating-A' operator of Beaver and Krahmer (2001). For example, suppose that sentence S_p^q is embedded in sentence ϕ, $\phi(S_p^q)$. This sentence will normally be associated with some presupposition, based on the heritage functions present in ϕ. However, if the embedded sentence S_p^q is parsed with Beaver and Krahmer's (2001) floating-A operator, the operator wipes out p as a presupposition and adds it to the asserted component: $(A(S_p^q))_{\mathcal{W}}^{p \wedge q}$. For example, a sentence like *the king of France isn't bald* can be parsed without any A, and this gives the meaning in (2-a). However, with an A embedded below negation, *not* (*A(the king of France is bald)*), the sentence gets the reading in (2-b). Thus, filtering theories have a general mechanism for cancelling presuppositions, and thus can avoid a lexical stipulation in negation itself. Moreover, filtering frameworks can re-capture the idea that presupposition cancellation is generally dispreferred with the (not unnatural)

assumption that A-insertion is marked.[7]

Second, the system in Karttunen and Peters (1979) has sometimes been criticized for stipulating the heritage properties of operators without relating them to other aspects of their semantics/pragmatics (e.g., Gazdar, 1979; Heim, 1983). This limitation is not inherent to filtering approaches, however. Indeed, there have been several attempts to replace stipulated heritage functions by deriving them from independent principles, such as those motivated by donkey anaphora (e.g., Heim, 1982), by pragmatic redundancy principles (e.g., Schlenker, 2008), by principles of epistemic reasoning (e.g., Chemla, 2009b), by principles of computational efficiency (e.g., Schlenker, 2009), by reasoning about relevance and uncertainty (e.g., Fox, 2008, 2012), and by constraints on the lexicaliztation of logical operators more generally (e.g., Katzir and Singh, 2012, 2013a). Thus, I am inclined to think that this is not a serious objection for filtering approaches in general.

Third, and most importantly for the current paper, it is totally mysterious that presuppositions of embedded constituents do, as a default, become pragmatic presuppositions of the sentences in which they are contained. In fact, this tendency is so strong that it was initially thought that this projection to the root *always* happens (Langendoen and Savin, 1971). Although this was quickly rejected, in part because of sentences like (4-b), the default character of this projection has been central to many important works (we turn to these default projection approaches shortly).

To see the nature of the problem, consider the fact that the following sentences all pragmatically presuppose that there is a cow in the barn:

(8) a. If Mary moved the hay bales, then I doubt that John thinks that the cow in the barn is hungry.
b. Does Jan ever wonder whether why Sue hopes that the cow in the barn is hungry?
c. Tell Luke that I'll steal his chickens if he ever reminds me about how Sue thinks the cow in the barn might go hungry!

Consider (8-a). Here, *the cow in the barn* is deeply embedded under several operators which under the filtering approach would be classified as presupposition filters (*if, doubt, believe*). Under common assumptions (e.g., Heim, 1992), the sentence semantically presupposes that if Mary moved the hay bales, then the speaker believes that John believes that there is a cow

[7]Some authors have raised conceptual concerns with local accommodation (e.g., Chierchia, 1995; von Fintel, 2008; Singh, 2014); see Singh (2014) for an attempt to get rid of cancellation devices. See also section 4 for a different way to eliminate dedicated cancellation mechanisms.

in the barn. Nevertheless, we come away from the sentence learning that there is in fact a cow in the barn, and we furthermore are expected to treat this inference as a presupposition. For example, the listener may respond to (8-a) with (9):

(9) A: If Mary moved the hay bales, then I doubt that John thinks that the cow in the barn is hungry.
B: Hey wait a minute! I didn't know there's a cow in the barn!

The puzzle is this: why is the pragmatic inference that there is a cow in the barn so much more salient and accessible than the semantic presupposition that if Mary moved the hay bales, then the speaker believes that John believes that there is a cow in the barn? I am not concerned with why there are pragmatic presuppositions that are different from semantic presuppositions. Recall that under filtering approaches, pragmatic presuppositions are a function of semantic presuppositions but need not be identified with them. This is commonplace in the study of meaning. My concern is that there seems to be no rationale for concluding that there is a cow in the barn if the only input to the inference process is (i) the semantic presupposition of the sentence, and (ii) propositional information in the context.

First, there seems to be nothing in the semantic presupposition itself qua proposition that invites this inference. For example, a sentence that paraphrases the semantic presupposition does not invite the inference that there is in fact a cow in the barn:

(10) If Mary moved the hay bales, then I believe that John believes that there is a cow in the barn.

Second, one has to do some mental work to realize that the semantic presupposition is available at all. This itself is somewhat surprising: why should the output of the linguistic system – which is context-invariant – be harder to retrieve than a presumably malleable, context-dependent pragmatic inference? However, the challenge is exacerbated by the fact that under common assumptions about the semantics/pragmatics interface the embedded presupposition should be unavailable at the root. A (filtered) semantic presupposition p *is* available in matrix position, but this is a just a proposition, a mere set of worlds. Of course, p has been derived from the embedded presupposition q in some fashion: $p = f(q)$, where f is shorthand for a possibly complex sequence of semantic operations. But this derivational history is lost at the root: here we only have access to p, and not to $f(q)$. This follows from the assumption that at each node in the tree, meaning is computed only

locally (on the basis of immediate constituents), and that what gets delivered to the pragmatics is the proposition denoted by the sentence, rather than its derivational history. Why, then, should this inaccessible proposition – the presupposition of an embedded constituent – be so salient? And why should it be the *preferred* reading? The challenge is to explain how a proposition that has been 'filtered away' by the linguistic system can be recovered and subsequently made the preferred interpretation of the sentence.

I will return to this challenge in section 3 after discussing approaches that perhaps more directly allow presuppositions of embedded constituents to surface as global pragmatic presuppositions (i.e., as pragmatic presuppositions at matrix position). These default projection approaches are designed in such a way that their projection mechanisms always have access to the presuppositions of (possibly deeply) embedded constituents. This information access allows such approaches to manipulate these embedded presuppositions, and to state pressures to project embedded presuppositions to the root. As we will see, this makes for a straightforward explanation of (7), but it leads to problems elsewhere. For example, the approach fails to account for data that suggest filtered presuppositions at the root are also sometimes produced.

3.2 Default projection

3.2.1 Potential presuppositions

Gazdar (1979) proposed that presuppositions of embedded constituents are always *potential* presuppositions of the complex sentence in which they are contained.[8] That is, the system that computes the pragmatic presuppositions of a complex sentence goes through a stage of computation in which it collects the presuppositions of all atomic constituents contained in the sentence. This set of 'potential presuppositions' then undergoes a series of tests to determine which of these survive to become actual presuppositions of the sentence. These tests involve consistency checks with the context, and with other inferences the sentence generates, such as its entailments and other conversational implicatures. We saw earlier that when an inconsistency with one of these inferences arises, the potential presuppositions of embedded constituents typically get cancelled. It is an important question why this should be, but what is important for current purposes is that this approach,

[8] Soames (1979) developed a proposal that was similar in spirit. I focus here on Gazdar's (1979), partly because it is more detailed. See also Mercer (1992) and Marcu (1994) for computational implementations of default projection systems.

unlike filtering approaches, allows the matrix position to access presuppositions of embedded constituents, and it predicts default global projection.

The system also brings some other welcome simplifications that lend it some explanatory force. The semantics is classical and there are no heritage functions. Hence, there is no question of relating heritage functions to other semantic properties of operators. Furthermore, the attempt to explain cancellation as a consequence of consistency requirements is appealing. We have seen that there is support for the general idea. For example, we saw in (4-b), (5-b), and (6-b) that if p is a potential presupposition of a sentence, and if p is entailed by the asserted component of the sentence, or if the speaker suggests that they are ignorant about whether p is true, this is enough to prevent p from becoming an actual presupposition of the sentence. If this were a true description of the data, we would want to know why potential presuppositions get cancelled by assertions and implicatures. However, there are reasons to doubt that this is a true generalization.

Consider conditionals like the following (modified from Soames, 1982, 1989; Heim, 1990):

(11) a. If Mary (the job candidate) graduated from MIT, the search committee will appreciate the fact that she graduated from an American university.

b. #If Mary (the job candidate) graduated from an American University, the search committee will appreciate the fact that she graduated from MIT.

Gazdar (1979) predicts that (11-a) should presuppose that Mary graduated from an American university, and he predicts that there should be no presupposition at all in (11-b). Both predictions have been argued to be incorrect. In (11-a), Gazdar predicts that the antecedent should trigger an ignorance implicature to the effect that the speaker does not know whether Mary graduated from MIT. This is consistent with the presupposition of the consequent that Mary graduated from an American university (the presupposition is triggered by *will appreciate the fact that*), and thus the presupposition should project uncancelled. This prediction is incorrect; the sentence presupposes nothing at all (e.g., Soames, 1982, 1989). For example, further embedding shows that the presupposition does not project (e.g., *do you think that if Mary graduated from MIT, the search committee will appreciate the fact that she graduated from an American university?*). Furthermore, the *Hey wait a minute!* diagnostic fails: it is odd to respond to (11-a) with # *Hey wait a minute! I didn't know Mary graduated from an American university!*

In (11-b), the antecedent triggers the implicature that the speaker is igno-

rant about whether Mary graduated from an American university. Assuming that the speaker knows that MIT is an American university, they cannot possibly know that Mary graduated from MIT; the ignorance implicature thus cancels this potential presupposition. But then we are left without an explanation of the strangeness of the utterance. Heim (1990) points out that a plausible account of the strangeness is that the sentence suggests by way of presupposition that if Mary graduated from an American university, then it is a matter of course that she graduated from MIT.[9] It is difficult to imagine what kind of evidence one would have for being in such an epistemic state. To furthermore presuppose such an odd proposition is conversationally inappropriate. Note that the strangeness persists under embedding: *#Do you think that if Mary graduated from an American university, the search committee will appreciate the fact that she graduated from MIT?* It is noteworthy that the strangeness reduces significantly if a speaker asserts the strange conditional instead of presupposing it: *If Mary graduated from an American university, the committee will think that she graduated from MIT* is nowhere near as bad as (11-b) (and similarly, *mutatis mutandis*, for *do you think that if Mary graduated from an American university, the committee will think that she graduated from MIT?*).[10]

Thus, Gazdar's (1979) attempt to replace a set of heritage functions with a general cancellation principle must be deemed unsuccessful. In fact, as pointed out in Heim (1983), the proposal is limited to potential presuppositions that are propositions; it is this assumption that allows consistency checks with other propositions. The proposal thus does not extend to subsentential constituents, and it does not provide filtered presuppositions to any complex sentence. For example, the proposal is silent on the presuppositions of quantified sentences, which contain within them formulas with free-variables and which the global context does not access (e.g., (1-d) and note 1; see Heim, 1983). Thus, the proposal has nothing to say about why (1-d) = *no girl in this room loves her dog* presupposes that every girl in this room has a dog. In fact, it doesn't even get this wrong; it simply doesn't say anything at all about such sentences. Something more general is needed.

[9]Heim (1990) used a different example but one that makes the same point: *if John has children, he will bring along his 4-year old daughter*.

[10]Under an assumed presupposition-assertion distinction, it is expected that implausible presuppositions should be more inappropriate than implausible assertions (e.g., Soames, 1989; Heim, 1992; von Fintel, 2008), an expectation that has received quantitative support from online processing tasks (e.g., Singh et al., 2015).

3.2.2 Scope ambiguity

It is common in linguistics to see an element appear overtly in one position but to assume that the element is interpreted in a position different from where it appears on the surface. Suppose with Russell that *the king of France* is one such element. For example, instead of denoting an individual, we might assume that *the king of France* is a quantificational noun phrase and that it can therefore undergo quantifier raising or some other scope-shifting-operation.[11] Then, when we see a complex sentence in which *the king of France* appears to be deeply embedded but is interpreted as if it were at the root, it might be that some covert displacement operation has moved the element from its surface position to matrix position, where it is ultimately interpreted.

This would have welcome consequences for the theory of projection. First, it would immediately solve the problem faced by filtering approaches: the matrix position would have access to the presupposition that appears to be embedded because at the relevant level of representation it is not embedded at all. Second, it would reduce the explanatory burden on the theory of presupposition projection, for projection would reduce to scoping-mechanisms for which there is ample independent motivation.

However, this move has little else going for it. First, it remains to be explained why presuppositions should prefer to take wide-scope, given that there is little evidence for a wide-scope preference in general. Second, we would need to say why matrix scope is interpreted with a pragmatic presupposition while narrow scope is interpreted as part of the asserted component. Third, the fact that presuppositions scope out of islands would need an explanation (though cf. Geurts, 1999b); for example, both of the sentences in (12) presuppose that there is a king of France, even though *the king of France* sits inside a scope-island in each case.

(12) a. If the king of France is bald, I'll mow your lawn
b. Every leader who meets the king of France is always amazed at how much wine he consumes

Finally, it is not only definite descriptions, but *all* presupposition triggers that have this profile: wide-scope readings are presupposed while narrow-scope readings are asserted, and there is a preference for the former. For example, *stop* behaves just like *the king of France* in all relevant respects, as the following sample should illustrate:[12]

[11] E.g., $[[\textit{the}]] = \lambda P_{et}.\lambda Q_{et}.\exists x((P(x) \wedge \forall y(P(y) \rightarrow y = x)) \wedge Q(x))$.

[12] Though see Heim (1992) for an attempt to give a scope analysis of *stop*.

(13) a. It hasn't rained all day. Therefore, it didn't stop raining. ($\not\rightsquigarrow$ it was raining)
b. If John is from Toronto, it has stopped raining. ($\rightsquigarrow$ it was raining)
c. A: If Mary moved the hay bales, then I doubt that John thinks that it stopped raining. ($\rightsquigarrow$ it was raining)
B: Hey wait a minute! I didn't know it was raining!

These difficulties seem hard to overcome. Nevertheless, the displacement idea is appealing, and a very influential approach to presupposition projection has taken syntactic displacement to be the core mechanism for projection. The approach gives up the idea that displacement happens on logical forms as commonly construed, and concomitantly gives up the assumption that quantifier-raising is responsible for displacement of presupposition-bearing elements.

3.2.3 A new representation: Discourse Representation Structures

Perhaps in part because the usual scoping mechanisms do not apply, a line of inquiry suggests positing a new level of representation, so-called 'Discourse Representation Structures' (DRSs), different from the logical forms created by the syntactic system and thus freed from the usual constraints on displacement (van der Sandt, 1992; see also Zeevat, 1992; Geurts, 1999a). This framework, Discourse Representation Theory (DRT), suddenly provides new possibilities for what gets moved where. A guiding motivation for the approach is that presupposition projection has much in common with anaphora resolution. Specifically, presuppositions (of embedded constituents) appear to be 'cancelled' in many of the environments in which pronouns find their antecedents, and they appear to 'project' to the root in many of the environment in which pronouns need to look outside of the sentence for their referent/binder. For example, the presuppositions in (14-a) and (14-b) are 'cancelled', and the pronoun in (14-c) finds its antecedent in the sentence itself.

(14) a. If there is a king of France, the king of France is bald.
b. If it was raining, it has stopped raining.
c. If there is a king of France, he is bald.

And when there is no antecedent for the pronoun in the sentence itself, as in (15-c), it needs to look to the global context to find one; and in (15-a) and

(15-b) the presupposition that there is a king of France projects outside of the (rest of the) sentence, to the root.

(15) a. If Mary brought in the hay bales, the king of France is bald.
b. If Mary brought in the hay bales, it has stopped raining.
c. If Mary brought in the hay bales, he is bald.

What connects run-of-the-mill presuppositions and pronouns? The guiding intuition is that presuppositions and anaphoric elements both require antecedents. Taking pronoun resolution as independent motivation, there are clearly defined paths in the search for an antecedent. The search procedure looks not only to c-commanding positions, but also 'sideways'; for example, an element in the consequent of a conditional can find its referent in the antecedent.[13] Indeed, this is motivated by donkey-anaphora:

(16) a. If John owns a donkey, I bet he beats it.
b. Every farmer who owns a donkey beats it.

The general prediction is that wherever pronouns can find antecedents, presuppositions can too. The key difference between them, under this approach, is that presuppositions typically have more content than pronouns, and thus (it is argued) this allows them to sometimes be accommodated into the positions where an antecedent was sought but not found. The landing sites in the quest for an antecedent thus determine a set of possible scope sites. For example, with conditionals *if A, then* B^q_p, antecedents may be found within B itself (e.g., *if John is from Toronto, there is a king of France and the king of France is bald*), it may be found in A (e.g., (16-a)), or it may be found outside of A (e.g., *There is a king of France. If John is from Toronto, the king of France is bald*).[14] If no antecedent is found, then these sites on the search path are possible landing sites for accommodation, and among them there is a stipulated anti-locality preference: wide-scope ('global accommodation') $>$ within A ('intermediate accommodation') $>$ within B ('local accommodation').

DRT overcomes the problem faced by filtering approaches: it clearly captures the idea that embedded presuppositions are accessible at the root (because they are sometimes literally displaced there), and it captures the

[13]By 'referent' I mean 'discourse referent,' for reasons discussed elsewhere (e.g., Karttunen, 1976; Heim, 1982).

[14]Schwarz and Tiemann (2015) present evidence that cost of processing a presupposition carrying element varies with the distance of its antecedent; DRT projection paths provide a straightforward measure of distance.

preference for wide-scope by postulating a preference for anti-locality in accommodation decisions.[15] Nevertheless, important problems remain.

First, so far as I know, there is no attested 'intermediate accommodation' reading of conditionals: that is, there is no attested sentence *if A, then* B_p^q which is interpreted as 'if A and p, then q.' This possibility is clearly predicted (cf. the donkey-pronoun facts in (16-a)), and is in fact predicted to be preferred to the narrow-scope local accommodation possibility. We have already seen cases of global accommodation (e.g., (15-a)), and we have also seen what might be argued to be examples of local accommodation (e.g., (11-b)). But there is no known case of intermediate accommodation into the antecedent. Thus, it is precisely the non-standard 'sideways movement' possibility that seems banned.[16]

It has been argued that intermediate accommodation is attested in quantified sentences. For example, *every man loves his children* is predicted to have a reading 'every man who has children loves them'. The sentence clearly admits of this reading, but this reading could also be generated if the domain of the quantifier were restricted to only those men who have children (e.g., Beaver, 2004; von Fintel, 2004a, 2008; Beaver, 2001; Beaver and Zeevat, 2007; Fox, 2012; though cf. Geurts and van der Sandt, 1999). The availability of a restricted domain can (for some reason) be reduced by making the restrictor more heavy. When we do this, the purported intermediate accommodation reading disappears: *every one of these fifteen men loves his children* cannot be true if eight of the fifteen men have children, all of whom love their children. To be true, all fifteen men must have children and must love them.

In fact, quantified sentences are generally problematic for DRT. For example, the reader can readily confirm that the system fails to predict that a sentence like (1-d) = *no woman in that room loves her dog* on a bound-variable construal of *her* presupposes that every woman in that room has a dog; note that neither of the following readings entails the universal inference.[17]

(17) Readings predicted by DRT:

a. Intermediate accommodation: no woman in that room who

[15] This notion of accommodation is different from what is assumed in other approaches, such as Heim (1982). See section 4, and the companion article on presupposition accommodation.

[16] Schlenker's (2011) modification of DRT explicitly bans such problematic movement.

[17] The global accommodation reading that DRT normally provides is unavailable in quantified sentences because that would involve unbinding a variable, which is ruled out by the so-called 'trapping constraint' of van der Sandt (1992).

has a dog loves it

b. Local accommodation: no woman in that room has a dog and loves it

Clearly, something other than scope is responsible for the universal presupposition here, which I should add has been found to be robust in experimental settings (Chemla, 2009a).

There are further difficulties with reducing presupposition projection to scoping, even if we consider cases where intermediate accommodation is irrelevant. Consider again negative sentences like *the king of France is not bald*. DRT generates the two readings in (2-a) and (2-b), and in fact predicts the preference for the global reading in (2-a). However, as we noted earlier, the reading in (2-a) is interpreted with a presupposition that there is a king of France while the reading in (2-b) is interpreted without any presupposition. DRT systems fails to account for this difference: it provides a theory of displacement that is motivated by anaphora, but the approach does not admit a presupposition-assertion distinction at all.[18]

This leads the approach to difficulties elsewhere. Specifically, it means the system is unable to generate 'filtered' presuppositions. But the availability of such presuppositions is readily demonstrated, as discussed earlier with respect to (11-b) (e.g., see also Beaver, 2001; Schlenker, 2011a).

Finally, there are examples where an embedded presupposition appears to occupy multiple scope positions. Presuppositions under attitude predicates are well-known cases (e.g., Heim, 1992; Geurts, 1999a; Beaver and Geurts, 2011; Sudo, 2014).

(18) John believes Mary's car is blue

Sentence (18) presupposes both that Mary has a car and that John believes it. Thus, the presupposition that Mary has a car appears to sit below *believes* and above it. Zeevat (1992) suggests an amendment to DRT under which apparent displacement of presuppositions actually involves copying, so that the element occupies multiple sites simultaneously. This might relate in potentially interesting ways to the copy theory of movement assumed in some of the syntactic literature (e.g., Chomsky, 1995), but as a generalization about presupposition projection it seems incorrect. For example, recall that quantified sentences project universal presuppositions: *no woman in that room*

[18] I believe this could be remedied with the proposal in Singh (2014) if the projection mechanism proposed there applied to the post-displacement structures predicted by DRT, but I will not try to establish this here.

loves her dog presupposes that every woman in that room has a dog. Now consider the following sentence, modified from Schlenker (2011a):

(19) John believes that no woman in that room loves her dog
  a. that every woman in that room has a dog
  b. that John believes that every woman in that room has a dog

Schlenker (2011a) points out that this sentence presupposes (19-a) and (19-b). The pattern is exactly like (18): the sentence inherits the presupposition of the complement of *believe*, p, and it presupposes that the subject believes p. Unlike (18), however, multiple copying will not help here: the embedded presupposition 'x has a dog' can be copied into the restrictor and/or the nuclear scope, but there is no way to get either (19-a) or (19-b) out of these operations. Thus, multiple copying does not provide a general solution to the way presuppositions project out of attitude predicates. The source of the problem is by now familiar: embedded presuppositions sometimes get appear in higher sentences in modified form, but default projection theories are unable to make sense of this.

3.3 Brief summary

We have seen that complex sentences with embedded presuppositions seem to be ambiguous. The usual ambiguity-generating mechanisms do not help. Nor does it help to add new levels of representation. The preference for wide-scope, encoded in the generalization in (7), remains mysterious from filtering approaches. At the same time, there is significant evidence for the need to derive modified presuppositions, and this is not possible in default projection approaches. In the next section I will explore a possible synthesis of these two approaches, in the spirit of Soames (1982), that might contribute to resolving this tension.

4 Exploring a synthesis

4.1 Filtering and potential presuppositions

Default projection approaches treat presuppositions of embedded constituents as formal objects that are in principle accessible in matrix position. This information access comes with a cost: they are unable to derive modified presuppositions. Filtering approaches, on the other hand, assign a unique semantic presupposition to any given logical form, and this is often a modified

presupposition of an embedded constituent. However, the fact that this matrix presupposition is modified, and the particular way in which it has been modified, is lost at the root. At this point it is just a (possibly partial or three-valued) proposition, and the presuppositions of embedded constituents are inaccessible. Thus, the fact that embedded presuppositions often do project, are salient to speakers and hearers, and often are more accessible than the filtered presupposition itself, is puzzling.

I would like to suggest a possible way out of this tension: maintain with filtering approaches the association of each LF with a unique semantic presupposition, but allow the pragmatics to access a set of potential pragmatic presuppositions, among which it will find the presuppositions of embedded constituents. Specifically, suppose that filtering approaches provide the correct semantic presuppositions of sentences, and suppose that the decision about what to pragmatically presuppose is made by choosing from a set of potential presuppositions generated by considering the semantic presuppositions of various sentences. Clearly, in order to account for default projection this set of potential presuppositions – call it $\mathcal{H}$ – should include the semantic presuppositions of atomic sub-constituents of the sentence. However, given the existence of filtered presuppositions, the set should also contain the semantic presuppositions of more complex constituents. Which constituents are those? A reasonable starting point is to assume that the LF of the sentence gives us everything we need. For the moment, we identify the set of constituents with the sentence's sub-constituents. Specifically, let π be identified with the projection component of one of the filtering theories, and let S be a sentence. Then:

(20) `Subsentences and potential presuppositions:`

a. The set of potential presuppositions of S is $\mathcal{H} = \{\pi(S') : S'$ an alternative of $S\}$. (We write $\mathcal{H}$ instead of the more accurate $\mathcal{H}(S)$ to reduce clutter.)

b. S' is an alternative of S if and only if S' is a sentence contained in S.[19]

Recall that the difficulty I identified for filtering approaches was that there was no rationale for the pragmatic system to infer an unfiltered embedded presupposition when the system only has access to a filtered presupposition and the propositional information in the context. However, what we may have missed is that there are more resources available in the context than merely the propositional information in it. In particular, what is salient

[19] We assume a reflexive notion of containment (a sentence contains itself).

is presumably part of the conversational score (Lewis, 1979), and when a speaker utters a sentence they change this part of the score by making a set of constituents salient. (20) is motivated by this idea: it suggests that the decision about what to pragmatically presuppose in context is made by consulting this resource of salient constituents, which for the moment we identify with the set of sentences contained in the uttered sentence.

Let me work through a concrete example. Consider again presuppositions in attitude contexts, which are problematic for both filtering and default projection approaches (e.g., Beaver and Geurts, 2011). I provide an illustrative sentence – together with its bracketing – in (21).

(21) $[_{S_0}$ John believes $[_{S_1}$ it stopped raining $]]$

a. It stopped raining

b. John believes it stopped raining

There are two sentences contained in (21): (21-a) and (21-b). In deciding what (21) presupposes, default projection approaches consider the presupposition of (21-a), r = that it was raining, and decide whether or not to project r to the root. They stipulate a preference for projection to the root, but what is important is that r is the only potential presupposition that the projection mechanism considers. Thus, default projection approaches derive the inference that it was raining, but fail to derive the presupposition that John believes it. Filtering approaches, on the other hand, compute a filtered presupposition for (21), $B_j r$ = that John believes it was raining. However, at matrix level there is no access to the presupposition of the embedded constituent (21-a). There *is* a stage of computation at which the embedded presupposition r is generated, namely, when (21-a) is processed, but there is no trace of this at the root: here, only the semantic presupposition $B_j r$ is available, and it is only this proposition that the pragmatics gets to see.

Clearly, the semantic presuppositions of *both* constituents are needed to generate the intuitively correct pragmatic presuppositions (21) has. I believe (20) provides a natural way to accomplish this: it allows the root position to recover its computational history, and to use this history to generate a set of potential presuppositions that may become actual pragmatic presuppositions of the complex sentence. To illustrate but one way to compute (20), suppose that the set of potential pragmatics presuppositions $\mathcal{H}$ of a complex sentence is computed 'bottom-up' by extracting the semantic presuppositions of sentences that are encountered along the way. In such an architecture, the semantic presuppositions of more deeply embedded constituents will be computed before the semantic presuppositions of higher sentences. Starting

with an empty set $\mathcal{H}$, suppose that the semantic presupposition of each sentence encountered in the computation is added to $\mathcal{H}$, and suppose that these semantic presuppositions are computed in the way suggested by filtering approaches. By the time the root is reached, $\mathcal{H}$ will be the set of potential pragmatic presuppositions that get assigned to the sentence. In this way, we add to filtering approaches the idea that there is a set of potential presuppositions, but we use the filtering mechanism to generate these presuppositions and we extract the presuppositions of complex constituents as well.

To see how this works, return to (21) and initialize the set of potential presuppositions to $\mathcal{H} = \emptyset$. The most deeply embedded constituent is (21-a), and at this stage the set of potential presuppositions gets modified by adding r to it: $\mathcal{H} \cup \{r\} \leftarrow \mathcal{H}$. The next sentence that gets encountered is (21-b). The semantic presupposition of this sentence gets added to $\mathcal{H} = \{r\}$: $\mathcal{H} \cup \{B_j r\} \leftarrow \mathcal{H}$. This is the root, and the output is $\mathcal{H} = \{r, B_j r\}$. We can think of $\mathcal{H}$ as the grammar's contribution to helping speakers and hearers decide what to presuppose in context. Note that, unlike default projection approaches, we have the filtered presupposition $B_j r$ as a formal object, and unlike filtering approaches the embedded presupposition r is available without any additional effort. I leave it to the reader to confirm that the system extends to the example in (19) in exactly the same way as it applies to (21).

Once a set of potential presuppositions is derived, what determines which potential presuppositions become actual pragmatic presuppositions?[20] It seems clear that the default interpretation is that we pragmatically presuppose r and $B_j r$. Thus, there appears to be a default to pragmatically presuppose each proposition in $\mathcal{H}$. This suggests that the computational problem facing speakers and hearers is to select a subset of $\mathcal{H}$ as the pragmatic presuppositions of the sentence in the given context, and that there is a default preference to presuppose all the propositions in $\mathcal{H}$ itself. In this way, we recover the generalization (7) where it appears to be true, but also extend it to cases where filtered presuppositions are also inferred by default, such as $B_j r$ in (21).

Of course, the pressure to select $\mathcal{H} \in \mathcal{P}(\mathcal{H})$ is just a default (we use '$\mathcal{P}(\mathcal{T})$' to mean "the power set of set T"). We have seen that presuppositions can be cancelled, for example. Consider again the case of negative sentences like *the king of France isn't bald*. Let f be the proposition that there is a king of France. Then in this case the set of potential presupposi-

[20] I will not here take a stance on the controversial question of whether such inferences are triggered by accommodation, that is, only when the context does not satisfy the matrix sentence's semantic presupposition. See Heim (1992, 2006) and Geurts (1999a) for competing views, and Katzir and Singh (2013b) for an unsuccessful attempt to dissociate the theories.

tions is $\mathcal{H} = \{f\}$: the embedded constituent semantically presupposes f, and negation is a hole and thus it doesn't contribute any new presupposition to $\mathcal{H}$. Continuing to assume that any subset of $\mathcal{H}$ may be chosen as actual, there are two possibilities for what will be the actual presupposition of the sentence: (i) $\mathcal{H} = \{f\}$, which seems to be the default, and (ii) the empty set $\emptyset$, which means that there will be no presupposition at all. With (ii) we reconstruct the effect of presupposition cancellation, but there is no longer any need for a dedicated cancellation mechanism like 'local accommodation' (Heim, 1983) or the floating-A operator of Beaver and Krahmer (2001). Instead, there is just a single process, 'choose a subset of $\mathcal{H}$,' and what is described as 'cancellation' amounts to nothing more than choosing an apparently marked subset of $\mathcal{H}$ (the empty set).[21] Because there is no other motivation for these cancellation mechanisms, this allows for a simplification to the theory of presupposition.

Aside from the two non-arbitrary subsets $\emptyset$ and $\mathcal{H}$, other subsets of $\mathcal{H}$ may be chosen but it has notoriously been harder to find examples of this in the literature. One much-studied case is conditional presuppositions. For example, consider the contrast in (22):

(22) a. If John is a mechanic, he'll bring his wetsuit
b. If John is a scuba diver, he'll bring his wetsuit
c. If John has a wetsuit, he'll bring his wetsuit

For any sentence *if* A, *then* B_p, we will have the following set of potential pragmatic presuppositions: $\mathcal{H} = \{A \rightarrow p, p\}$. This is because the consequent semantically presupposes p, and the matrix sentence semantically presupposes the filtered presupposition $A \rightarrow p$. There is a strong tendency to interpret such sentences with presupposition p, as in (22-a), which pragmatically presupposes that John has a wetsuit (whether or not he's a mechanic). This is yet another case of the default preference to pragmatically presuppose all propositions in $\mathcal{H}$: assuming a material implication analysis of conditionals, $p \wedge (A \rightarrow p)$ is equivalent to p.

However, neither (22-b) nor (22-c) pragmatically presupposes that John has a wetsuit. In the case of (22-c), this might be because the antecedent generates an ignorance inference concerning John's having a wetsuit, which in turn gives a good reason for not presupposing that he does (see also note 20). However, in (22-b) there is no such conflict. Instead, it seems that the conditional $A \rightarrow p$ – or more accurately, the subset $\{A \rightarrow p\} \in \mathcal{P}(\mathcal{H})$ – can be selected alone if it is supported by a statistical generalization (e.g.,

[21] Recall that atomic sentences entail their presuppositions, so no cancellation is possible here.

that scuba divers generally have wetsuits).[22] The factors that allow for a set other than $\emptyset$ or $\mathcal{H}$ to be selected are hard to pin down, and I will not discuss them here.[23] The important point is that if the choice of a subset is constrained by non-arbitrariness, then plausibility considerations might allow certain subsets different from $\emptyset$ or $\mathcal{H}$ to enter the competition and sometimes win.

In fact, this possibility might shed light on an old puzzle in satisfaction-theoretic approaches to filtering. Satisfaction theories demand that a sentence that semantically presupposes p be used only in those contexts that entail p (Karttunen, 1974; Stalnaker, 1974; Heim, 1983). With this in mind, consider the following dialogue, from Heim (1992), between two kids talking on the phone (F-marked constituents are pronounced with pitch accent):

(23) John: I_1 am already in bed.
Mary: My parents think that I_F am also_1 in bed.

Suppose that I_F *am* $also_1$ *in bed* presupposes that $g(1)$ is in bed, where g is a contextually determined assignment function subject to the constraint that $g(1)$ be someone other than the speaker. In the given context, $g(1)$ = John. The verb *think*, like *believe*, is a filter, such that the sentence uttered by Mary semantically presupposes that her parents think that John is in bed. But Heim (1992) notes that Mary's parents need not have any belief about John for the sentence to be felicitous, nor is the hearer compelled to accommodate this information. The appropriateness of the sentence seems assured by John's assertion that he is in bed. This is surprising for satisfaction theories: the semantic presupposition of a sentence is waived only by local accommodation, but our natural interpretation of the sentence is that it pragmatically presupposes that someone other than Mary is in bed, and this is satisfied by John's assertion that he is in bed. There is no local accommodation here, and the actual semantic presupposition seems irrelevant.

Heim (1992) hinted at an analysis under which Mary's utterance is given a *de re* construal: 'of the property of also being in bed, my parents think I

[22]Note that if we replace the lexical items here with nonce words, the sentence is ambiguous: *If John is a kabaddi player, he'll bring his chappal*. To understand the sentence, we feel that we need some contextual information about whether there's a connection between being a kabaddi player and having a chappal: if kabaddi players in general have chappals, we stick to a conditional presupposition, but if there's no such connection, then we conclude that John has a chappal.

[23]Work on the so-called 'proviso problem' (Geurts, 1996) in particular has been concerned with clarifying these factors; see e.g., Karttunen and Peters (1979); Beaver (2001); Heim (2006); van Rooij (2007); von Fintel (2008); Pérez Carballo (2007); Singh (2007, 2008, 2009); Schlenker (2011b); Lassiter (2012); Fox (2012).

have it.' This description of the property 'being in bed' is true of it just in case John is in bed, and in the context only Mary can describe it this way (her parents clearly can't). Heim expressed reservation about whether the proposal can be worked out (see her note 51). Under our proposal, this innovation can be avoided if we assume that (the conjunction of the propositions in) any subset of $\mathcal{H}$ may be the pragmatic presupposition of the sentence, even if the result does not entail the semantic presupposition of the sentence itself. Thus, in (23), the set of potential presuppositions is: {that John is in bed, that Mary's parents think that John is in bed}, and it seems that speaker and hearer are satisfied with taking John's being in bed to be the pragmatic presupposition of the sentence even though the semantic presupposition itself is disregarded and not entailed by John's being in bed. Allowing for this possibility involves a significant departure from at least some versions of the satisfaction theory, and would demand significant revisions to the bridge principles that are commonly assumed. This is not the occasion to explore these possibilities, though I hope it is useful to at least mention the kinds of questions that arise once we begin exploring the synthesis.

4.2 Returning to previously raised questions

With $\mathcal{H}$ in hand, let me return to some of the questions raised at the end of section 1.3.

First, what is the mechanism that gives rise to the apparent ambiguity in what a sentence presupposes? Our answer is that there is a choice in which subset of $\mathcal{H}$ is selected. In principle, the ambiguity should grow exponentially in the size of $\mathcal{H}$ (because the cardinality of the power set of any finite set is exponentially larger than the cardinality of the set itself).

Second, why is there a preference for embedded presuppositions to project to the root? Such a preference has long been noted, both in default projection approaches but also in filtering approaches (e.g., Heim, 1983). Our answer is that this preference has been misdescribed, which might make sense of why it has resisted explanation (see Geurts, 2000 and Beaver and Zeevat, 2007 for discussion). If what I am suggesting here is on the right track, the preference instead is to select the entire set $\mathcal{H}$. It is an interesting question what this preference follows from. Let me dwell somewhat on it here.

First, there is work to be done in clarifying the notion of 'preference'. The data suggest that, unless there is compelling reason to not choose $\mathcal{H}$, this choice is essentially forced on us. For example, we are typically unaware that there is any other reading at all. Of all the subsets of $\mathcal{H}$, why should this one be so strongly imposed on us? When looking for a subset of

a set, there are two non-arbitrary sets in any context of use: the empty set, and the entire set. These correspond precisely to 'cancellation' and to 'default projection', respectively. But the data suggest that default projection is preferred to cancellation, which means that $\mathcal{H}$ is preferred to $\emptyset$. Why?

A few considerations come to mind. First, this preference might follow from something like the 'strongest meaning hypothesis' (Dalrymple et al., 1998), a principle that has been proposed for presuppositions in previous work (e.g., Blutner, 2000). The principle has been argued to be inadequate (e.g., Geurts, 2000; Beaver and Zeevat, 2007), but this might have been due to incorrect assumptions elsewhere (e.g., filtered presuppositions weren't considered). Second, the linguistic system might have a general tendency to seek out maximal elements of ordered sets.[24] Here, the set $\mathcal{P}(\mathcal{H})$ is naturally ordered by the inclusion relation, and under this ordering $\mathcal{H}$ corresponds to the maximal element and $\emptyset$ corresponds to the minimal element. Finally, economy-theoretic principles might also be relevant. Why go through the bother of using a sentence that has potential presuppositions $\mathcal{H}$ if the elements of this set are not going to be used?[25] Sub-optimal choices should be justified, and if there is no obvious purpose that is served by creating $\mathcal{H}$ only to disregard the elements in it, good conversational partners would avoid this option wherever possible. These considerations do not answer the question of why $\mathcal{H}$ stands out, but I hope the directions mentioned might be considered worth pursuing in future work.

Finally, we raised the question of why the presupposition of an embedded constituent is pragmatically presupposed when the presupposition projects, and why there is no pragmatic presupposition at all when it remains local in its triggering constituent. Our answer is that there will be an intuitively felt non-trivial pragmatic presupposition anytime a non-empty subset of $\mathcal{H}$ is selected to become the set of actual pragmatic presuppositions. The case of an embedded presupposition projecting is just a special case of this general result (the embedded presupposition is an element of the subset that is chosen). When the empty set is chosen, there is obviously no pragmatic presupposition to speak of;this is described as 'presupposition cancellation, but under the current direction nothing is being cancelled.

[24] See e.g., a typology of such operators in Fox and Hackl (2006). In Katzir and Singh (2013a), it is assumed that simplex operators are restricted to `min` and `max`. However, as noted there, `max` operators can also appear with *n-* marking (e.g., *nor, never*) but `min` operators never do (e.g., **nand*, **nalways*). This might suggest that `max` is somehow more central than `min`.

[25] Spector (2014) has recently argued for a condition that bans the use of superfluous alternatives in implicature computation.

4.3 A brief remark on potential presuppositions

We are pursuing the idea that the pragmatic presuppositions of a sentence S in a given context are determined by selecting elements from a set of potential presuppositions $\mathcal{H}(S)$, generated by considering the semantic presuppositions of a set of alternative sentences. We have further been assuming that the set of alternatives is identified with the set of sentences contained in S. There are two conceptual motivations behind the general approach: (i) the LF of the sentence itself is a valuable resource (speakers choose certain forms for a reason), (ii) one of the consequences of using a particular LF is that other LFs are made salient, and what we presuppose in context seems to make use of LFs that are salient in the context.

The idea of using sets of alternative sentences to derive pragmatic presuppositions has been explored in some of the recent literature (e.g., Heim, 2006; Singh, 2007, 2008, 2009; Schlenker, 2011b; Fox, 2012). This work suggests that alternatives that are not subconstituents might also be needed. Consider for example what Schlenker (2011a) calls the 'Singh/Geurts problem:'

(24) If John is a scuba diver and wants to impress his girlfriend, he'll bring his wetsuit

Ignore all presupposition triggers except *his wetsuit*, and symbolize the sentence as *if* A_1 *and* A_2 *then* B_p. Then the formulation in (20) would associate (24) with the following set of potential presuppositions: $\mathcal{H} = \{p, (A_1 \wedge A_2) \rightarrow p\}$. However, the intuitively felt pragmatic presupposition here is $A_1 \rightarrow p$, and this is not the presupposition of any constituent in (24). Evidently, what is needed is a way to use *if John is a scuba diver, he'll bring his wetsuit* as an alternative. Following Schlenker (2011b), we need to 'ignore' certain parts of the sentence, here *and wants to impress his girlfriend*. One way to do this is to expand the set of alternatives from the set of sentences contained in S to to the set of sentences derivable by deleting parts of the tree, or equivalently, by substituting nodes in S with their subconstituents (a subset of the operations used to generate scalar alternatives in Katzir, 2007 and Fox and Katzir, 2011). Thus consider the following revision to (20), different only in the alternatives that are assumed ((20-b) is replaced by (25-b)):

(25) `Deletion and potential presuppositions:`

a. The set of potential presuppositions of S is $\mathcal{H} = \{\pi(S') : S'$ an alternative of $S\}$.

b. S' is an alternative of S if and only if S' can be derived by replacing nodes in S with their subconstituents.

The sentences derivable using (25-b) are a superset of the sentences derivable using (20-b) because (25-b) produces subsentences as well as other sentences that are not constituents of the uttered sentence. This helps with (24), but it runs into problems elsewhere. Consider the following example from Geurts (1996):

(26) Mary knows that if John is from Toronto, he has a wetsuit

The sentence semantically presupposes that if John is from Toronto he has a wetsuit, and this is also the pragmatic presupposition of the sentence. This is exactly what we expect if (20-b) is used, because the only sentence contained in (26) that has a presupposition is the root. But it is surprising if (24) is used, because there are alternatives that carry presuppositions, such as *Mary knows that John has a wetsuit*, which presupposes that John indeed has a wetsuit. But the sentence does not presuppose this, nor does it presuppose anything other than the semantic presupposition of the sentence itself. Unless one can find a principled reason to prevent these potential presuppositions from becoming actual, there is a real tension here.[26] I will leave the matter here, and refer the reader to relevant literature (see especially Schlenker, 2011b,a; Fox, 2012).

5 Concluding remarks

The projection problem for presuppositions is perhaps really a set of problems about the interaction between syntax, semantics, pragmatics, and general world knowledge. I hope that our focus on the default projection generalization has helped illuminate the richness of the subject: its puzzling data, the many innovative attempts to describe and explain them, the many open questions that remain, and the potential consequences for the architecture of language and mind.

[26] Heim (2006) and Singh (2008, 2009) suggest that this inference might be blocked by an ignorance inference that about John's having a wetsuit, bringing us back to a Gazdarian picture about the interactions between implicatures and presuppositions. Working this out here would take us too far from the main thrust of the paper. See also Spector and Sudo (2014) for interactions between ignorance inferences and presuppositions.

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