DRT with Local Contexts[1]

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Abstract: In this note, we reconstruct some results of the DRT analysis of presupposition projection within the theory of local contexts of Schlenker 2009. The latter offered a way to annotate every sentence with variables that denote the various local context sets that play a crucial role in Heim's satisfaction theory (Heim 1983). In standard satisfaction theories, a presupposition must be entailed by its local context. Here we allow a presupposition to be indexed with other local contexts, and we propose – following van der Sandt 1992 and Zeevat 1992 – that presuppositions are preferably anaphoric to the highest possible context. The resulting analysis emulates some desirable results of DRT – notably its solution to the 'Proviso Problem' (Geurts 1999). But it arguably improves on DRT in some respects: it can generate genuine conditional presuppositions; and it yields more adequate results for some quantified examples. Several limitations of the theory – some of them quite severe – are also discussed.

In earlier work, we proposed an algorithm that annotates every sentence with context variables on propositional and predicative expressions (Schlenker 2009). These variables denote the 'context sets' that play a crucial role in Heim's dynamic theory of presupposition projection (Heim 1983). *Modulo* certain assumptions, the resulting theory is equivalent to Heim's, but it does without dynamic lexical entries: the value of the context variables can be *predicted* once the syntax and the classical semantics of a sentence have been specified (in Heim's framework, by contrast, dynamic lexical entries could be stipulated at will, which made the analysis insufficiently explanatory).

In this earlier work, we followed Heim's satisfaction theory in claiming that a presupposition must be entailed by its local context. But since in our analysis context variables can be explicitly represented in Logical Forms, we can also explore a different analysis, much closer to the spirit of Discourse Representation Theory (DRT, van der Sandt 1992, Geurts 1999). We briefly sketch this theory and list some cases in which it improves on orthodox DRT, and others in which it inherits some of its difficulties, or must be refined to match its results. The present note attempts, like Zeevat 1992, to unify Heim's theory and DRT. But the strategy we adopt is very different from Zeevat's, in at least two respects: first, Zeevat assumed a rich dynamic semantics, whereas we start from a notion of local contexts which is entirely derivative on a classical semantics; second, Zeevat 'semanticized' DRT's representational analysis by appealing to stacks of information states to keep track of the possible antecedents of presuppositions – whereas we directly encode the connection between a trigger and its antecedent in the syntax (we leave for future research a systematic comparison with Zeevat's system).

The definition of local contexts used in Schlenker 2009 is given in Appendix I. For present purposes, the reader may simply assume that our context variables denote the local contexts of Heim's analysis. Typographically, a context variable appears as a superscript right before the expression whose local context it provides. Let us give three examples.

(i) Take a sentence *F* uttered in a (global) context set C. In ${}^{c_0}F$, which is *F* decorated with the local context variable c_0, the latter just denotes C.

[1] Many thanks to Emmanuel Chemla, Bart Geurts and an anonymous referee for suggestions and criticisms on an earlier version. All errors are mine.

(ii) Now consider a sentence *(F and G)*. We can annotate it with context variables as in $^{c_0}(^{c_1}F$ *and* $^{c_2}G)$. As before, c_0 denotes C, and so does c_1. But c_2 denotes the local context of *G*, which is the intersection of C with the meaning of *F* - written as C ∧ **F** (∧ is used for generalized conjunction/intersection, and we put in bold the semantic value of an expression).

(iii) Finally, consider a sentence *(F or G)*. We can annotate it to yield $^{c_0}(^{c_1}F$ *or* $^{c_2}G)$, where c_0 and c_1 denote C. As for c_2, it is shown in Schlenker 2009 that it denotes the intersection of C with the meaning of *(not F)* (i.e. C ∧ **(not F)**). While Heim 1983 did not discuss disjunction, our result is equivalent to the dynamic analysis offered in Beaver 2001.

We will now set out to reconstruct some of the main ideas of DRT. Our goal is to show that *if one believes in DRT in the first place, then one should consider the present attempt as offering some improvements on it*. Our goal is thus a modest one: we do not claim that the resulting theory is a fully adequate analysis of presupposition projection, but only that it is a natural candidate to consider in current debates on this topic. To be quite explicit: some of the problems that are inherited from DRT at the end of the day seem to us to be quite severe.

1 Emulating DRT

1.1 Basic ideas

DRT (van der Sandt 1992, Geurts 1999) is a representational theory of presupposition that was intended as an alternative to Heim's purely semantic 'satisfaction theory' (Heim 1983). One key motivation was that the satisfaction theory often predicts presuppositions that are too weak – which has been dubbed the 'Proviso Problem'. To give but one example, Heim's analysis predicts for (1)a a conditional presupposition, of the form: *if the problem was easy / difficult, then someone solved it* (technically, this result is obtained because those worlds within the context set that satisfy the antecedent of the conditional must satisfy the presupposition of its consequent). But in fact one typically obtains a stronger, unconditional presupposition. Furthermore, it is difficult to argue that world knowledge alone is responsible for the strengthening, because (1)b does yield a conditional presupposition of precisely this form – and this one is *not* strengthened.

(1) a. If the problem was easy / difficult, then it isn't John who solved it. (Geurts 1999)
=> Someone solved the problem.
b. Peter knows that if the problem was easy / difficult, someone solved it. (Geurts 1999)
≠> Someone solved the problem.

The basic idea of DRT is that presuppositions are parts of a Logical Form that want to 'percolate up' as far as possible in a sentence. Whenever possible, they are given matrix scope, though other – and less preferred – possibilities are also open. To illustrate, we start from a sentence such as (2)a, which is given the initial representation in (2)b – and here too the presupposition is underlined.

(2) a. If John is realistic, he knows that he is incompetent.
b. $[_1$ x: John x, $[_2$: realistic x] ⇒ $[_3$: <u>x is incompetent</u>, x believes that x is incompetent]]

There are various 'projection sites' that the underlined material could land to (accessibility constraints are taken to be given independently by constraints on anaphora, which is what DRT was originally designed to handle in Kamp 1981). We obtain three possible readings depending on where the presupposition lands: in (3)a it appears at the matrix level, and we

obtain an unconditional inference that John is incompetent – which is the preferred reading; in (3)b, the presupposition lands in the antecedent of the *if*-clause ('intermediate accommodation'), while in (3)c it stays in its original position ('local accommodation'). In this case these readings are not plausible, but they have been claimed to be instantiated in other cases (this is not debated for local accommodation; intermediate accommodation is far more controversial, as is for instance discussed in Beaver 2001).

(3) a. **Reading 1 [preferred]: Global Accommodation**
[$_1$ x: John x, **x is incompetent** [$_2$: realistic x] ⇒ [$_3$: x believes that x is incompetent]]
b. **Reading 2: Intermediate Accommodation**
[$_1$ x: John x, [$_2$: realistic x, **x is incompetent**] ⇒ [$_3$: x believes that x is incompetent]]
c. **Reading 3: Local Accommodation**
[$_1$ x: John x, [$_2$: realistic x] ⇒ [$_3$: **x is incompetent**, x believes that x is incompetent]]

We will attempt to emulate the main results of DRT by implementing in a very different way its key intuition, which is that *presupposition resolution is a species of anaphora resolution*. Since DRT was intended as a theory of anaphora resolution in Kamp 1981, its adoption for presuppositional purposes already encoded this intuition in van der Sandt's work (1992). Here we will explore a different anaphoric theory: we will suggest that presupposition triggers must be literally indexed with context variables which explicitly represent in a Logical Form the local contexts that played a crucial role in Heim's analysis (1983).

On a technical level, we assume the analysis developed in Schlenker 2009, which offered a systematic way of annotating sentences with context variables on propositional and predicative expressions. Since it was assumed that each presupposition must be entailed by its *local* context, there was no need to indicate which trigger depends on which context variable. By contrast, we will now assume that presupposition triggers must be coindexed with some context variable (in simple cases, coindexation is with one context variable only, but we consider below the case of coindexation with two context variables).

(4) a. Each presupposition trigger is coindexed with a context variable.
b. The context of speech shoud guarantee that the presupposition of each trigger is entailed by each context variable it is coindexed with.

As in DRT, some notion of accessibility should be defined to constrain indexing possibilities. For present purposes, we can take a context variable to be accessible to a trigger just in case it appears on a constituent that dominates it (though this rule could easily be modified):

(5) A context variable is accessible to a trigger *T* if and only if it appears on a constituent that dominates *T*.

If indexing were always maximally local, we would obtain a variant of Heim 1983 and Schlenker 2009. But here we will follow (some versions of) DRT in assuming a different indexing rule:[2]

(6) Index a presupposition trigger with the highest accessible context variable, subject to the following constraints:
(i) No constituent should be made trivial (i.e. contradictory or tautologous) relative to its most local context.
(ii) Subject to (i), a trigger should in general be coindexed with the highest accessible context variable

[2] Both van der Sandt 1992 and Geurts 1999 state that accommodation is usually done at the highest possible site. In van der Sandt's words: "accommodation will generally take place at the highest accessible level such that the resulting structure does not violate general constraints on (un)binding and acceptability".

1.2 Matrix vs. local indexing

Three simple examples are given in (7).

(7) a. ^{c_0}[It has [stopped raining]$_0$]
b. ^{c_0}[If ^{c_2}[John is outside], ^{c_1}[it has stopped raining]$_0$]
c. ^{c_0}[If ^{c_2}[it rained], ^{c_1}[it has stopped raining]$_1$]

-In (7)a, *[stopped raining]* is coindexed with the only available context variable, c_0, which denotes the global context C – hence a presupposition that it rained.
-In (7)b, there are two accessible context variables, c_0 and c_1. Coindexation with the higher variable c_0 also yields a presupposition that it is raining (Heim 1983 predicted a conditional presupposition that *if John is outside, it is raining*). (Note that given (5), the variable c_2 is not accessible to the consequent of the conditional, because it appears on a constituent, namely the antecedent *John is outside*, which does *not* dominate the consequent.)
-In (7)c, coindexation with c_0 would force the global context to entail that it is raining – which would make the antecedent of the conditional locally trivial. Hence coindexation with c_1 is forced. As in Heim's system, the local context of the consequent is the global context updated with the information that it rained – hence no matter what the global context is, c_1 will entail the presupposition of the consequent; thus the entire sentence presupposes nothing. (Here too, the variable c_2 is not accessible to the consequent of the conditional.)

1.3 Intermediate indexing vs. intermediate accommodation

In some cases, DRT allows for the possibility of intermediate accommodation. Some - but not all - of these cases can be handled by allowing a presupposition trigger to be indexed with an intermediate context variable (note that we clearly distinguish in our terminology 'intermediate accommodation', which is a mechanism of orthodox DRT, and 'intermediate indexing', which is a mechanism of the present theory; the two sometimes do and sometimes do not yield similar results).

Let us start with some of the examples which, as Bart Geurts reminds us, are particularly robust (see also Geurts 1999). Consider the examples in (8)-(9):

(8) John believes that if Fred comes to the party, the king of France will be there, too. (Geurts, p.c)

(9) a. Mary is convinced that if Obama agrees to meet with me, I will realize that he is a genius.
b. Mary is convinced that if Obama agrees to meet with me, he is a genius.

In (8) and (9)a, we can derive an inference that the *agent* believes that the presupposition of the embedded clause is satisfied: John believes that there is a king of France; and Mary is convinced that Obama is a genius; we need not derive the stronger inference that the *speaker* adheres to such a belief (for instance, a diehard Republican could utter (9)a felicitously). Let us focus on (9)a.[3]
-A straightforward extension of Heim's theory, developed in Heim 1992, predicts that each world compatible with Mary's beliefs should satisfy the presupposition of the embedded clause. The latter is itself predicted to yield a conditional presupposition, of the form: *if Obama agrees to meet with me, he is a genius*. So in the end we predict an inference such as (9)b.
-In fact, however, a stronger inference is obtained: *Mary is convinced that Obama is a genius*. Furthermore, it is not easy to argue that world knowledge leads to a strengthening of

[3] (8) is harder to analyze because the world variable of the definite description could be 'bound' within the conditional or by the attitude verb – which complicates the discussion.

the conditional inference, since in (9)b (considered now as an object-language sentence) it fails to obtain.

Orthodox DRT can solve the problem by taking this to be a case of intermediate accommodation: the presupposition triggered by *realize* is accommodated (i.e. moved or copied) above the conditional but within the scope of the attitude verb. Thus the initial representation in (10)a is resolved as in (10)b (we abstract away from inessential details).

(10) a. [$_1$ x: Obama x, Mary is convinced that [$_2$: [$_3$: x agrees to meet with me] ⇒ [$_4$: <u>x is a genius</u>, I believe that x is a genius]]]
b. [$_1$ x: Obama x, Mary is convinced that [$_2$: **x is a genius** [$_3$: x agrees to meet with me] ⇒ [$_4$: I believe that x is a genius]]]

In this case, we can come close to the results of DRT with intermediate indexing. Let us see how (for the moment, we treat *I will realize that he is a genius* as a propositional presupposition trigger).

(11) ^{c_0}[Mary is convinced ^{c_1}[that if Obama agrees to meet with me, ^{c_2}[I will realize that he is a genius]$_1$]]

Here we have assumed that the presupposition trigger is not indexed with c_0 (maybe because the resulting presupposition is known to be false), but rather with c_1. Note that this is possible given the accessibility rule in (5), since c_1 appears on a constituent (namely the entire clause embedded under *convinced*) which dominates the presupposition trigger. In the framework of Schlenker 2009, c_1 will end up denoting the set of worlds compatible with what Mary is convinced of.[4] With this indexing, we predict that the global contexts should ensure that Mary is convinced that Obama is a genius – which appears to be correct.[5]

There are other cases in which our analysis *fails* to replicate the orthodox DRT account of intermediate accommodation. This is systematically the case when intermediate accommodation is in a restrictor – for instance the restrictor of a conditional, as in (12), or the restrictor of a quantifier, as in (13). For concreteness, consider (12)a (previously discussed as (2)), with the initial representation in (12)b, and the DRT resolution (through intermediate accommodation) in (12)c.

(12) a. If John is realistic, he knows that he is incompetent.
b. [$_1$ x: John x, [$_2$: realistic x] ⇒ [$_3$: <u>x is incompetent</u>, x believes that x is incompetent]]
c. [$_1$ x: John x, [$_2$: realistic x, **x is incompetent**] ⇒ [$_3$: x believes that x is incompetent]]

(13) a. No student has stopped smoking.
b. [$_1$ No x: [$_2$: student x] [$_3$: <u>x used to smoke</u>, x doesn't smoke]]
c. [$_1$ No x: [$_2$: student x, **x used to smoke**] [$_3$: x doesn't smoke]]

For (12)a, we end up in orthodox DRT with an inference that *if John is realistic and he is incompetent, he knows that he is*. By similar reasoning, we obtain for (13)a an inference that *no student who smoked has stopped* (as we discuss the below, experimental results suggest that the latter result is too weak). In our system as we defined it in Section 1.1, intermediate indexing is not possible in cases such as (12)-(13). For concreteness, consider our analysis of (12)a, given in (14):

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[4] See Schlenker 2009 Section 3.2.1 for discussion. For technical reasons, this result requires the adoption of a bidimensional semantics such as the one used by Kaplan to treat indexicals (Kaplan 1989).

[5] The logical reason why we can emulate the results of intermediate accommodation in (11) is that *x is convinced that F* (evaluated at a given world) has a universal semantics: (i) every world compatible with what *x* believes satisfies: *F* holds in w. In the system of Schlenker 2009, the local context of *F* is the set of worlds that are compatible with what *x* believes. In (11), intermediate indexing with c_1 yields a requirement that: (ii) every world w compatible with what *x* believes satisfies: Obama is a genius in w. (i) and (ii) taken together are equivalent to: (iii) every world w compatible with what *x* believes satisfies: (a) Obama is a genius in w, and (b) *F* holds in w. Taking *F* to be the embedded conditional in (11), we derive the truth conditions predicted by orthodox DRT with intermediate accommodation in (10)b.

(14) ^{c_0}[If ^{c_2}[John is realistic], ^{c_1}[he knows that he is incompetent]$_2$]

The variable c_2 does not appear on a constituent that dominates the presupposition trigger (unlike the variable c_1 in (11)); given the accessibility rule in (5), c_2 is not accessible to the trigger, and for this reason intermediate indexing is impossible. Importantly, even if we allowed intermediate indexing (by modifying (5)), it would yield different results from orthodox DRT's intermediate accommodation. Consider for instance (12). For Heim, the local context of the antecedent of a conditional is just the global context set C, and this result is also obtained in Schlenker 2009 - hence c_2 just denotes C. So in this case indexing with c_2 yields the same result as matrix indexing – and not at all the results of intermediate accommodation in DRT.[6]

The reason for the difference between intermediate *indexing* (in our system) and intermediate *accommodation* (in orthodox DRT) is that, in the latter case, a presupposition that is accommodated in a certain locus becomes part of the assertive content in that locus. Our theory does no such thing: local contexts are not 'added' to the meaning; rather, they aggregate the information contributed by the earlier parts of a sentence or discourse. They then impose different constraints on the global context depending on which trigger is indexed with which context variable.

There has been considerable debate about cases of intermediate accommodation, with several authors (especially Beaver 2001) expressing skepticism as to their existence (this skepticism is strengthened by some of Chemla's experimental results, as we'll see below). Importantly, however, this skepticism concerned examples such as (13)-(13), with accommodation into a restrictor, rather than the 'robust' examples in (8)-(9). In other words, the relatively clear cases of intermediate accommodation are ones that our analysis allows for, while the controversial cases are ones our analysis precludes. We tentatively conclude that it might be a good thing that we do not generate all cases of intermediate accommodation (we come back to the issue of intermediate accommodation in Section 3.2 and in Appendix II).

1.4 Local indexing vs. local accommodation

What should we do in cases such as (15), where the constraints in (6) can't be satisfied?

(15) ^{c_0}[It didn't ^{c_1}[stop raining]] … because it never rained.

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[6] For (13)a, intermediate indexing in the present system would also yield very different results from intermediate accommodation in orthodox DRT. As in the case of (14), we would need to modify the accessibility rule in (5) to allow the trigger in (i) to be coindexed with the local context of the restrictor (since the latter does not dominate the trigger):

(i) ^{c_0}[No ^{c_2}[student]] ^{c_1}[has stopped smoking]$_2$

(Note that for simplicity we analyze (i) without variables. See Section 3.1 for a discussion of variables.) If (5) were relaxed to allow for this indexing, we would obtain an implausibly strong presupposition, namely that *every individual in the domain used to smoke* (this is because the local context c_2 of *student*, which is of predicative type, is the property which, in every world w of the context set C, is true of all the individuals in the domain; for this property to entail the property of having smoked, it must be that every individual in the domain used to smoke). Therefore, if (5) were relaxed so as to make this indexing possible, it would be wise to constrain the system further, e.g. by making such an indexing a very last resort.

Following the spirit of Heim 1983, Schlenker 2009 predicts the same value for c_0 and c_1 (negation does not affect the computation of local contexts). But the global context can't be one in which it rained, since this would make the *because*-clause trivially false.[7]

Within orthodox DRT, matrix accommodation cannot work, because it would lead to the assertion of a contradiction (with a meaning akin to: *it rained and …. because it never rained*). Instead, local accommodation must be used; thus the initial representation in (16)a ends up being interpreted as in (16)b, which is adequate.

(16) a. [not [: <u>used to rain</u>, rain]]
b. [not [: **used to rain**, rain]]

But within the present system, local indexing does not help (which again underscores the fact that indexing and accommodation are two different things). So we will go for the simplest formal solution: as a last resort, a presupposition can be turned into part of the assertive component.[8]

(17) If a presupposition cannot be satisfied according to (6), it may be turned into a part of the assertive component.

We discuss in Appendix II an alternative which is much closer to Heim's view of 'local accommodation', and which also makes it possible to reconstruct some (possibly dubious) cases of intermediate accommodation.[9]

2 Improving on DRT ?

2.1 Quantified statements

In DRT, the 'trapping constraint' forces a presupposition that contains a bound variable to remain within the scope of its binder. This is the case in *No student stopped smoking*, which is predicted to mean *No student who smoked stopped* (intermediate accommodation), or *No student smoked and stopped* (local accommodation). But Chemla 2009 shows with experimental means that for (French) examples with the determiner *no* a universal inference is obtained: *Every student smoked*. The same result is of course obtained for *every*, but it must be mentioned that for other quantifiers universal inferences are quite a bit less strong (we do not derive the latter result; see Chemla 2009 for details).

How can the present account deal with the facts for the determiner *no*? Consider (18).

(18) ^{c_0}[[No ^{c_2}student] ^{c_1}[stopped smoking]$_1$]

The only accessible context variables are c_0 and c_1. c_0 is propositional, while c_1 is predicative – as is the presupposition of *stopped smoking*. The latter must be indexed with c_1, and we derive the result of Heim 1983 and Schlenker 2009: the property of being a student in C must

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[7] An anonymous referee asks whether this case couldn't be handled in terms of metalinguistic negation. It could, but the solution wouldn't generalize: the effects of local accommodation can be seen in sentences that do not contain a negative operator, for instance: *If I realize that I have made a mistake, I will own up to it*. The presupposition triggered by *realize* does not project out of the antecedent of the conditional; it seems to be locally accommodated within that antecedent. An analysis in terms of metalinguistic negation would not be applicable in this case.

[8] This is also the analysis of local accommodation offered in Schlenker 2009. This operation is very simple to implement because the semantics assumed in that framework is bivalent. For this reason, applying local accommodation just means that the 'official' semantics of the expression is computed without further ado; in particular, the bivalent semantics gives to a clause *<u>p</u>p'* the very same meaning as to the conjunction *(p and p'),* and this meaning is precisely what is desired when local accommodation is applied.

[9] See Schlenker 2009 Section 5.1. for a brief discussion of intermediate accommodation within that framework.

entail the property of smoking – hence the universal inference that *every student used to smoke*.

In other cases, the present system is less adequate. As was also shown in Chemla 2009, presupposition projection from the restrictor of quantifiers is quite weak. This can be illustrated with the following contrast:

(19) a. None of my students who applied for this job knows that he is incompetent.
Predicted presupposition (Heim 1983): Each of my students who applied for this job is incompetent.
Actual presupposition: Same.

b. None of my students who knows that he is incompetent applied for this job.
Predicted presupposition (Heim 1983): Each of my students is incompetent.
Actual presupposition: Much weaker inference.

When the presupposition trigger is embedded within the nuclear scope, we obtain the inference predicted by Heim 1983. Not so when the trigger is in the restrictor: no universal inference is derived, or at most a very weak one.

DRT cannot derive the nuclear scope case, as we already noted. But with respect to the restrictor, it does just fine – intermediate accommodation into the restrictor yields a final meaning akin to: *No student who is incompetent and knows it applied for this job*; this seems about right. By contrast, the present approach does fine in the nuclear scope case, but it replicates Heim's predictions for the restrictor (because only local indexing is available) – and these appear to be too strong.

2.2 Conditional Presuppositions

It has been argued that in some cases *bona fide* conditional presuppositions do arise (e.g. Beaver 2001). By '*bona fide* conditional presuppositions' I mean conditional inferences that project like presuppositions, and thus cannot be explained away as mere entailments. I believe the examples in (20) have this property, but given standard disagreements on such matters in the literature, experimental data would be needed to settle the issue (see Chemla and Schlenker 2011b for a preliminary experimental attempt, based on the anaphoric trigger *too*).

(20) a. If you accept this job, will you let your family know that you're going to be working for a thug?[10]
=> If you accept this job, you're going to be working for a thug.
≠> You're going to be working for a thug.
b. If you accept this job and let your family know that you are going to work for a thug, they won't be happy.
=> If you accept this job, you're going to be working for a thug.
≠> You're going to be working for a thug.

(20)a has the form *if p, q̲q' ?* with *p = you accept this job* and *q = you will work for a thug*. If the conditional did not appear in a question, the inference we obtain (= *If you accept this job, you are going to be working for a thug*) could be treated as a mere entailment. But the fact that the conditional inference survives in a question suggests that we are dealing with a *bona fide* conditional presupposition. The same argument applies to (20)b, which is of the form *if p and q̲q', r*. Here we obtain the conditional inference predicted by Heim 1983: *p and q̲q'* presupposes *if p, q*, and this presupposition projects out of the antecedent of the conditional; this fact is unexplained if we are dealing with a mere entailment of the second conjunct, or if presuppositions project as they do in orthodox DRT.

[10] Thanks to D. Rothschild for discussion of this and related examples.

DRT has no way of deriving *bona fide* conditional presuppositions. But the present system does: if we tweak the indexing rules in (6) so as to allow for local indexing in these cases, we obtain exactly Heim's presuppositions, i.e. a conditional inference. A simplified example is given in (21), where we take the entire second conjunct to trigger a propositional presupposition of the form *you will work for a thug*.

(21) ^{c_0}[You will accept this job and ^{c_1}[your family will know that you will work for a thug]$_1$]

Here the presupposition trigger in the second conjunct is coindexed with its local context c_1; we obtain a requirement that c_1 should entail *you will work for a thug*, hence a conditional presupposition that *if you accept this job, you will work for a thug*.

Of course it remains to be explained when the indexing rules in (6) hold and when they don't, making local indexing possible in (21). We did not attempt to answer this question; all we wanted to show was that the present system has the ability to generate conditional presuppositions – unlike orthodox DRT.

2.3 Negations Ex Machina

In several cases, it is the *negation* of an earlier expression that serves to justify a presupposition. This is most clearly seen in examples that involve 'strong triggers' such as *too*, which is known not to allow for local accommodation (Beaver and Zeevat 2007).

(22) I doubt that Goldman Sachs will be prosecuted. But...
a. .... either Goldman Sachs won't be prosecuted, or Morgan Stanley will be too.
b. (?) ... either Morgan Stanley will be prosecuted too, or Goldman Sachs won't be.

(23) a. Unless Goldman Sachs isn't prosecuted, Morgan Stanley will be <prosecuted> too.
b. (?) Unless Morgan Stanley is prosecuted too, Goldman Sachs won't be.

In these examples, we see that in (i) *F or q'*, (i') *q' or F*, (ii) *unless F, q'* and (ii') *unless q', F*, the presupposition *q* can be satisfied by the negation of *F* (here, *F* is itself negative, with *F = Goldman Sachs won't be prosecuted*, so *not F* is equivalent to: *Goldman Sachs will be prosecuted)*.[11] For Schlenker 2009, these facts are unsurprising:

-(i) (illustrated in (22)a) is expected because the local context of *q'* is C ∧ **(not F)**, i.e. is the original context C updated with the negation of the first disjunct (as is the case in Beaver 2001).

-(ii) (illustrated in (23)a) is also expected because *unless F, q'* has the same classical meaning as *F or q'* (at least as a first approximation), and the clauses appear in the same order in the two constructions. In Schlenker 2009 the local context of an expression is computed on the basis of the classical meaning and syntax of the sentence it occurs in; hence the local context of *q'* is the same in *unless F, q'* and *F or q'*. Therefore if *unless F, q'* is uttered in a context set C, the local context of *q'* is C ∧ **(not F)**.

(i') (illustrated in (22)b) can be explained on the assumption that one may in this case compute (probably at some cost) a 'symmetric local context', which takes into account information about the entire sentence (rather than just the beginning, as the 'incremental local contexts' that are more standardly used).[12]

(ii') (illustrated in (23)b) follows in similar fashion from the assumption that 'symmetric local contexts' are available but costly.

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[11] Thanks to Mike Solomon for discussion of these examples.

[12] See Chemla and Schlenker 2011a for an experimental investigation of cases in which a presupposition is justified by material that comes later in a sentence ('symmetric readings').

How can orthodox DRT derive these results? For (i), it could postulate that there is a covert *else*, meaning *if not*, in the second disjunct. This covert conditional clause could serve as an antecedent for the presupposition that appears in the second disjunct. But it is hard to motivate such an approach for (i'), (ii) and (ii'), because no *else* can appear in the relevant positions (constructions of the form *else qq' or F*, *unless F, else qq'*, and *unless else qq', F* are just ungrammatical).

Within the system developed here, we can immediately derive the desired results by postulating that these examples involve local indexing, as is shown in simplified form in (24).

(24) ^{c_0}[Unless I turn down this job, ^{c_1}[your family will know that you will work for a thug]$_1$]

2.4 Multiple indexing

Both orthodox DRT and Heim's satisfaction theory face problems with belief sentences (see Geurts 1999, chapter 5, for an in-depth discussion). The difficulty is that the sentences in (25) give rise to two inferences: (i) that the presupposition of the embedded clause is true (hence that it was in fact raining); and (ii) that the agent believes it to be true too (so that John believes that it was raining).

(25) a. John believes that it has stopped raining.
b. Does John believe that it has stopped raining?

Heim 1983, 1992 only predicts inference (ii) (i.e. a presupposition that *John believes that it was raining*); it needs a strengthening mechanism to obtain inference (i). Orthodox DRT can predict inference (i) (*it was raining*) because the initial representation in (26)a is preferably resolved by accommodating the presupposition with matrix scope, as in (26)b. A strengthening mechanism is needed to get inference (ii).

(26) a. [: John believes that [: it rained, it doesn't rain]]
b. [: **it rained**, John believes that [: it doesn't rain]]

The position of orthodox DRT raises two problems.

-First, as soon as the presupposition trigger contains a bound variable, the possibility of matrix accommodation is precluded by the 'trapping constraint', and we wrongly predict that inference (i) should go away.

(27) a. John believes that each of my students knows that he is incompetent.
=> Each of my students is incompetent
=> John believes that each of my students is incompetent.
b. John believes that none of my students knows that he is incompetent.
=> Each of my students is incompetent
=> John believes that each of my students is incompetent

-Second, the strengthening rule (which Geurts calls 'importation') seems to be so strong that it cannot be overridden – which raises questions about its non-semantic nature.

(28) *Situation:* It has been raining for the last hour, but John has been watching a video in the basement for the last 2 hours.
a. John is convinced that it's not raining.
b. #John believes that it has stopped raining – in fact, he is convinced that it's not raining.

(28)b should be non-contradictory on the representation (26)b, but this just does not seem to be the case.[13]

[13] Geurts 1999 argues (p. 169) that importation doesn't always apply. He writes in particular that the sentence *The policeman thought that my sister was drunk* "would not normally license the inference" that the policeman "believed of the speaker's sister that she is his sister". But on any theory this observation is neutral among the

We can solve the second problem by positing that in this case – and possibly in all other cases as well – matrix indexing comes *in addition* to local indexing (for reasons discussed in Section 3.2, we *fail* to solve the second problem, which involves bound variables). Thus the presupposition trigger must at least be indexed with its local context, and whenever possible it is also indexed with the highest available context, which yields representations such as (29):

(29) ^{c_0}[John believes that ^{c_1}[it has [stopped raining]$_{0,1}$]]

Here we will have a dual requirement:
-c_0, which denotes the global context, should entail that it rained.
-Due to local indexing, c_1, which denotes the worlds compatible with what John believes, should also entail that it rained – as is desired.

DRT took its inspiration from mechanisms of anaphora resolution. From this perspective, multiple indexing should be unsurprising. It is uncontroversial that plural pronouns can have split antecedents. In addition, certain varieties of *PRO*, the unpronounced subjects of infinitives, have been argued in Landau 2000 to have indexing requirements that are similar to those we posit for presuppositions:
-*PRO* must always be bound locally.
-In addition, it may have other, non-local antecedents.
An example is provided in (30), where $PRO_{1,2}$ has both a local antecedent (*John*) and a non-local one (*Mary*).

(30) a. Mary^1 wondered whether John^2 really wanted PRO$_{1,2}$ to meet at 1am.
b. [Each boy]$_1$ told [each girl]$_2$ that he$_1$ wanted PRO$_{1,2}$ to meet at 1am.

3 Further Problems

The present approach encounters further problems; they are of two kinds: in our analysis of variables, we inherit weaknesses of Schlenker 2009, which can be remedied; in other cases, we inherit some problems of DRT.

3.1 Variables

For simplicity, Schlenker 2009 primarily discussed a variable-free fragment with generalized quantifiers and monadic predicates. But a systematic treatment of variables is needed, on pain of making unfortunate predictions in even the simplest examples, such as (31):

(31) If John is wise, he has stopped smoking.

We would like (31) to be a case of matrix indexing, yielding an unconditional presupposition that John used to smoke. But technically *stop smoking* is predicative, and so is the presupposition it triggers in the framework of Schlenker 2009. Its local context is predicative as well, but the global context is not. So at this point we can only obtain the representation in (32):

(32) ^{c_0}[If John is wise, ^{c_1}[he has ^{c_2}[stopped smoking]$_2$]]

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competing theories of presupposition projection: noun phrases are independently known to carry something like world variables (Heim 1991). When *sister* is indexed with the actual world rather than with the attitude verb, we obtain a De Re reading which, on any theory, should not entail that the policeman believes of the speaker's sister that she is his sister.

The presupposition trigger *stopped smoking* is indexed with its local context (which is of predicative type), and we end up with a conditional presupposition of the form: *if John is wise, he used to smoke*. The Proviso Problem has reappeared.

In this case, there is a solution. Following DRT, let us represent all presuppositions as propositional, with the potential presence of variables. To accommodate these, the system of Schlenker 2009 must be modified by taking contexts to denote functions from assignment functions to propositions (this system is sketched in Appendix IV of Schlenker 2009). To avoid confusion with context variables, we will henceforth write individual variables as *x*, *y*, *z*. In this system, (31) can now be represented as (33):

(33) ^{c_0}[If John is wise, ^{c_1}[he$_x$ has has stopped smoking]$_0$]

As in Heim 1983, the context set C must be taken to incorporate assignment functions. Specifically, let us take C to be a set of pairs of the form <assignment function s, world w>, or equivalently to be a function of type <a, <s, t>>, where *a* is the type of assignment functions. To obtain coreference between *he$_x$* and *John* in (33), all such pairs in C (i.e. all pairs <s, w> such that C(s)(w) = 1) must guarantee that s(x) is John. As before, c_0 denotes C. When the consequent of the conditional is coindexed with c_0, as is represented in (33), the requirement will be that C should guarantee that *he$_x$ smoked* is true; in other words, all pairs <s, w> in C should guarantee that s(x) smoked in w - as is desired.

3.2 Quantified Statements Revisited

We preserve the results of our 'old' approach to quantified statements when variables are taken into account. In particular, local indexing gives rise to a universal presupposition for statements such as (18), repeated as (34). In a system with variables in which all presuppositions are propositional, it is treated as in (35).

(34) ^{c_0}[[No ^{c_2}student] ^{c_1}[stopped smoking]$_1$]

(35) ^{c_0}[[No student]$_x$ ^{c_1}[x stopped smoking]$_1$]

It can be checked that in this modification of Schlenker 2009, c_1 will denote the set of pairs <s, w> such that for some s' which is an x-variant of s, <s', w> is in the initial context set and s(x) is a student in w.[14] As in DRT, we will need a constraint to block the equivalent of

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[14] As before, we take the initial context set C to be a function of type <a, <s, t>> (i.e. a set of pairs of the form <assignment function, world>). The argument is in two steps. Let us call f the function defined by: for every assignment function s and world w,
f(s)(w) = 1 iff for some assignment function s', C(s')(w) = 1 and s' $\approx_x$ s and s(x) is a student in w.

1. First, we note that for any nuclear scope V (which may contain variables, and which is propositional type), if c_1 denotes f, we have:

(i) C $\models^{c_{1\text{-}f}}$ [[No student]$_x$ ^{c_1}V] $\Leftrightarrow$ [[No student]$_x$ V]

or in other words

(ii) for all s, w such that C(s)(w) = 1, $[\![[\text{No student}]_x\ ^{c_1}\text{V}]\!]^{s,w,c_{1\text{-}f}} = [\![[\text{No student}]_x\ \text{V}]\!]^{s,w,c_{1\text{-}f}}$
where $[\![^1\text{V}]\!]^{s,w,c_{1\text{-}f}} = [\![c_1]\!]^{s,w,c_{1\text{-}f}} \wedge [\![\text{V}]\!]^{s,w,c_{1\text{-}f}}$
and $[\![c_1]\!]^{s,w,c_{1\text{-}f}} = \text{f(s)(w)}$

2. Second, we note that if c_1 denotes a more restricted function than f, for some *V* the equivalence in (i) will fail

'unbinding'. Specifically, a presupposition trigger *T* should not be indexed with a context variable c_i unless c_i is in the scope of the binders of all the variables in *T*.[15] So in this respect we need the same kinds of assumptions as DRT did.

The constraint against unbinding means that in other cases the Proviso Problem will rear its ugly head again (and this problem extends to the case of quantified presuppositional expressions in the scope of attitude reports).

(36) If I don't give an exam, none of my students will know that he is incompetent.

The intuitive presupposition of (36) is that *each of my students is incompetent*. But local indexing, represented in (37), gives rise to a conditional presupposition, of the form: *if I don't give an exam, each of my students is incompetent*.

(37) ^{c_0}[If I don't give an exam, [none of my students]$_x$ ^{c_1}[[x will know that he$_x$ is incompetent]$_1$]

This problem also arises in DRT, since there too any presupposition induced by the quantified statement must be accommodated in the scope of the quantifier, and thus no unconditional presupposition can be obtained.

3.3 The Singh/Geurts Problem

Geurts 1996 and Singh 2007 show that in examples such as (38) we obtain a semi-conditional presupposition, of the form: *If John is a scuba diver, he has a wetsuit* - rather than a 'fully conditional' presupposition, of the form *If John is a scuba diver and wants to impress his girlfriend, he has a wetsuit*.

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

There is no satisfactory way to derive this result in the present framework.

(39) ^{c_0}[If ^{c_2}[John is a scuba diver] and ^{c_3}[he wants to impress his girlfriend], ^{c_1}[[he'll bring his wetsuit]$_{0?\,1?}$]]

Indexing the presupposition trigger with c_0 yields an unconditional presupposition; indexing it with c_1 yields a fully conditional presupposition. Given our indexing convention, c_2 and c_3 are not accessible. If they were, we could index the trigger with c_3 and obtain the right result. But as soon as we change the order of the conjuncts, we would fail again, as in (40): in this

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to hold. So suppose that for some assignment function s', C(s')(w) = 1 and s' $\approx_x$ s and s(x) is a student in w and f'(s)(w) = 0. Let us take $V = Px$, where at world w *P* holds of s(x) and nothing else.
It is clear that s', w are such that C(s')(w) = 1. Furthermore, (iii) holds because by assumption there is a student in w who satisfies *P*.

(iii) $[\![$[No student]$_x$ Px] $]\!]^{s', w, c_{1-f'}} = 0$

But (iv) also holds:

(iv) $[\![$[No student]$_x$ ^{c_1}Px] $]\!]^{s', w, c_{1-f'}} = 1$

The reason is that there is only one x-variant of s' which would make *Px* true in w - namely the function s. But by assumption f'(s)(w) = 0, so $[\![^{c_1}Px]\!]^{s', w, c_{1-f'}} = 0$.

(iii) and (iv) together show that when c_1 denotes f' it is 'too restrictive'; f is thus the strongest innocuous restriction one can find – it is the local context of the nuclear scope.

[15] Absurd results would follow if we allowed *x stopped smoking* to be indexed with the matrix context c_0 in (35): it would be required that every pair <w, s> in the initial context set C (denoted by c_0) should guarantee that s(x) smoked in w. But of course nothing should force a *free* pronoun he_x in another sentence to denote some individual that did not smoke!

case no local context incorporates the information that John is a scuba diver without also including the information that he wants to impress his girlfriend.

(40) c_0[If c_3[John wants to impress his girlfriend] and c_2[he is a scuba diver] and, c_1[[he'll bring his wetsuit]$_{0?\,1?}$]

We conclude that with respect to the Geurts/Singh data, our analysis is in no better position than DRT (or Heim's semantics, for that matter).

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Although at least two important problems faced by DRT remain unsolved, we hope to have shown that a relatively simple modification of the analysis of Schlenker 2009 can emulate and in some respects improve upon orthodox DRT. The resulting analysis follows Heim 1983 in being based on local contexts; it departs from it in taking local contexts to be entirely derivative on a bivalent, non-dynamic semantics; and it follows a crucial insight of DRT in taking presupposition projection to be a species of anaphora resolution – in the present framework, anaphora to local contexts. Among other issues, one crucial question for future research will be to determine whether the problems of Sections 3.2 and 3.3 can be solved.

Appendix I. Definition of Local Contexts (Schlenker 2009)

Heim's local contexts are derived in Schlenker 2009 from (a notational variant of) the following rule:

(41) The local context of an expression *d* of propositional or predicative type which occurs in a syntactic environment *a* _ *b* in a context C is the strongest proposition or property x which guarantees that for any expression *d'* of the same type as *d*, for all strings *b'* for which *a d' b'* is a well-formed sentence,

C $\models^{c' \rightarrow x}$ a (c' and d') b' ↔ a d' b'

(If no strongest proposition or property x with the desired characteristics exists, the local context of *d* does not exist[16]).

This rule is 'incremental' because it computes the local context of an expression *d* on the basis of information that comes *before d* in the sentence. Another version of the rule can be used to compute 'symmetric local contexts', which take into account information that comes before *and* after *d* in the sentence (see Schlenker 2009, Section 4 for discussion).

[16] See Schlenker 2009 for a discussion of the case in which local contexts do not exist.

Appendix II. Intermediate Accommodation.

In this Appendix we sketch a way to implement Heim's notion of local accommodation, which can then be extended to handle cases of intermediate accommodation within DRT. Whether such a mechanism is desirable is unclear: as was noted in Section 1.3, the clearest cases of intermediate accommodation are already handled by our basic system, and it is only for the more controversial ones that the additional mechanism developed below could be useful.

This mechanism was briefly sketched in Schlenker 2009 (Section 5.1). We can stipulate that, under certain specified conditions, one can interpret a sentence $a\ [_\alpha \ldots \underline{d}d' \ldots]\ b$ (where the constituent α has a propositional or predicative type) as if it were $a\ ^{c_i^+}[_\alpha \ldots \underline{d}d'_i \ldots]\ b$, where c_i^+ denotes a strengthened context, possibly at an intermediate site, which guarantees that the presupposition of d is entailed by context variable it is coindexed with. In this case the presence of c_i^+ will affect the truth conditions rather than just the felicity conditions of the sentence. So it is important to be clear on the interpretation of $^{c_i^+}[_\alpha \ldots \underline{d}d'_i \ldots]$, which should be treated as the conjunction of c_i^+ and $[_\alpha \ldots \underline{d}d'_i \ldots]$ (when 'normal' rather than 'strengthened' contexts are used, the algorithm of Schlenker 2009 guarantees that local contexts don't add anything to the meaning, so that F has the same truth-conditional contribution as ^{c_i}F if the latter is analyzed as the conjunction of c_i and F).

With this mechanism in place, we can in principle emulate all cases of intermediate accommodation within DRT (keeping in mind that this is always a dispreferred strategy). All we need to add is the assumption that a presupposition trigger can be indexed with a context variable that does not appear on a constituent that contains it. In this way, (43) will give rise to the same truth conditions as (42) resolved with intermediate accommodation.

(42) a. If John is realistic, he knows that he is incompetent.
b. $[_1$ x: John x, $[_2$: realistic x] ⇒ $[_3$: <u>x is incompetent</u>, x believes that x is incompetent]]
c. $[_1$ x: John x, $[_2$: realistic x, **x is incompetent**] ⇒ $[_3$: x believes that x is incompetent]]

(43) ^{c_0}[If ^{c_2}[John is realistic], ^{c_1}[[he knows that he is incompetent]$_2$].

Here the trigger is indexed with the local context c_2 of the antecedent clause – which denotes the same proposition as the matrix context c_0. If for some reason one cannot adapt the initial context set to guarantee that John is incompetent, we can as a last resort replace c_2 with a stronger local context c_2^+, which is c_2 to which we add the assumption that John is incompetent. When we compute the truth conditions of *If* $^{c_2^+}$ *[John is realistic], [[he knows that he is incompetent]*$_2$, we interpret the antecedent as the conjunction of c_2^+ and *John is realistic*, i.e. *(c_2 and John is incompetent) and John is realistic*. Since c_2 itself is guaranteed to make no non-trivial semantic contribution, this is equivalent to *John is incompetent and John is realistic* – and we derive the same result as the DRT representation in (42)c.

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