

Presupposition Projection as Anaphora Resolution

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Abstract

The present paper presents an anaphoric account of presupposition. It is argued that presuppositional expressions should not be seen as referring expressions, nor is presupposition to be explicated in terms of some non-standard logic. The notion of presupposition should not be relegated to a pragmatic theory either. Instead presuppositional expressions are claimed to be anaphoric expressions which have internal structure and semantic content. In fact they only differ from pronouns and other semantically less loaded anaphors in that they have more descriptive content. It is this fact which enables them to create an antecedent in case discourse does not provide one. If their capacity to accommodate is taken into account they can be treated by basically the same mechanism which handles the resolution of pronouns. The theory is elaborated in the framework of discourse representation theory. It is shown that pragmatic factors interfere in the resolution of presuppositional anaphors. The resulting account can neither be classified as wholly semantic nor wholly pragmatic. Section 1 presents a survey of standing problems in the theory of presupposition projection and discusses the major competing approaches. An argumentation for a purely anaphoric account of presupposition is given in section 2. Section 3 presents a coding of presuppositional expressions in an extension of discourse representation theory. The final section is devoted to a discussion of the constraints which govern the resolution of presuppositional anaphors.

1 REFERENCE, BINDING, AND PRESUPPOSITIONAL EXPRESSIONS

The traditional view on presupposition has it that presuppositions are referring expressions. When we use a sentence containing a proper name or definite description, we do not state that some object has a certain property, as the Russellian analysis implies. A proper use of such a sentence rather requires that the referring expression pick out some given object. Only if it does may we check for a particular property whether it holds of this object. If it does not, the sentence will not get an interpretation or, as Strawson phrased it, 'the question of truth or falsity simply does not arise'. This view originally derives from Frege's philosophy of language. For Frege it is referring expressions that give rise to presuppositions. Frege also insists that the reference of a complex expression is a function of the references of its parts. Thus, if one component expression of a complex expression lacks a reference, the whole expression will lack a

reference. Given his doctrine that the reference of a sentence is its truth value, it is thus predicted that no sentence in which a non-referring expression figures as a part can have a truth-value. This consequence automatically carries over to any extensional compound. Presupposition failure is infectious. If one of the component sentences of a complex sentence suffers from presupposition failure and thus lacks a truth-value, any compound in which it figures as a proper part will lack a truth-value as well. However, as is shown by the standard examples from the literature on presupposition projection, this view gives rise to many counterintuitive predictions. Obviously, all of the following sentences can have a determinate value, even if John doesn't have any children. It is also clear that none of them inherits the presupposition that he has children as is predicted under a purely Fregean account:

- (1a) John has children and *his children* are bald.
- (1b) If John has children, *his children* are bald.
- (1c) Either John does not have any children or *his children* are bald.

A second problem with the view that presuppositional expressions are referring expressions has been observed as early as 1973 by Mates. Presuppositional expressions may contain anaphors and these may be bound by external antecedents. This may seem innocuous with respect to the examples in (1), for in these sentences the pronoun depends on an antecedent which is a proper name and thus a referring expression itself. It does, however, give rise to serious problems as soon as a pronoun in a presuppositional expression is bound by an external quantifier:¹

- (2a) Someone had a child and *his child* was bald.
- (2b) If a man gets angry, *his children* get frightened.
- (2c) Every man kissed *the girl who loved him*.

In all these cases the description contains a pronoun which is bound by and thus depends on an external quantifier. Consequently there is no uniquely identifiable object on which the 'presuppositional' expression depends and this in turn means that there is no way to analyse these descriptions as referring expressions.

Strawson's revival of presupposition theory in the 1950s gave rise to two different explications of the semantic notion of presupposition. The first explication is very close to Frege's. A sentence presupposes another sentence just in case the latter must be true for the first to have a truth-value.² On this view presuppositional expressions are referring expressions. It is thus vulnerable to the objection stated above. The second explication takes preservation under negation to be the defining characteristic. Presuppositions are defined as those inferences which are entailed both by their carrier sentence and its negation. Let us call this the inference view on presupposition. According to this view a

sentence φ presupposes a sentence ψ just in case $\varphi \models \psi$ and $\neg\varphi \not\models \psi$. This explication actually requires a trivalent or other non-standard logic. However, on its standard definition the notion of entailment adopted is the classic one. This makes it easy to show that this strategy, like any attempt to define presupposition in terms of the classic notion of entailment, cannot succeed. For the entailment relation adopted is a monotonic one and presuppositions generally display a non-monotonic behaviour. Note that in the a-sentence the possessive phrase *Harry's child* induces the presupposition that Harry has a child:

- (3a) It is possible that *Harry's child* is on holiday.
- (3b) It is not possible that *Harry's child* is on holiday.
- (3c) It is possible that Harry does not have a child, but it is also possible that *{he/Harry's child}* is on holiday.
- (3d) Harry does not have a child. So *{he/Harry's child}* cannot be on holiday.

Note furthermore that we intuitively infer from both (3a) and its negation (3b) that Harry has a child. If we take this inference to be an instance of semantic entailment, the definition of semantic presupposition predicts that Harry has a child is presupposed by both (3a) and (3b). Since the entailment relation employed is a monotonic one, it is simultaneously predicted that this inference is preserved under growth of information. But this last prediction is clearly wrong. If we add the information that Harry may not have a child as in (3c) or that he does not have one as in (3d), the presuppositional inference disappears without a trace. It follows that under its standard definition the inference view of presuppositions is simply wrong. It also follows that any attempt to account for the full range of presuppositional phenomena in terms of the classic notion of entailment is doomed to failure.

Two remarks should be made at this point. Firstly, the phenomena just discussed are known from the literature on presupposition projection under the name of presupposition cancellation. This phenomenon actually gave rise to a third view on the nature of presupposition, the pragmatic paradigm. Presuppositional expressions are not taken to be referring expressions, nor are presuppositions viewed as semantic inferences which should be accounted for in terms of truth and entailment. They are instead taken to be purely pragmatic and context-dependent and have one central feature in common with Gricean conversational implicatures: when they conflict with contradictory information they will not give rise to inconsistency. Instead conversational presuppositions will be lifted or altered in some way and the original inferences will not be computed with respect to this new situation. It is then important to notice that it need not be conflicting information which is responsible for the removal of presuppositional inferences. In (3c) we added the information that Harry may not have children. This does not conflict with the presupposition that he has one, but nevertheless defeats the inference.

Secondly, but most importantly, it should be pointed out that the claim that presuppositional inferences can be defeated by the addition of extra information simply is another way of saying that presuppositional inferences behave in a non-monotonic way. Cancellability or defeasibility is just non-monotonicity and it is this simple fact which precludes a definition and treatment of presupposition by means of a logic which relies on the classic notion of entailment.³

The alternative approach we just alluded to and which dominated presupposition theory during the 1970s is to treat presupposition as an essentially pragmatic phenomenon. Inspired by the work of Grice, the informational content of natural language utterances was taken to consist of two parts: the proposition expressed in view of the semantic rules of the language and further information conveyed by pragmatic means. The basic tenet of this view is that semantic and pragmatic information constitute two different types of content. Propositional content captures only part of what is intuitively conceived as the meaning of an utterance. Presuppositions and implicatures equally contribute to our understanding of natural language sentences. But the latter are computed in a different way. They are not *part* of the truth-conditional content, but computed *on the basis* of the propositional content of the sentence uttered, contextual information, and pragmatic principles of a Gricean nature. They are thus computed and represented separately and merged only afterwards into a more substantial proposition. Contextual update will take place both with respect to the propositional content and information which is conveyed by other means. It is the sum of both which will be incremented into the next context.

The general picture derives from Stalnaker's work: utterances are construed as context-sentence pairs. A discourse is conceived as a sequence of utterances. Given an utterance of a sentence φ in a context c we first compute $\llbracket \varphi \rrbracket_c$, the proposition expressed by φ in c . Only then is further pragmatic information computed on the basis of contextual information and the propositional content of the sentence uttered. The proposition expressed and the pragmatic information invoked give, when taken together, the information conveyed by this utterance in this context. Now both the proposition expressed and the information conveyed may be constructed as formal objects of a similar kind. Just take them to be sets of possible worlds. Their intersection will then give us a new and more informative proposition. Let us call this object $IC(\varphi, c)$, the informative content of the sentence φ in the context c . It is this object which will be incremented into the next context. The next context will thus comprise all the previously accumulated information + all the semantic and pragmatic information which is conveyed by the utterance itself. The following utterance will be interpreted with respect to this information.⁴

The view just sketched has a number of non-trivial implications. Firstly, it

means that it is utterances not sentences which are the primary information carrying units. Secondly, it implies that in processing a sentence φ its semantic content should be determined *before* any pragmatic information can be computed and this in turn implies that pragmatic information is to be represented separately from semantic content.

The first of these claims is uncontroversial. The second and third, however, turn out to be wrong. In fact, the postulation of priority of semantic content over implicatures and presuppositions and the representation of semantic and pragmatic information by separate expression give rise to three interconnected problems. We get a notion of propositional content which is rather counter-intuitive with respect to extensional contexts and plainly wrong with respect to intensional ones. We run into binding problems when presuppositions and implicatures enter into scope relations with quantified expressions and, finally, we blur the distinction between accommodation as a procedure which adjusts contextual parameters with respect to which the current utterance is to be processed and contextual incrementation as a mapping of the adjusted context into the next one.

The basic problem lies in the separation of semantic and pragmatic content. In the remainder of this section I will first discuss how this gives rise to a rather thinned and counterintuitive notion of propositional content. I will then go on to survey the problems which arise out of the fact that *all* pragmatic information may enter into binding relations with the content expression and conclude with some remarks on the difference between accommodation and contextual incrementation. In the next section I will present an alternative theory which does not run into the problems discussed here.

Among the authors who adhere to the pragmatic picture it is generally assumed that logical operators take scope over presuppositional expressions.⁵ Thus (4) is represented as (4a) and is said to presuppose (4b). In the standard case the full interpretation will thus consist of the sum of the semantic and pragmatic information which is equivalent to the narrow scope reading given in (4c):

- | | | |
|------|--|---------------------------------|
| (4) | It is not true that the thief stole my Mac.
The thief did not steal my Mac. | |
| (4a) | $\neg\exists! x (\text{thief } x \wedge \text{steal_Mac } x)$ | <i>content expression</i> |
| (4b) | $\exists! x (\text{thief } x)$ | <i>presupposition</i> |
| (4c) | $\exists! x (\text{thief } x \wedge \neg \text{steal_Mac } x)$ | <i>content + presupposition</i> |

The truth-conditions are taken to be classical. A negated sentence will thus never entail its presupposition, but it will be said to presuppose it by default, that is, it will presuppose it if pragmatic conditions do not forbid accommodation of the presupposition in the context of utterance. It follows that a presupposition which is embedded under a non-entailing operator will never

be part of the propositional content, but will be merged with it only afterwards. And since propositional content is one factor in determining whether the presuppositional expression can be accommodated, it also means that the computation of propositional content has priority over the computation of presuppositions in a very strict sense: the propositional content should be fully determined before any presuppositional information can be computed.

Now it might be objected that we could, in the above case, take recourse to scope after all. The presuppositional expression might be computed with respect to a representation on which the negation has a narrow scope. One objection is that we would now get the prediction that the existence of a (unique) thief is both asserted and presupposed. But there is another objection which is more relevant to our present purposes.⁶ The Russellian stance does not work for other types of embedding. Consider (5a) where the presuppositional expression figures in the antecedent of a conditional. In this environment presuppositions generally survive:

- (5a) If the thief stole his Mac, John will ensure his next one.
 (5b) $\text{Steal_mac}(\zeta x \text{ thief } x) \rightarrow \text{Insure_next_one } j$

The conditional consists of two independent propositions. The description in the antecedent will thus never take scope over the full conditional. We therefore have to accept the prediction that this sentence can be true even if there is no thief. The information that there is such a thief will be computed only after the determination of the propositional content and only then enter as part of the more informative proposition we just called its informative content.

The real problem emerges as soon as it comes to modal embeddings:

- (6) It is possible that the thief stole my Mac.
 (6a) $\Diamond \exists! x (\text{thief } x \wedge \text{steal_Mac } x)$ *content expression*
 (6b) $\neg \Box \exists! x (\text{thief } x \wedge \text{steal_Mac } x)$ *scalar implicature*
 (6c) $\exists! x (\text{thief } x)$ *presupposition*

When we now merge the different expressions into a more substantial proposition, we get the wrong results. For the presuppositional expression states that there is a (unique) thief in this world, the content expression that in some other world there is a possibly different thief who stole my Mac, and the implicature that it does not hold for every world that it contains a (unique) thief who stole my Mac. However, we would rather want one and the same thief to verify the presuppositional-, content- and implicature-expression as it happens in (7b):

- (7) It is possible that the thief stole my Mac.
 (7a) There is a thief . . . he possibly, but not necessarily stole my Mac.
 (7b) $\exists x! (\text{thief } (x) \dots \Diamond \text{stole-Mac } (x) \dots \neg \Box \text{stole-my-Mac } (x) \dots$

Of course the Russellian would again appeal to scope and claim that both the presuppositional and implicature expression should be computed with respect to the representation in which the modal operator has scope over the description. But apart from the fact that we would run again into the problem that the presupposition would be both asserted and presupposed, it should be noted that it is easy to think up more complicated examples where this strategy does not work. Just embed (7) in the antecedent of a conditional. Now the description may have scope over the modal, but never over the full implication. We thus end up with one thief in this world and a possibly different one in another world who stole my Mac there.

Let us look again at the binding problem involved in these examples. In the previous examples the problem arose out of the separation of semantic and presuppositional content which is inherent in the pragmatic picture. On a pragmatic account the semantic content is determined first and it is only then that presuppositional and implicatural information is computed. However, as (7) demonstrates, the computation of propositional content seems to be dependent on a prior determination of the presupposition. It is exactly this the pragmatic scheme does not allow.⁷

We run into similar problems when variables in presuppositional expressions enter into sentence internal scope relations with quantified expressions. Some examples were given in (2a)–(2c) which I repeat here. In all these cases a pronoun in a presuppositional expression depends on an external quantifier:

- (2a) Someone had a child and *his child* was bald.⁸
- (2b) If a man gets angry, *his children* get frightened.
- (2c) Every boy kissed *the girl who loved him*.

In the above cases we find a pronoun in an open presuppositional expression which is bound by a quantifier outside this expression. This prevents a coding of the presuppositional content by means of an independent expression.

Karttunen & Peters (1979) noted that the same problem arises for lexical presuppositions. (8a) induces the presupposition (8b):

- (8a) John managed to open the door.
- (8b) It took John some effort to open the door.

Their two-dimensional semantics thus predicts that the indefinite (9a) presupposes the corresponding indefinite (9b):

- (9a) Someone *managed* to succeed George V on the throne of England.
- (9b) It took someone some effort to succeed George V on the throne of England.

This prediction can easily be shown to be wrong by embedding (9a) in the antecedent of a conditional or by questioning it.⁹ In the absence of any

contextual information presuppositions are preserved in these environments, but (10) and (11) clearly do not give rise to a presuppositional inference:

- (10) If someone *managed* to succeed George V on the throne of England, he will have kept it for years.
 (11) Did someone *manage* to succeed George V to the throne of England?

Again the problem arises from having to bind the indefinite NP in the presuppositional and the content expression by different quantifiers. Instead, we would want to identify the actual successor of George V with the person who is presupposed to have had difficulties doing so. But this is precisely what the use of two different quantifiers prevents.

It should be noted that this problem is a general and fundamental one. It will arise whenever a quantifier binds some variable in a presuppositional expression. Consider (12a)–(12c).

- (12a) A child beats his cat.
 (12b) A child has a cat.
 (12c) If a child beats his cat, he will be punished.

The truth-conditional content of (12a) can be represented as (13a):

- (13a) $\exists x\exists y(\text{child}(x) \wedge \text{cat}(y) \wedge \text{poss}(x, y) \wedge \text{beat}(x, y))$

We might try to represent the presuppositional expression as follows:

- (13b) $\exists x\exists y(\text{child}(x) \wedge \text{cat}(y) \wedge \text{poss}(x, y))$

But now the existential quantifiers in (13a) and (13b) may pick different child/cat pairs and after accommodation of the presuppositional expression we are likely to end up with the wrong result that there is a child who has a cat and yet another child who has a cat and beats it.

The final problem with the pragmatic point of view is that it obscures the difference between accommodation and contextual incrementation. Intuitively presuppositional information is information which is taken for granted. The understanding of a sentence which contains some presuppositional constructions normally requires some context in which it can be interpreted. In many cases the context of utterance will already contain the presupposition, but this need not be the case. If a presupposition is not already there, the context of utterance may be adjusted. The default option is to add the presupposition so as to make the utterance interpretable after all. Lewis (1979) coined the term accommodation for this strategy. It should be noted then that the accommodation is a strategy of repair. It does not simply add some information to the propositional content of the sentence uttered, nor is it part of the process of incrementation thereby affecting the *next* context in the same way that propositional or implicatural information does. On the contrary, accommoda-

tion is a strategy of repairing the context of utterance in order to get an interpretation for the sentence to be processed. If a relevant contextual parameter does not have an appropriate value, the hearer will infer it and adjust the context so as to provide an interpretation for the utterance after all. Accommodation is thus best seen as a kind of pre-processing of an utterance in order to adjust contextual parameters so as to create an auxiliary content in which it can be interpreted. It is the context thus established which enters in the computation of the content, implicatures, and other pragmatic information. Contextual incrementation will then map the adjusted context into the next one.

2 PRESUPPOSITION AS ANAPHORA

In the previous section I tried to establish three claims. Presuppositional expressions cannot be conceived of as referring expressions, nor should presuppositions be conceived as logical inferences to be accounted for in some multi-valent or partial logic. I also argued that the pragmatic account cannot be maintained in its standard formulation. A principled division of informational content into a semantic and a pragmatic part gives rise to binding problems whenever presuppositional expressions enter into scope relations with quantified expressions.

In the present section I will present an alternative and elaborate on van der Sandt (1989) and van der Sandt & Geurts (1991). I will claim that presuppositions are just anaphors. They can be treated by basically the same mechanism that handles the resolution of pronominal and other anaphoric expressions. In fact, they differ in only two respects. Firstly, unlike pronouns they contain descriptive content which enables them to accommodate an antecedent in case discourse does not provide one. And, secondly, they have internal structure of their own. They can thus contain free variables and be incomplete in the sense descriptions may be and they thus may be bound in exactly the same way by external quantifiers. In sections 3 and 4 we will present a resolution mechanism for presuppositional expressions. It will turn out that the very same mechanism which handles the resolution of presuppositional anaphora simultaneously takes care of pronominal resolution.

Let me first point out that it has been noted by several authors that definite descriptions can be used anaphorically. It was, however, simultaneously taken for granted that their presuppositional properties had to be handled by a separate mechanism. Anaphoric treatments of definite descriptions are found, among others, in McCawley (1979), Lewis (1979) and many workers in AI.¹⁰ However, McCawley takes Karttunen's (1974) rules of contextual satisfaction as

a starting point in order to explain their projection behaviour. Lewis requires for a definite description to denote some individual that this individual is the most salient one having the relevant properties according to some contextually determined salience ranking. He does not, however, discuss the projection properties of the associated presuppositions. The closest to the position defended here is the view put forward in Heim's thesis (1982). Her statement of the novelty/familiarity condition simply comes down to the claim that definiteness is anaphoricity. However, Heim simultaneously states that definites have, apart from their anaphoric property, a presuppositional property¹¹ and this property simply is a species of a felicity condition which gives rise to the problems involved in presupposition projection.¹² A related but different view is taken in a subsequent paper devoted to presupposition projection (Heim 1983).¹³ Here Heim takes Karttunen's conditions of contextual satisfaction as a starting point and reinterprets them as definedness conditions on contexts. First, the presuppositional property has to be defined for each trigger. The inheritance property, that is, what happens to the presuppositional property under embedding, should then fall out as a consequence of the rules of context change.¹⁴

The present paper follows van der Sandt (1989), and van der Sandt & Geurts (1991) and defends the claim that presupposition projection and anaphora resolution should not be handled by separate mechanisms. This claim applies basically to all paradigm cases of presupposition. It is therefore not just definite descriptions which are anaphoric. Once we take VP-anaphora and full propositional anaphora into account the claim that presuppositions are anaphoric expressions covers presuppositional adverbs like *too* and *even*, aspectual verbs like *begin*, *stop* and *continue*, cleft constructions, temporal clauses and factives. All these triggers are anaphoric in the same sense, though they may differ in their capacity to accommodate.¹⁵ The claim that definites are anaphoric is thus seen as a special case of the more general phenomenon that all presuppositions are anaphoric expressions.

In this section I will first present some suggestive material to illustrate a number of non-trivial correspondences between anaphora resolution and presupposition projection. I will then go on to show that this parallelism generalizes to the paradigm cases of presupposition inducers, I will correlate the basic terminology from the literature on presupposition projection to the basic notions of anaphora theory, and finally point out how such a view on presupposition and anaphora extends the scope of testability of theories of presupposition projection. In the next sections I will develop these ideas in the framework of discourse representation theory.

The first attempt to give an account of presupposition projection is Karttunen (1973). In this article he presents (14a)–(16a) as his paradigm cases:

- (14a) Jack has children and *all of Jack's children* are bald.
 (15a) If Jack has children, then *all of Jack's children* are bald.
 (16a) Either Jack has no children or *all of Jack's children* are bald.

Compare these sentences with the well-known donkey sentences which gave rise to the development of discourse representation theory:

- (14b) John owns a donkey. He beats it.
 (15b) If John owns a donkey, he beats it.
 (16b) Either John does not own a donkey or he beats it.

Now the problem as Karttunen formulated it for the theory of presupposition was rather different from the problem donkey sentences posed for anaphora theory. For Karttunen the problem came down to the following. In contrast to logical inferences, presuppositions normally do not enter into any scope relations with embedding operators, but tend to survive any depth of embedding, quite independently of the logical properties of the embedding operators. In the above cases they somehow disappear, however, and this is exactly what the projection problem for presuppositions comes down to. How do we determine the parameters needed to compute the presuppositions of a complex sentence out of the triggers and their components and, given these parameters, how do we define a recursive procedure which yields the actual presuppositions on the basis of these triggers and the composition of the sentence? So the actual problem was how to account for the fact that none of the sentences (14a)–(16a) preserves presupposition that Jack has children.

The problem as it was formulated with respect to the donkey sentences was quite a different one. It was to find a mechanism which would account in a uniform way for the anaphoric links between the pronouns and their antecedents in the (b)-sentences. The terminology in which the problems were discussed was equally different. While presuppositions were said to be filtered, cancelled or satisfied by the context of utterance, anaphora theory focused on the analysis of pronouns which were analysed in terms of co-reference and binding.

The parallelism between the (a)- and (b)-sentences will be obvious. Wherever we find a full NP in the (a)-sentences we find a pronoun in the (b)-sentences. We could as well pronominalize the presupposition triggers in the (a)-sentences, thus turning them into donkey sentences, or expand the pronouns in the (b)-sentences to full definite NPs, thus turning them into paradigm cases of presupposition filtering. No difference in interpretation results in either case.

- (17a) If Jack has children, then they are bald.
 (17b) If John owns a donkey, he beats *his donkey*.

These observations at least suggest that a similar mechanism underlies both pronoun resolution and presuppositional filtering. They also suggest another terminology of describing the presuppositional phenomena. Instead of saying that the presuppositions in the (a)-sentences are suspended, cancelled or neutralized, we should say rather that they are linked up or bound to a previously established antecedent just like the pronouns. Note that the behaviour just observed is not confined to NP-anaphora (that is, definite descriptions and the related possessives and restrictive relative clauses). Once we look at VP- and full propositional anaphora, the parallelism extends quite naturally to other kinds of presupposition inducers:

VP-anaphora (*clefts, aspectual verbs, presuppositional adverbs*):

- (18a) If someone solved the problem it was Julius who {solved it/did}.
 (18b) If Harry stopped smoking, John {stopped/did} too.

Full propositional anaphora (*factives, temporal clauses*):

- (19a) If John is ill, Mary regrets {that/that he is ill}.
 (19b) If John died, he did see his children before {that/he did/he/died}.

Just as in the case of the NP-anaphors we find no difference in interpretation between the VP- and propositional anaphors and their full lexical expansion. And just as in the previous cases the presuppositional expressions seem to be bound by a previously established antecedent.

It is only when we look at presuppositional constructions which cannot be linked directly with a proper antecedent that we find a crucial difference. In case a pronoun cannot be linked with a suitable antecedent, the whole sentence will not get an interpretation. However, under the same conditions presuppositional sentences may get a determinate value. There is an obvious explanation for this. Presuppositional constructions differ from pronouns, VP- or propositional anaphors in that they have semantic content of their own. This accounts for the fact that presuppositional constructions unlike pronouns or other unloaded anaphors have a capacity to accommodate. In case a semantically empty anaphor does not succeed in finding a proper antecedent it will not get a determinate value. However, presuppositional expressions will generally contain enough descriptive content of their own to establish an antecedent in case the previous discourse does not provide one. The discourse will be repaired so as to provide an accessible antecedent and the anaphoric expression may get an interpretation after all. The following pairs illustrate the effect of accommodation:

- (20a) All of Jack's children are bald.
 (20b) They are all bald.
 (21a) If baldness is hereditary, then *all of Jack's children* are bald.
 (21b) If baldness is hereditary, then they are all bald.

This brings me to the basic explanation. Presuppositions are simply anaphors. They only differ from pronouns or other kinds of semantically less loaded anaphors in that they contain enough descriptive content to establish a reference marker in case discourse does not provide one. In this case the lexical material will be accommodated. A further observation which will turn out to be crucial is that accommodation normally takes place with respect to the context established by the previous discourse. In the terminology of discourse representation theory this means that the antecedent will preferably be accommodated at top level of discourse structure. In contrast to the situation where a presupposition is bound at some subordinate level, the information contained in the trigger will be entailed by the DRS and be preserved intuitively. Note that this is what we would expect given the intuitive notion of presupposition as information taken for granted and note also that this explains the intuition that presuppositions, unless filtered, cancelled or neutralized, are entailed by their matrix sentence. In (21a) the information contained in the presuppositional expression is accommodated at top level and thus entailed by the DRS thus adjusted. It should nevertheless be pointed out that certain principles of a pragmatic nature *may* force accommodation at some subordinate level. In these cases the presupposition will still be there. It will not, however, be entailed by the adjusted context, but it will remain invisible and not surface as an intuitive inference.

This picture allows us to reinterpret the central theoretical notion of presupposition theory. To say that a presupposition is projected (in a given discourse) simply means that the lexical information contained in the 'presuppositional anaphor' has been accommodated at some level of discourse structure, thus providing an accessible antecedent after all. In this view projection is a repair strategy which enables us to establish an anaphoric link even if the current discourse does not provide a suitable antecedent. To say that a sentence is presupposing (or that its presupposition is preserved in a context of utterance) is a special case of accommodation. It tells us that the presupposition has been accommodated at the top level of discourse structure. Neutralization or presuppositional satisfaction boils down to anaphoric binding at some level of representation. And the notion of cancellation makes no sense anymore. We can do away with it as a misleading label which was introduced to cover those cases where a presupposition is not perceived as an intuitive inference, that is, those cases where a presupposition is bound to (and its descriptive content thus absorbed by) some antecedent, as well as those cases where a presupposition has been accommodated at some subordinate level, because projection to the top level would result in inconsistency or otherwise violate pragmatic constraints on accommodation.

Before giving a more precise account of the ideas put forward I still have to elaborate on two points. The first concerns the difference between the notion of

anaphoric binding envisaged here and the notion of contextual satisfaction adopted by Karttunen and Heim. This difference will turn out to yield different predictions both with respect to the neutralization of presuppositional information and the interpretation of accommodation as a contextual repair mechanism. The second question concerns the testability of the claim that presupposition is a species of anaphora.

The basic claim in Karttunen (1974), Stalnaker (1973, 1974) and Heim (1983) is that the presuppositions of a carrier sentence must be entailed by the context in order for them to *satisfy the presuppositions* of this sentence, or, to use a shorter but equivalent terminology, these presuppositions must be entailed by the context of utterance in order for this context to *admit* this sentence. Admittance or presuppositional satisfaction is thus defined in terms of entailment. Heim (1983) reinterprets these requirements as definedness conditions on the contextual update. On her account no contextual update will take place unless the presuppositions of a sentence are satisfied, i.e. unless their descriptive content is entailed by the context of utterance.

Remember that linguistic presuppositions are conventionally associated with lexical items and syntactic constructions. This allows us to assign to each simple sentence a finite list of elementary presuppositions.¹⁶ Call this set $\text{Pres}(\varphi)$ for a given sentence φ . The presuppositional requirement that simple sentences impose upon the context can then be characterized as follows:

- (22) A context c admits a simple sentence φ just in case c entails $\text{Pres}(\varphi)$.

The context of utterance will thus only admit a sentence φ if it already entails all of φ 's elementary presuppositions, or, in Heim's terms, the contextual update of a sentence in φ in a context c will only be defined if c entails all its elementary presuppositions. If φ is complex, presuppositional admittance can be defined recursively by associating with each constituent sentence of φ its own, so-called 'local' context and requiring that each of the constituent sentences is admitted by its local context:

- (23) A context c admits a complex sentence φ iff each of φ 's constituent sentences are admitted by their local contexts.

For a negated sentence the local context simply is the global context. A context will thus admit the negation of a sentence just in case it admits its unnegated counterpart, or $c + \neg\varphi$, the contextual update of a negative sentence will be defined just in case $c + \varphi$, the contextual update of its non-negated counterpart, is defined. This captures the fact that sentences tend to preserve their presuppositions under negation. In case φ is a conjunction or conditional the local context is determined as follows:

- (24) In case φ is of the form ' ψ and χ ' or 'if ψ then χ ', c is the local context for ψ and $c + \psi$ is the local context for χ .

Talking again in terms of definedness conditions, this means that $c + \psi \rightarrow \chi$ will be defined just in case $c + \psi$ and $(c + \varphi) + \psi$ are defined. It is thus required that all presuppositions of the antecedent are entailed by the context of utterance and that the presuppositions of the consequent are entailed by $c + \psi$. This predicts that the presuppositions of the antecedent always carry over to the matrix. The requirement that the local context for the consequent $c + \psi$ should entail the presuppositions of χ comes down to the requirement that the global context c should entail $\psi \rightarrow \text{Pres}(\chi)$. The presuppositions of the consequent of a conditional thus always surface in a weakened form. The limiting case is where ψ already entails the presuppositions of χ . Now $\psi \rightarrow \text{Pres}(\chi)$ is trivially true and presuppositional satisfaction is guaranteed automatically. Falsity of the presupposition cannot give rise to undefinedness of the contextual update. The presupposition is effectively neutralized.

A simple example may illustrate this. According to the rules given above a context c will admit (25a) just in case c entails (25b):

- (25a) If John is married, his wife will be happy.
 (25b) If John is married, John has a wife.

The consequent of (25a) triggers the presupposition that John has a wife. The clauses given above require that this presupposition should be entailed by the local context for the contextual update to be defined, i.e. it should be entailed by $c + \textit{John is married}$. The global context c should consequently entail the implicative proposition (25b). Since this is a tautology, and since tautologies give no new information whatsoever, the condition for definedness is a trivial one. Definedness is guaranteed automatically and the content of the presupposition is effectively neutralized.

The following sentence poses a more substantial requirement on the context of utterance:

- (26a) If John made coffee, his wife will be happy.
 (26b) If John made coffee, he has a wife.

Assuming that it is not known beforehand that John has a wife, the local context, $c + \textit{John made coffee}$, does not entail that John has a wife. Again the requirement that the local context should entail this elementary presupposition comes down to the requirement that c should entail the implicative proposition *If John made coffee, he has a wife*. The prediction therefore is that an utterance of (26a) presupposes that John has a wife, on the assumption that he made coffee. In other words it presupposes (26b).

This brings us to the question as to what happens when the presuppositions of a sentence are not entailed by the context of utterance which, according to the view just sketched, would make the contextual update undefined. Here Lewis's (1979) notion of accommodation comes in.¹⁷ Accommodation is a

mechanism which, if applicable, will simply insert the required presupposition into the context of utterance.¹⁸ It is thus a mechanism which under certain conditions adjusts the context of utterance by accommodating the required presupposition so as to make the utterance defined after all. The absence of a 'required' presupposition need not therefore result in infelicity. It is by means of this notion of accommodation that Karttunen and Heim account for the fact that utterances may introduce new information simply by presupposing it. If presuppositions are not neutralized, they can be accommodated so as to restore definedness after all. On Heim's account definedness can be restored in either of two ways. We may either accommodate the missing presupposition globally, that is, into the context of utterance, or insert it locally, which in the above case would amount to inserting in the antecedent of the conditional. *Ceteris paribus*, global accommodation is the preferred option.

With respect to examples like (26a) it does not make much difference whether we globally or locally accommodate. Consider a sentence of the form $\varphi \rightarrow \psi$, where ψ triggers a presupposition χ . Global accommodation would put the implicative proposition $\varphi \rightarrow \chi$ into the context of utterance. Local accommodation would put χ into the local context that is in $c + \varphi$. Both operations would satisfy the presuppositional requirement and thus guarantee contextual update, but in both cases the resulting context will only entail the conditionalized presupposition. The alternative would be globally to accommodate the descriptive material contained in the trigger straight away, instead of the sentential presupposition computed according to the clauses above. This would also restore definedness, but not minimally. It also requires an answer to the question why we should compute a weak sentential presupposition, but accommodate a stronger one.¹⁹

It has been argued (Zeevat 1991, this volume) that anaphoric binding can be reduced to entailment and that the view on presuppositional requirements put forward in this paper can be amalgamated to the one which has been defended by Karttunen and Heim, provided we make some proper adaptation to both theories. I have my doubts about this claim. There are a number of non-trivial differences between anaphoric binding on the one hand and contextual satisfaction in the Heim/Karttunen sense on the other.

As we saw, the basic requirement put forward on the Karttunen/Heim account is that the presuppositions of an utterance should be entailed by the local context. If they are, definedness of the contextual update is guaranteed and the presuppositions are not felt to have a true presuppositional status any more. The reductionist account would thus predict that as soon as the information triggered by a presupposition inducer is found in an accessible position, the material thus found constitutes *the* antecedent for the anaphoric expression. Let me first remark that we should *not* require that there be an entailment relation between an antecedent and an anaphoric expression but rather that this relation

should be one of subsumption. However, even if the requirement that an anaphor must be entailed by its antecedent can be defended, this requirement can only be maintained as a necessary but certainly not as a sufficient condition. A discourse will normally contain many male individuals. If we adopt the requirement that an antecedent expression should entail the anaphor, each male individual is a *potential* antecedent for a pronoun which requires the antecedent to be of the male gender. The actual antecedent still has to be selected from these. It is here that the differences between an anaphoric view and the contextual satisfaction view come out most clearly. The satisfaction view predicts that once the presuppositional material has been found the presupposition is effectively neutralized. This is not quite what we expect on an anaphoric view. The latter predicts that if some discourse referent with suitable properties is found this referent is a potential antecedent. Such a potential antecedent will, however, only absorb the descriptive content associated with the presuppositional anaphor if it is actually selected as its antecedent. If not, this material may be absorbed by another suitable candidate or be accommodated after all. An anaphoric view thus predicts that presuppositional anaphors may be genuinely ambiguous, that is, there should be cases where we can either select among different antecedents or have the choice between either binding or accommodating. It thus simultaneously predicts that we should find cases which allow a certain variability in interpretation and in particular a choice between a presupposing and a non-presupposing reading, where the satisfaction account predicts just presuppositional neutralization. This variability in interpretation is what we actually find.

In order to bring out the differences between the two views, I will first consider a case where the lexical material contained in the presuppositional trigger is entailed by the local context but nevertheless cannot serve as a proper antecedent, and then discuss some cases which actually give rise to the variability in interpretation we would expect on a purely anaphoric view.

In the following sentence the antecedent entails the information induced by the presuppositional trigger in the consequent:²⁰

(27) If John has grandchildren, *his children* must be happy.

The Karttunen/Heim account predicts that the presupposition is satisfied trivially and that this sentence thus cannot have a presuppositional reading. I contend that this sentence has both a presuppositional and a non-presuppositional reading and that for this particular example the presuppositional reading is strongly preferred. Note that the grandchildren in the antecedent of the conditional cannot serve as a proper antecedent for the presuppositional expression in the consequent. The presupposition thus cannot be bound and will be accommodated so as to provide an antecedent after all. The preference for global accommodation moreover predicts accommodation at top level and

consequently a presupposing interpretation for this sentence on its preferred interpretation. The non-presupposing interpretation comes about by accommodating the presupposition in the antecedent of the conditional.²¹

The second type of examples consist of cases where a presupposition may but need not be bound. Soames observed that conditionals in which there is a one-sided entailment relation between the antecedent and the presupposition of the consequent allow a non-presupposing reading and claimed that they were completely neutral with respect to the truth of the presuppositions. Of course, if we think in terms of cancellation such a claim makes sense. A presupposition is either cancelled or not. So if we perceive a non-presupposing reading for a particular sentence, we have no other choice than to maintain that the presupposition does not survive. On the present account there is no need to entertain this assumption. If I am right in claiming that in many cases presuppositions *may* but *need not* be bound to a potential antecedent, such examples display exactly the variability we would expect.

- (28) If John has an oriental girlfriend, his girlfriend won't be happy.
 (29) If John murdered his wife, he will be glad that she is dead.
 (30) If someone at the conference solved the problem, it was Julius who solved it.

I argued before that sentences of this type display a genuine ambiguity.²² The presuppositional interpretation is most easily perceived in the following continuations, which eliminate the presupposing reading:

- (28') If John has an oriental girlfriend, his girlfriend won't be happy, but if he has one from France . . .
 (29') If John murdered his wife, he will be glad that she is dead, but if she took those pills herself . . .
 (30') If someone at the conference solved the problem, it was Julius who solved it, but if it was solved at Nijmegen University, it certainly was not Julius.

Which interpretation we get depends on whether or not we resolve the presuppositional anaphor in the antecedent. If we take the first option the descriptive material associated with the presuppositional expression will be absorbed in the antecedent. The second option yields accommodation of the presuppositional material into the context of utterance.²³

An important feature of the theory presented here is that it is not just testable with respect to our intuitive judgements with respect to the survival of presuppositions, but also with respect to the possibility of pronominal uptake. One of the most salient characteristics which distinguishes presuppositions from logical inferences is their tendency to survive embedding, no matter what the logical properties of the embedding operators are. Presuppositional constructions thus do not normally enter into scope relations with quantifiers or

logical operators. If they survive they behave like indexicals or other context-dependent expressions. On the current account this is a consequence of their capacity to accommodate. As I pointed out before, accommodation of the presuppositional material creates a discourse referent, provides it with descriptive material associated with the presuppositional expression, and thus establishes an accessible antecedent. If accommodation takes place at top level, this creates a discourse marker, which can subsequently function as an antecedent for pronouns or other anaphoric expressions to come.

This gives us a further test to distinguish presuppositional from non-presuppositional readings. If a sentence is presupposing in a given context the discourse marker thus created should allow anaphoric take-up in subsequent sentences. So let us consider the above examples again:

- (31) If John has an oriental girlfriend, his girlfriend won't be happy. She has always been rather jealous.
- (32) If John has grandchildren, his children will be happy. They wanted to have offspring long ago.
- (33) If the problem was solved at the conference, it was Julius who solved it. But whether he did or not, the solution was brilliant anyway.

It should be observed that these continuations cannot be treated as an instance of modal subordination. Neither the pronouns nor the description can access the anaphoric antecedent in the antecedent clause of the conditional. Both require an antecedent at the main level of discourse. This shows that the presuppositions in these conditionals are neither neutralized nor weakened to an implicative proposition. For this would deprive us of the possibility of accounting for the anaphoric links in the above sentences.

3 ANAPHORIC STRUCTURES IN DISCOURSE REPRESENTATION THEORY

In the present section I will develop the informal ideas outlined above in discourse representation theory. The account of anaphoric structures in discourse representation theory follows van der Sandt & Geurts (1991). For details concerning the actual construction mechanism out of the syntactic parse of a sentence I refer to the same paper.

In Kamp's original formulation a discourse representation structure or DRS K is an ordered pair $\langle U(K), \text{Con}(K) \rangle$, where $U(K)$ is a universe of discourse markers and $\text{Con}(K)$ a set of conditions. Indefinite NPs introduce discourse markers into the universe of a DRS. These discourse markers then serve as the referent for the NP for the remainder of the discourse. Pronouns or other

anaphoric expressions may pick them up. Conditions assign properties to the members of $U(K)$ and thus encode the descriptive content of the predicates. Discourse markers thus store whatever information accumulates on them when discourse proceeds.

Two salient features of Kamp's original formulation are that the construction procedure works top-down and that pronouns are resolved on-line during the construction procedure. The construction of each new DRS is based on the DRS representing the previous discourse and the syntactic parse of the sentence to be processed. The syntactic tree of the sentence under analysis is taken apart top-down and during this process new markers and conditions are added immediately to the main DRS. The same applies to anaphoric expressions. When the construction algorithm encounters a pronoun or other anaphoric construct it is resolved immediately against the universe of the main DRS.

The present account differs in three respects. Firstly, the construction process works bottom-up. Secondly, the construction procedure is indirect in that we will first construct a provisional DRS from the syntactic parse of the sentence. Such a 'sentence'-DRS is an auxiliary construct which only after the completion of the construction procedure is merged with the incoming DRS.²⁴ The final and most important difference is that anaphoric elements are encoded separately in a DRS. They are therefore not resolved straight away against the content of the main DRS, but they are processed only after the DRS constructed for the incoming sentence has been completed and merged with the main DRS. I will refer to this construct as a resolved or proper DRS. A proper DRS will thus not contain any unresolved anaphoric expressions and it is to this construct that the standard interpretation rules apply. So we will construe a DRS as consisting of three components, a universe of discourse markers, a set of conditions, and its so-called A-structure. The latter component is a set of DRSs. They collect the anaphoric elements of the sentence to be processed. This last difference is a crucial one and derives from the fact that presuppositional expressions differ from pronouns or other anaphoric elements in that they may have the same internal complexity that non-presuppositional phrases of the same syntactic category exhibit.

As I said before, presuppositions need not be independent of each other. In fact presuppositions may embed further presuppositional constructions or other anaphors. Some obvious, but in the literature on presupposition unfortunately neglected examples are found in open descriptions:

- (34) Every girl loves *her* cat.
 (35) If every farmer would fondle *his* donkey, donkeys would be happier.
 (36) John has a goose and every farmer loves *his* goose.

In (34) and (35) a pronoun inside a presuppositional expression is bound by the quantified NP in subject position. As I pointed out in section 1, this is exactly

the reason why it is wrong to analyse presuppositional expressions as referring expressions. Sentence (36) shows how the interpretation of a presuppositional expression may vary depending on the antecedent chosen for the embedded anaphor. This turns out to be the general case both for pronouns and presuppositional anaphors and is one of the reasons for choosing an indirect construction procedure. We will see that in order to determine the correct interpretation of a sentence we first have to process the deepest embedded anaphor. The resolution and interpretation of the embedding anaphor will then depend on the result of this.

Note that once we allow anaphoric expressions to have internal structure there is no limit on the depth of embedding. The following presuppositional constructions embed other presuppositional constructions, which again contain further anaphoric expressions:

- (37) Mary didn't realize that it was Harry who bought the butcher's goose.
- (38) John didn't know that the thief lost his watch in the backyard.
- (39) If John has children, he will regret that all of his children are bald.

In (37) a factive complement, which is itself a presuppositional anaphor, embeds a presupposition inducing cleft, which contains a possessive construction, which in turn contains a definite description. We thus arrive at the following hierarchy of presuppositional anaphors:

- (37a) It was Harry who bought the butcher's goose.
- (37b) Someone bought the butcher's goose.
- (37c) The butcher had a goose.
- (37d) There is a butcher.

Sentence (38) illustrates a presuppositional construction which embeds several other presuppositional anaphors at the same level of embedding. This example also shows that the latter may both enter into scope relations with expressions inside and outside the embedding presuppositional expression. Processing and interpreting the embedding anaphor obviously depends on a prior resolution of the embedded ones. Sentence (39) differs in that a presuppositional anaphor (the possessive construction) embedded in another one (a factive complement) is bound in the antecedent of a conditional. Note that no antecedent can be found for the embedding anaphor. This might invite one to accommodate the factive presupposition at top level of representation. That would, however, yield the wrong prediction that (39) presupposes that all of John's children are bald. It transpires that the natural accommodation site for this presupposition is the antecedent of the conditional and the reason is obvious. Accommodation at top level would project the anaphoric expression *John's children* up to a position where it could not access its antecedent marker any more.

The above observations give rise to a natural and central constraint on

accommodation, which I mention now and which I will discuss later in more detail. If an embedded anaphor is bound to some accessible antecedent, none of the embedding anaphoric expressions can be accommodated any higher. As I said, the reason is obvious. Accommodating the full expression beyond the binding site of an embedded anaphor would unbind a variable in the latter.

Before giving some examples I will first give the formulation for the language. The definition extends the standard definitions for the language of discourse representation theory in that they allow an explicit coding of multiply embedded anaphoric expressions:

DRS definition

The vocabulary is identical to the language of discourse representation theory. It consists of a set U of discourse markers: u, v, w, u_1, u_2, \dots , a set of n -place predicates: $P_1 \dots P_n$ and the operators \neg, \rightarrow , and \vee to form complex conditions.

A DRS K is a triple $\langle U(K), \text{Con}(K), A(K) \rangle$, where

- (i) $U(K)$ is a finite and possibly empty set of discourse markers.
- (ii) $\text{Con}(K)$ is a set of simple or complex conditions.
- (iii) $A(K)$ is a (possibly empty) set of DRSs.

A condition is an expression of the following form:

- (i) If P is an n -place predicate and $u_1 \dots u_n$ are discourse markers, then $P(u_1, \dots, u_n)$ is a simple condition.
- (ii) If u_i and u_j are discourse markers then $u_i = u_j$ is a simple condition.
- (iii) If K and K' are DRSs, then $\neg K$, $K \rightarrow K'$ and $K \vee K'$ are complex conditions.

For a given DRS K we will refer to $A(K)$ as its A -structure. This structure collects the anaphoric elements of K . As we pointed out, an anaphoric expression may simultaneously contain any number of other anaphoric expressions. An A -structure is thus defined as a *set* of DRSs. We noted furthermore that each anaphoric expression may itself embed other anaphoric expressions up to any depth. Any member of an A -structure is thus itself a DRS. This gives us a simple way to embed anaphoric expressions inside larger anaphoric expressions.

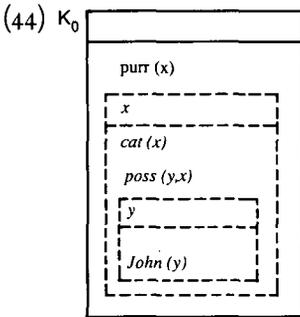
An example may demonstrate the function of an A -structure. Consider the following sentences:

- (40) John's cat purrs.
- (41) John has a cat. It purrs.
- (42) John has a cat. His cat purrs.

The construction algorithm will associate the following structure with sentence (40):²⁵

$$(43) \langle \emptyset, \{ \text{purr}(x) \}, \{ \langle \{x\}, \{ \text{cat}(x), \text{poss}(x, y) \}, \{ \langle \{y\}, \{ \text{John}(y) \}, \emptyset \} \rightarrow \} \rangle \rangle \rangle$$

In the pictorial representation (44) I use dotted boxes as a mnemonic device to indicate the members of an A-structure. Italicizing will be used throughout as a means to indicate anaphoric material. Bold indicates material which has been accommodated. This is just for clarity. Nothing substantial hinges on it. It



is easy to read off from this representation that (40) contains two anaphoric expressions, one for the full possessive construction and one for the proper name which is contained in it.²⁶ Its universe is empty and so is the A-structure of the deepest embedded anaphor. Though K_0 is a DRS according to the above definitions it is as yet unresolved and does not allow an interpretation.

In order to make clear how an A-structure is resolved we need some more definitions. As I said, DRSs are constructed in two stages. First, a DRS is constructed for the incoming sentence. This DRS is then merged with the main DRS, which result in a new DRS in which the anaphoric structures still await processing. Only then are the anaphoric expressions resolved against the content of the new DRS, thus yielding a proper DRS. Merging the DRS for the incoming sentence with the content of the main DRS is a rather simple operation which involves taking the union of the universe of both DRSs and merging their conditions and A-structures.

Merging

Given two DRSs K and K' , the merge of K with K' is defined as follows:

$$K \sqcup K' := \langle U(K) \cup U(K'), \text{Con}(K) \cup \text{Con}(K'), A(K) \cup A(K') \rangle$$

Anaphora resolution is now a partial function from DRSs to DRSs, which should obey the standard constraints on accessibility. On the current account

accessibility is a relation between members of the universe of an A -structure and established markers. Accessibility is the first and foremost constraint on the possibility of anaphoric binding and regulates the projection of presuppositional material upwards through DRSs. Again we have to extend the definitions in order to take the contribution of A -structures into account.

Subordination

A DRS K_i immediately subordinates a DRS K_j if one of the following holds:

- (i) There is a K_k such that $K_j \rightarrow K_k \in \text{Con}(K_i)$
- (ii) There is a K_k such that $K_i \rightarrow K_j \in \text{Con}(K_k)$
- (iii) There is a K_k such that $K_j \vee K_k \in \text{Con}(K_i)$
- (iv) There is a K_k such that $K_k \vee K_j \in \text{Con}(K_i)$
- (v) $\neg K_j \in \text{Con}(K_i)$.
- (vi) $K_j \in A(K_i)$.

A DRS K_i subordinates a DRS K_j just in case

- (i) K_i immediately subordinates K_j .
- (ii) There is a K_k such that K_i subordinates K_k and K_k subordinates K_j .

Accessibility

Let $u \in U(K_j)$, where K_j is an element of some A -structure and v an established marker in some $U(K_i)$. Now v is accessible to u just in case K_i subordinates K_j .

We furthermore distinguish between the local domain and the accessible domain of an anaphoric DRS. Let K be an anaphoric DRS, that is, an element of some A -structure. Its local domain is $U(K)$. Its accessible domain $\text{Acc}(K)$ is the set of all markers which are accessible from the elements of $U(K)$.

Note that according to these definitions no anaphoric marker in an A -structure $A(K)$ can access a marker in its local domain, nor any other marker in a superordinate A -structure. Anaphoric markers will thus always be resolved outside an A -structure.

Subordination imposes a tree-structure on DRSs, which extends inside A -structures. It tells us which markers are accessible from a given marker and thus can be identified with it. On the present account anaphora resolution is not limited to the identification of discourse markers, as is the standard case with pronominal anaphora. Instead it is an operation on (sub) DRSs. It is then convenient to have the notion of a projection line. A projection line is one path through an accessibility tree from a sub-DRS to the root of the tree. It tells us which route an anaphor must take when it is projected to a higher position in a DRS.

Projection lines

Let K_0 be a main DRS and K_n a member of some A-structure. The projection line of K_n is a sequence of DRSs ($K_0 \dots K_n$) each member of which immediately subordinates the next one. A DRS K_j will be said to be lower on K_n 's projection line than K_i just in case K_i subordinates K_j . K_j is higher on K_n 's projection line than K_i , if K_j subordinates K_i .

DRSs may contain any number of unresolved anaphors. Resolution of all anaphoric expressions contained in a DRS will yield a proper DRS which can be interpreted with respect to a model according to the standard embedding conditions.²⁷ Anaphora resolution is thus a complex function from DRSs to DRSs. In the case of anaphoric binding the resolver puts in equations which link discourse markers and transfer the conditions associated with the anaphoric expression to the binding site. In case of accommodation the resolver will percolate an A-structure upward along its projection line and add both its markers and the conditions to the accommodation site. If this process is successfully completed for all A-structures in a given DRS we end up with a resolved or proper DRS. A proper DRS is thus a DRS with an empty A-structure.

Proper DRS

Let K_i be a member of some A-structure.

- (i) K_i is simple or non-anaphorically-embedding just in case $A(K_i) = \emptyset$.
- (ii) K_i is empty just in case $K_i = \langle \emptyset, \emptyset, \emptyset \rangle$.
- (iii) If K_i is empty and K_i' is immediately superordinate to K_i , then K_i' is empty just in case $K_i' = \langle \emptyset, \emptyset, K_i \rangle$.

A DRS is proper just in case it does not contain any non-empty A-structure.

This brings me to the notions of binding and accommodation. Both are operations on DRSs. In order to see whether a presuppositional anaphor can be bound to some pre-established antecedent we follow up its projection line in order to find a suitable antecedent. If we do, the anaphoric marker can be identified with the established marker. The associated conditions will be transferred to the binding site and the antecedent thus inherits all the descriptive information associated with the presuppositional anaphor. If no suitable antecedent for a presuppositional anaphor can be found, it will be accommodated. Accommodation generally will take place at the highest accessible level such that the resulting structure does not violate general constraints on (un)binding and acceptability. Technically, accommodation consists in transferring the anaphoric marker plus its conditions to the level of accommodation,

thus adjusting the discourse structure by establishing an accessible antecedent after all.

The following definition tells us how binding and accommodation can transform an unresolved DRS into a resolved one. In the next section we will give the constraints which allow us to determine what admissible binding and accommodation sites are for an anaphoric expression in a given DRS.

Resolution

Let K be a DRS and let K_s be the source of an anaphoric expression, that is an element of an A-structure of some sub-DRS of K and let $A(K_s)$ be empty. Let its target be a (sub)DRS K_t on K_s 's projection line. Let K_s have the markers $y_1 \dots y_m$ and $\text{Acc}(K_t)$ the markers $x_1 \dots x_n$. Let f be a function from $U(K_s)$ to $\text{Acc}(K_t)$, such that the conditions of K_t are compatible with the conditions of K_s under the substitution of $y_1 \dots y_n$ for $x_1 \dots x_n$.

The resolution of the anaphoric structure K_s with respect to K_t yields a DRS K' , which differs from K in the following respects.

Binding

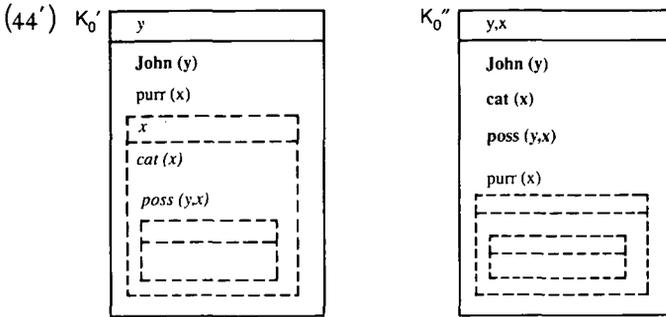
- (i) $U(K_s') = \text{CON}(K_s') = \emptyset$
- (ii) $U(K_t') = U(K_s) \cup U(K_t)$
- (iii) $\text{CON}(K_t') = \text{CON}(K_s) \cup \text{CON}(K_t) \cup \{x = y \mid x = f(y)\}$

Accommodation

- (i) $U(K_s') = \text{CON}(K_s') = \emptyset$
- (ii) $U(K_t') = U(K_s) \cup U(K_t)$
- (iii) $\text{CON}(K_t') = \text{CON}(K_s) \cup \text{CON}(K_t)$

Accommodation of K_s into K_t is thus just like binding with the one exception that no restrictions on compatibility are required and no anaphoric equations are added to $\text{Con}(K_t)$.

It is worth running through an example and to look in some more detail how the resolution algorithm would map the unresolved DRS (44) into a proper DRS. The deepest embedded anaphor we find is the A-structure set up for the proper name. Going upwards along its projection line we check whether a suitable antecedent can be found. In this case we will not. Hence we add y to $U(K_0)$ and the associated condition to $\text{Con}(K_0)$. This yields K_0' . Next we start processing its embedder. Again we will not find an antecedent for the embedding presuppositional expression. It will be accommodated as well, yielding K_0'' . This is precisely the DRS which the conventional construction rules would yield



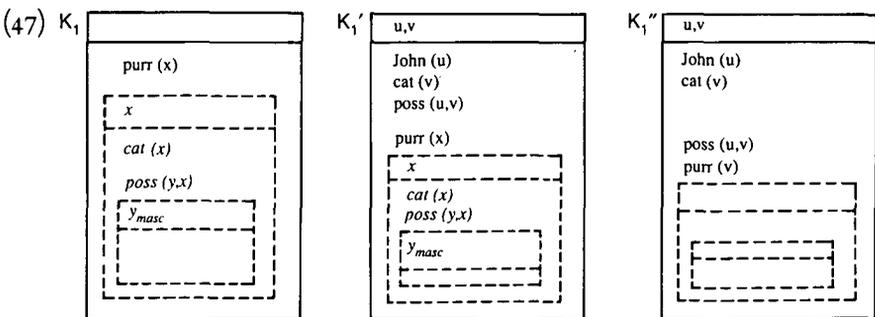
Consider now (45) which is like (40) except that we find a pronoun where (40) has a proper name.

(45) His cat purrs.

The representation is K_1 , which is exactly like K_0 , except that we find a pronoun where K_0 has a proper name. Again we will not find an antecedent. And since pronouns lack the capacity to accommodate, no interpretation would come about if (45) were processed in isolation. However, if (45) were processed given an incoming DRS, which already contains the information that John has a cat, the embedding presupposition will be bound to this pre-established animal:

(46) John has a cat. His cat purrs.

Merging K_1 with the incoming DRS yields (47). Resolution is now straightforward. We first equate the pronominal y with u and subsequently the x with v and transfer the associated conditions to the main DRS, which yields the K_1'' .



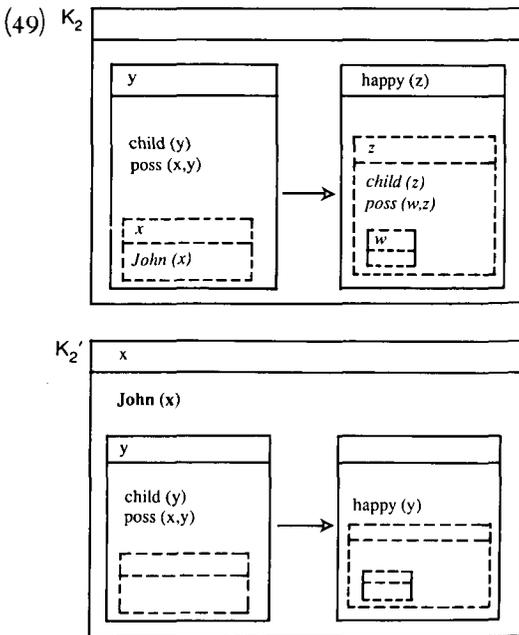
Note that K_1'' is like K_0'' . They only differ in the way they are constructed. In K_0'' John's cat comes about by accommodation, in K_1'' the possessive construction is bound to a previously established antecedent. Note furthermore that (44) is intuitively presupposing while the discourse in (46) is not. This illustrates our informal discussion in the previous section. On the current

account the intuitive notion of presupposition coincides with accommodation at top level of discourse structure. However, if some presupposition is bound to some previously established antecedent, the presuppositional construction will be absorbed in its antecedent and not be felt to have a presuppositional status any more. This captures the common intuition that presupposition and assertion are complementary notions. It also shows how presuppositional material can be entailed without being presupposed.

Sentence (48) is one of the paradigm cases of cancellation or filtering in conditionals:

(48) If John has a child, his child is happy.

The initial representation is depicted in (49). Again we will not find an antecedent for the proper name. Thus accommodation at top level will ensue.



Next the pronominal marker in the consequent will be processed and equated with the marker just established for John. Processing the remainder of the possessive construction is then straightforward. Following up its projection line we will find a perfect match for the presuppositional anaphor in the antecedent if we equate z with y and w with x . Transferring the conditions to the antecedent box then results in K_2' , which is identical to the DRS we would have derived straight away for its pronominal counterpart under a coreferential reading for *John* and the pronoun.

(50) If John has a child, he is happy.

Binding and accommodation are subject to a variety of constraints. I will discuss these constraints in the next section in order to determine what proper binding and accommodation sites are. This will bring us back to the standard problems involved in presupposition projection.

4 PROJECTION AS RESOLUTION

Let me recapitulate what we have done up to now. Assuming a bottom-up construction procedure, we opted for an indirect construction mechanism. First, a DRS is put together from the syntactic parse of the sentence. This DRS collects but does not resolve the anaphoric elements in its A-structure. Merging this DRS with the main DRS yields a new DRS in which the anaphoric elements still await resolution. Only then does the actual processing of anaphoric elements take place. The anaphoric expressions are either linked to some previously established antecedent or, if they have enough descriptive content, accommodated at some level of representation. In order to see whether a presuppositional anaphor can be bound to some pre-established antecedent we follow up its projection line and link it to a marker that is a suitable antecedent. The marker in the A-structure encoding the anaphoric expression will be identified with the antecedent marker, which after transfer of the conditions inherits all the descriptive information associated with the presuppositional anaphor. If no suitable antecedent for the anaphor can be found, it will be accommodated. 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. Once we have resolved all anaphoric expressions, we end up with a proper DRS to which the standard rules of semantic interpretation apply.

The task which faces us then is to specify under what conditions the anaphoric expressions coded in the A-structures of a DRS can be resolved with respect to a certain target. In the proposal put forward here this simply comes down to giving the principles which constrain binding and accommodation. We can look at this in either of two ways. The first way is rather procedural and leads to a backtracking mechanism. The second way is more declarative. It sorts out possible resolutions by filtering them through a series of successive *constraints*.

In the first process, anaphora resolution proceeds as follows. Beginning with the most deeply embedded anaphor, anaphoric material will climb up along projection lines until a proper binding site is found, that is, a site which contains or is compatible with the (presuppositional) anaphor. If so, we will identify the

markers of the A-structure with the relevant markers in the binding site and transfer the associated conditions. If we reach the root of the accessibility tree and no binding site is found, we will try to accommodate the anaphoric material, that is, we will insert the discourse marker of A-structure and add the associated conditions. But now it might turn out that this violates the constraints on accommodation which we will discuss shortly. If so, we will go back along the anaphor's projection line and try to accommodate one level lower, repeating this procedure until a proper accommodation site is found. Next, the same procedure will be applied to the anaphoric expression which resides one level higher on the same projection line. If this procedure can be completed for all A-structures we will end up with a full DRS. If no binding or accommodation site can be found, the construction algorithm will come to an end and the whole discourse will lack an interpretation, just as would happen with sentences containing pronouns, which cannot be linked to a suitable antecedent.

The process just sketched automatically gives binding priority over accommodation. Both binding and accommodation can only take place at accessible positions. But binding involves a search upwards along the anaphor's projection line and will thus normally take place at the nearest accessible position. Accommodation, on the other hand, goes downwards. If accommodation at top level is blocked due to an imminent violation of well-formedness conditions on discourse structures, the next attempt at accommodation will be made one level lower. In the process of resolving a presuppositional anaphor we thus trace a loop along the anaphor's projection line.

Implementing this strategy, though possible, gives rise to some technical problems and leads to further complications when pragmatic factors interfere during an attempt at resolution. The first obstacle we encounter is that the constraints on contextual acceptability, which are crucial to determine whether a presuppositional expression can be accommodated, are essentially dependent on logical properties. These, however, are only defined for full DRSs. Remember that a DRS may contain any number of unresolved anaphors. This obviously leads to problems when we check for logical properties like consistency or entailment. For interpretation and determination of these logical properties can only ensue after full resolution of all anaphoric expressions. Except for the simplest cases, implementing this strategy will thus involve a substantial amount of backtracking.

In this paper I will explore a simpler alternative. Note that a DRS can only contain a finite number of anaphoric expressions each of which can only be resolved at a limited number of sites along its projection line. The strategy I envisage is to collect the possible solutions and sort these out by applying a series of successive constraints. These will sort out the possible solutions to a number of admissible ones. If this successive sorting out does not yield a single

solution, further discourse constraints will define a preference order over the resulting set. This procedure minimizes the need for backtracking and will still yield a preferred interpretation. It has moreover the conceptual advantage of separating absolute constraints like conditions on variable binding and acceptability from discourse properties like recency or salience and the contribution of non-linguistic knowledge in determining a suitable antecedent.²⁸

The picture as I will present it here is as follows. For an unresolved DRS the accessibility constraints and the constraints on binding allow a number of possible resolutions. Resolution of all anaphoric expressions in accordance with these constraints determines a proper DRS, which is subject to the standard rules of interpretation. Let us call this the set of logically *possible interpretations*. However, only a part of the possible interpretations may respect the restrictions on acceptability. Acceptability will thus sort out this set to a smaller one which we call the set of *admissible interpretations*. But, as I said, the set determined by the previous constraints may still not single out a unique interpretation, as happens in (27)–(30). I will furthermore assume that the resulting set is ranked by a preference order, which is determined by full versus partial matching, relative distance along its projection line, discourse principles, and non-linguistic knowledge. These factors then finally single out the *preferred interpretation*. A full discussion of the discourse factors that co-determine the choice of the preferred interpretation if the resolver leaves open a number of logical possibilities is beyond the scope of this paper. In the following I will limit myself to the constraints on binding and acceptability and make some short remarks on the latter constraints when we come back to the matter of ‘pragmatic’ ambiguity.

The accessibility constraint has been discussed in the previous section. Thus in order to pin down what admissible interpretations are I will first discuss the constraints on binding. Then I will show how the acceptability constraints further sort out the possible interpretations to the set of admissible interpretations.

The constraints on binding involve the interaction between quantified expressions and presuppositional anaphors. Consider the following sentences:

- (51) A man loves his wife.
- (52) If a man loves his wife, she is happy.
- (53) Every man loves his wife.
- (54) If every man would love his wife, women would be happier.
- (55) Every man who loves his wife will be rewarded.
- (56) Nobody loves his mother in law.

In section 1 I noted that such sentences present problems for the view that presuppositions are referring expressions, since they contain free variables

which are bound externally by a quantified NP. If we derive for (51) the presupposition that a man has a wife and accommodate this presupposition into the main DRS, we end up with the awkward prediction that some man has a wife and a possibly different one loves her. With respect to (53), we would get an equally bad prediction. This sentence would presuppose that every man has a wife. This is in fact the presupposition that Heim's theory predicts for (51) and (53), and, even worse also for (55) and (56).²⁹ When we embed these sentences it is easy to see that both predictions are wrong. Neither does the truth of (52) require that a man has a wife, nor does (56) require that every man has a wife.

The current theory predicts that no sentence which contains an open phrase in which a variable is bound by an outside quantifier can ever have a presupposing reading. Instead (53) will come out as equivalent with (57) and (54) as equivalent with (58):

(57) Every man who has a wife loves her.

(58) If every man who has a wife would love her, women would be happier.

Similarly I want for (56) the interpretation that no man who has a mother in law loves her.

The source of the problem is clear. Consider (53). The presuppositional expression *his wife* contains another anaphor which depends on the quantified NP *every man*. Thus projection of the full expression to top level would cut the link between the pronoun and its binder, thus creating a free variable in a condition which cannot access its antecedent any more. It was to prevent this that we set up the hierarchical ordering of A-structures and required that in case of multiple embedding the deepest embedded anaphor has to be processed first. The solution is then simple. When we start processing the embedder, the embedded anaphor will already be resolved. The embedder thus cannot be projected any higher along its projection line without creating a free variable in a condition which cannot be bound by its intended antecedent. Note that it would be wrong to insert a variable at top level and to interpret it by means of its existential or universal closure. Such a procedure would, in fact, yield exactly the same predictions as emerge on Heim's or Cooper's account. The correct way to proceed is to start processing with the deepest embedded anaphor and to put a natural ban on the unbinding of anaphoric links already established. This procedure intercepts an embedding anaphor at the place where an embedded expression is bound, and prevents the resolver from accommodating the embedding expression any higher along its projection line. The definition requires the notion of a discourse marker occurring free in some condition.

Free discourse markers

A discourse marker u is free in a condition C of a DRS K just in case u occurs in C and $u \notin \text{Acc}(K)$.

Possible resolutions

Let K_0 be a DRS, K_s an element of the A-structure of some sub-DRS of K_0 and $\langle K_0, \dots, K_s \rangle$ its projection line.

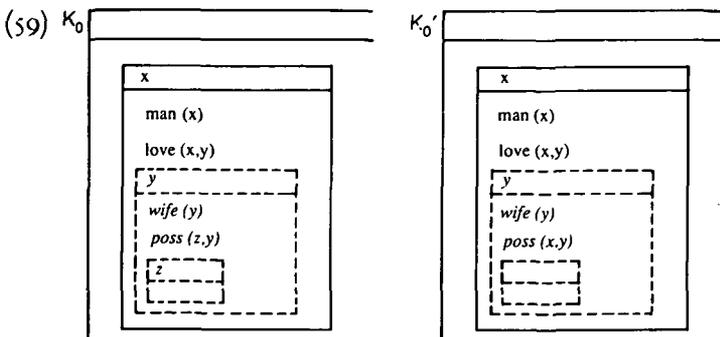
Resolution of K_s with respect to some (sub)DRS K_t is subject to the following constraints:

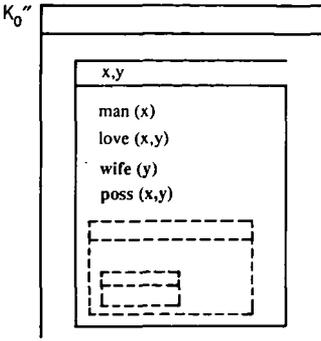
- (i) K_t is on K_s 's projection line.
- (ii) $A(K_s)$ is empty.
- (iii) There is no K_i on K_s 's projection line such that $A(K_i)$ is non-empty.
- (iv) No condition in K_t contains a variable which occurs free.

Any DRS which has been resolved in accordance with these constraints is a possible resolution. The standard interpretation rules apply to it.

Clause (i) encodes the basic requirement of accessibility; (ii) guarantees that no anaphoric expression will be processed until all embedded anaphors have been resolved; (iii) imposes a left-right ordering on the resolution process—it guarantees that the resolver will not find any unresolved anaphor on its path when processing an anaphoric expression. Finally, (iv) encodes the central constraint: no attempt at resolution may result in unbinding a variable.

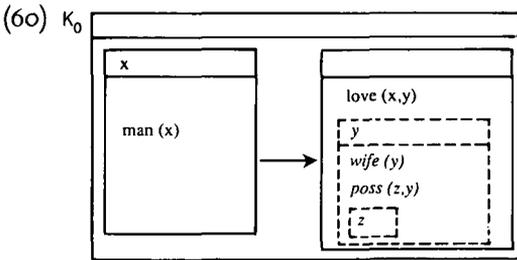
Example (59) illustrates how an embedded anaphor may intercept its embedder. The construction rules yield the inner box of K_0 as the initial representation for (51). Assuming that the pronoun is coreferential with the subject NP K_0 transforms in K_0' by identifying z with x . When we start processing the remaining A-structure we will not find a proper binding site. Thus accommodation will ensue. Clause (iv) ensures that the highest place this anaphoric expression can be accommodated is sub-DRS where it originates. This correctly yields K_0'' . Note that the same prediction ensues for (56). The resulting DRS only differs in that the embedded box is prefixed with a negation operator. Since the relevant anaphoric expression can never escape the box



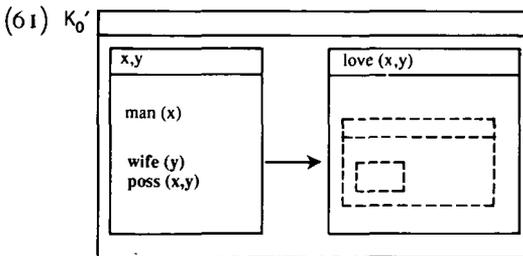


where it originates, it is predicted that no sentence which contains (51) or (56) as a component part can ever be presupposing.

(53) differs in that it allows two possible solutions. The initial representation can be seen in (60). After processing the pronoun we end up with two possible



accommodation sites, the antecedent- and the consequent-box. Given the first option, the anaphoric material will be transferred to the antecedent of the conditional, yielding K_0' ((61)). The second possibility will leave the anaphoric



material at the position where it originates. (53) thus allows two possible resolutions. But given the preference to accommodate as highly as possible, the first option which yields the interpretation given in (57) is the preferred one.

Accessibility and the conditions on binding determine the set of possible

interpretations of a sentence in a given discourse. But as we said before, not all possible interpretations are admissible. In previous work I have argued at length that contextual acceptability is the crucial constraint governing accommodation. The view put forward there is that a presupposition can never be accommodated into the context of utterance in case this would violate the constraints on contextual acceptability.³⁰ On the current account this principle still holds. However, since our DRT implementation also allows accommodation on subordinate levels we will have to revise our formulation so as to make it applicable to subordinate levels of representation.

For the extensional fragment presented here the following constraints on acceptability suffice.

Admissible resolutions

Let K_0 be the incoming DRS, K_1 the merge of a DRS with K_0 and K_1' a possible resolution of K_1 . The resolution of K_0 to K_1' is subject to the following conditions in order to be admissible:

- (i) K_1' is informative with respect to K_0 , that is K_0 does not entail K_1' .
- (ii) Resolving K_0 to K_1' maintains consistency.
- (iii) Resolving K_0 to K_1' does not give rise to a structure in which
 - (a) some subordinate DRS K_i is entailed by the DRSs which are superordinate to it,
 - (b) $\neg K_i$ is entailed by the DRSs which are superordinate to it.

The first two clauses encode Stalnaker's (1978) conditions on assertions. The requirement of consistency requires no further discussion. Informativeness arises from independently motivated conversational principles. The main purpose of discourse is to convey information, and information is conveyed relative to background information, which is already part of the current DRS. In DRT an assertion is thus incremental in the following sense. After an assertion has been made, its content will be added to the DRS under construction. The informational status of its content thereby changes. It will become part of the DRS from then on and can function as an antecedent for coming anaphoric expressions. Now the point of an assertion is to introduce new information. Its utterance would be superfluous in a discourse which already contained or entailed its content. Processing such an utterance would result in a trivial mapping of the current DRS on to itself: no information would be added. Thus the informativeness constraint accounts, among other things, for the unacceptability resulting from iteration of sentences which have been uttered before or which contain information which has already been established in the current DRS. The following pieces of discourse are unacceptable precisely because they violate this condition.

- (62a) John has a dog. John has a dog. John has a dog.
- (62b) John managed to buy a dog. John has a dog.
- (62c) John has a dog. Either he has a dog or he has a cat.

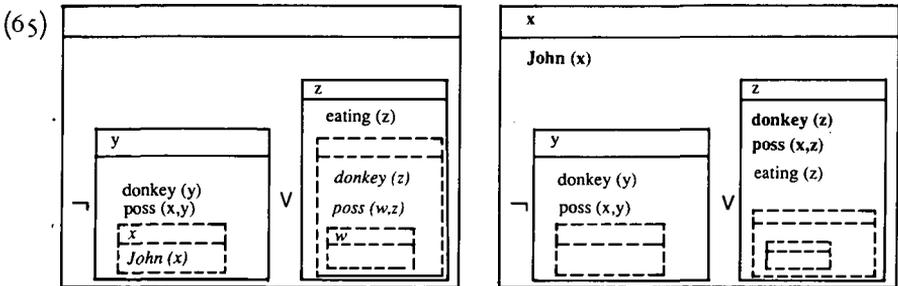
Clause (iii) requires that the principles of informativeness and efficiency carry over to subordinate DRSs with respect to the information established in their local context, that is, the (sub) DRSs they are subordinate to.³¹ In incremental terms one could say that no provisional update may lead to inconsistency and each provisional update should at least provide some new information.³² It marks, *inter alia*, the following pieces of discourse as unacceptable:

- (63a) John has a dog. If he has a dog, he has a cat.
- (63b) John has a dog. If he has a cat, he has no dog.
- (63c) John has a no dog. Either he has a dog or he has a cat.

Acceptability constrains resolution. In fact it sorts out the set of possible resolutions to a smaller set of admissible ones. The underlying reason is obvious. When processing a sentence, a cooperative hearer will take care that the resulting structure is acceptable and coherent. The following two sentences illustrate this:

- (64a) Either John has no donkey or his donkey is eating quietly in the stable.
- (64b) Either John is out of hay or his donkey is eating quietly in the stable.

Note that the first sentence can never have a presupposing reading, and it is easy to see why. The construction mechanism yields K_1 ((65)). Resolution proceeds



in the same way as before. First, the A-structure in the first disjunct will be resolved which results in accommodation of the proper name at top level. Then the pronoun will be bound to the marker which has just been established. The interesting part lies in the processing of the A-structure for the donkey. The accessibility constraint forbids binding of the anaphoric expression in the first disjunct. The only possible solutions are accommodation at top level or one level lower along its projection line, i.e. the box where it originates. Both are possible resolutions in the sense that neither violates the constraints on binding. But

only accommodation in the subordinate box is *admissible*, since accommodation at top level would violate clause (iii) of the acceptability constraint. It would, in effect, represent the following unacceptable discourse:

(66) John has a donkey. Either he has no donkey or his donkey is eating quietly in the stable.

The resulting structure is K' which is admissible and correctly represents the meaning of (64a) and its paraphrase (67):

(67) Either John has no donkey or he has one and it is eating quietly in the stable.

Compare this result with the predictions with respect to (64b). Here the first disjunct is logically independent of the presuppositional expression in the second one. Accommodation can thus take place at top level without violating the acceptability constraint, and given the general preference for accommodation at top level it is predicted that the preferred reading of this sentence is the presupposing one.

I will give here only two more examples to show how acceptability constrains the resolution of presuppositional anaphors. Many more can be found in the literature on presupposition projection.

(68) Either the king or the president of France opened the exhibition.

(69) If John is married, his wife is happy.

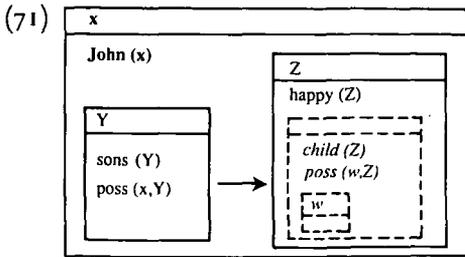
Assuming that countries cannot have both monarchs and presidents, (68) admits only one solution. Given our discussion thus far the reason will be clear. Accommodation of both the king and the president at top level would violate the consistency requirement. Accommodation of only one of the presuppositional expressions is not allowed either. Although this would not result in an inconsistent DRS, it would yield a sub DRS being inconsistent with the superordinate one, thus violating clause (iii_b). It will also be clear why (69) can never have a presupposing reading. Accommodation of the presuppositional anaphor at the top level would induce an entailment relation between the main DRS and the antecedent of the conditional, thus violating (iii_a).

In section 3, I pointed out that on an anaphoric account of presupposition we would expect a genuine ambiguity in presuppositional expressions. We already met some such examples at the end of section 2 where I discussed the data that Soames (1979) adduced against the implicature-cancelling account. I will conclude this paper with two types of cases. The first one allows both binding and accommodation. In the second one the ambiguity derives from the possibility to accommodate at different levels of representation.

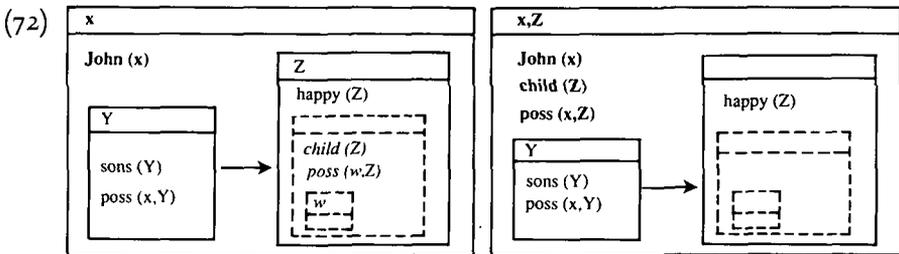
Consider first (70):

(70) If John has sons, his children are happy.

The initial processing of the DRS constructed for this sentence yields K_0 ((71)).



Notice that the antecedent entails the presuppositional expressions in the consequent and note furthermore that the lexical material matches only partially. We thus may, but do not have to identify the marker for the sons in the antecedent with the presuppositional anaphor in the consequent. Further processing thus yields (at least) two readings.³³ Anaphoric binding absorbs the presuppositional expression in the antecedent and thus gives a non-presuppositional interpretation. However, the constraints given above also allow accommodation of the presuppositional expression at top level. Since the entailment relation between the antecedent and the presuppositional expression is only one-sided, accommodation of the presuppositional expression at top level will not yield a structure in which the main DRS entails a subordinate one. The resulting structure is K^* which represents the reading that John has children and if he has sons (or, if there are sons among them), (all of) his children are happy ((72)).



The second case (73) finally gives an example where a genuine ambiguity arises out of different accommodation possibilities.

(73) If John has grandchildren, his children are happy.

Though John's having grandchildren entails that he has children, it will be clear that the grandchildren in the antecedent clause do not provide an anaphoric antecedent for the children in the consequent. Again the entailment relation is one-sided. Accommodation at top level now yields the presupposing reading. The preference for accommodation at the top of the projection line predicts

that this reading is, *ceteris paribus*, the preferred one. Note that this also predicts the possibility of pronominal take-up as (74) illustrates:

(74) If John has grandchildren, his children are happy. They wanted to have offspring long ago.

The second possibility is accommodation in the antecedent. This gives the non-presuppositional reading which states that if John has grandchildren and (thus) children, his children will be happy.

Acknowledgements

The basic idea underlying this paper derives from work which was done from 1987 to 1989 on a Huygens fellowship granted by the Dutch Organization for Pure Research (NWO). The initial idea is found in a preliminary form in van der Sandt (1987/9) and in van der Sandt and Geurts (1991). I owe thanks to many people who commented on earlier presentations of the ideas contained in this paper. Here I want to mention in particular Bart Geurts and Henk Zeevat, who commented on earlier versions of this paper.

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NOTES

- 1 Benson Mates (1973) points out that (i) descriptions containing open descriptive phrases present problems for a theory which analyses presuppositional expressions as referring expressions and (ii) these descriptions can be handled by Russell's theory. The basic argument is that the theory of descriptions applies to all expressions which can be represented by means of his description operator which allows us to eliminate such descriptions from all contexts in which they might occur. Mates takes this as an argument for the superiority of a Russellian analysis over a presuppositional one. Mates's paper contains a number of other observations that have not been discussed in the literature on presupposition and which are relevant to the purposes of this paper. See also Neale (1990) for further
- discussion of the relevance of open descriptions for anaphora theory.
- 2 See van Fraassen (1969) for a formalization of this account.
- 3 The idea of restoring the inference view on presupposition by adopting of a non-monotonic logic is found in Mercer (1992). However, Mercer does not take the classic semantic account as a starting point, but reinterprets and elaborates Gazdar's (1979) pragmatic theory in terms of Reiter's (1980) default logic. He shows in particular that once we extend the notion of logical inference so as to include non-monotonic ones a number of phenomena which seem to elude a logical treatment can be integrated in the logical paradigm. With respect to the orthodox semantic notion of presupposition no such attempt has been undertaken up to now.

- 4 The scheme given here is roughly the picture Stalnaker sketched in a series of papers starting in the early 1970s (see in particular 1970, 1974, 1978). An explicit statement is found in the appendix of Stalnaker (1976), where he makes a formal distinction between the notion of semantic and pragmatic interpretation and where the notion of pragmatic interpretation is made dependent on a prior determination of the semantic content. I am, however, reluctant to attribute the view as I sketch and criticize it here to Stalnaker in its full generality. For one thing, Stalnaker never explicitly defended the separation of semantic and pragmatic content in the way it is found in, for example, Gazdar (1979), Karttunen & Peters (1979) and—based on Stalnaker's scheme—in van der Sandt (1988). Heim (1992) treats Stalnaker's writings as a precursor of current theories of dynamic semantics, and the latter need not be vulnerable to the arguments given here with respect to the strict semantics/pragmatics dichotomy found in the writings just mentioned.
- 5 The mistaken assumption that logical operators always take scope over presuppositional expressions and that the presupposition can be derived separately is found, among others, in Gazdar (1979) and van der Sandt (1988).
- 6 A further problem is that it is rather unclear how scope generalizes to kinds of presupposition inducers other than definite descriptions and constructions which can be analysed as such.
- 7 Note that the above arguments don't just hold for presuppositions, but apply to pragmatic information in general. It turns out that all pragmatic information may entertain anaphoric links to the content expression they are associated with. While presuppositional expressions may provide antecedents for anaphoric expressions in the content expression, implicatures may be anaphorically linked to both. Consider:

- (i) It is possible that a thief took my Mac.
Scalar implicature
 It is not necessary that *he* took my Mac.

Note that it would be wrong to compute the implicature that it is not necessary that *a thief* took my Mac. The same holds for the following generalized variant:

- (ii) A: I am out of gas.
 B: There is a gasoline station around the corner.
Generalized conversational implicature
 It is open.

The main difference is the following. In case presuppositions are not already there they will be accommodated and the material thus accommodated may bind the anaphoric expression in the content or implicature expression. In the case of implicatures both the presupposition and the content expression may provide the antecedent for the anaphor in the implicature expression.

- 8 I adopt the common view that possessive constructions like *John's child* or *his child* are analysed as complex definite descriptions.
- 9 Karttunen & Peters point out that (9a) sounds odd precisely because it presupposes the falsehood that it was difficult for the actual successor of George V to succeed him to the throne. However, the presupposition computed is trivially true: for almost everyone except the actual successor it would have been extremely difficult to succeed George V.
- 10 Webber (1978) is a representative example.
- 11 'Generalizing from example (4) [i.e. The cat is at the door], I am proposing that the present theory be augmented by the following assumption: Definites contrast with indefinites in yet another respect, aside from their different behaviour with respect to Quantifier Indexing and the Novelty Conditions: In definites, the descriptive content of the NP is pre-

- supposed, whereas in indefinites it is (merely) asserted' (Heim 1982: 233).
- 12 'Felicity conditions of any sort give rise to a problem analogous to the famous projection problem for presuppositions' (Heim 1982: 320).
 - 13 Heim (p.c.) pointed out that the views of her thesis are only partially compatible with her 1983 approach to presupposition projection. A full comparison between the two views and the account presented here would take me too far afield and has to await another paper. A comparison and elaboration in terms of update semantics of Heim's (1983) account and the account given here is given in Zeevat (this volume).
 - 14 For yet a further elaboration of an application of her account to attitude contexts, see Heim (1992).
 - 15 Possible exceptions are Fillmore's lexical presuppositions that are triggered by such lexical items as *bachelor* which may perhaps be better treated as sortal restrictions on these predicates. They do, however, display the same type of projection behaviour as the above-mentioned triggers. Zeevat (1991, this volume) points out that they differ with respect to their behaviour in attitude contexts. I refer to Zeevat's paper where the same phenomenon is observed with respect to factives.
 - 16 Such a procedure to extract the descriptive material from their lexical or syntactic sources is either assumed or given for all theories of presupposition projection. Gazdar (1979) calls them pre-suppositions, Karttunen & Peters (1979) conventional implicatures, van der Sandt (1988) elementary presuppositions. Seuren (1985) distinguishes between preconditions and satisfaction conditions for predicates, where the preconditions code the presuppositional properties.
 - 17 'Some things might be said to require suitable presuppositions. They are acceptable if the required presuppositions are present; not otherwise. . . . Be that as it may, it's not as easy as you might think to say something that will be unacceptable for lack of a required presupposition. Say something that requires a missing presupposition, and straightaway that presupposition springs into existence, making what you said acceptable after all . . . call it the *rule of accommodation for presupposition*.
If at time *t* something is said that requires presupposition *P* to be acceptable, and if *P* is not presupposed just before *t*, then—*ceteris paribus* and within certain limits—presupposition *P* comes into existence at *t*.' (Lewis 1979: 340)
 - 18 A general requirement for accommodation is that the sentence uttered should contain some conventional mark or some feature of interpretation which requires a readjustment of contextual parameters for its utterance to be felicitous. Accommodation will then have the following effect: If a relevant contextual parameter does not have an appropriate value, the hearer will infer it and adjust the context so as to make the utterance felicitous after all. It will be clear that in the absence of any substantial constraints the whole notion of accommodation would be vacuous. Heim requires just consistency. See section 4 for a discussion of contextual acceptability as a constraint on accommodation.
 - 19 Accommodation of the trigger instead of the sentential presupposition is the option taken by Zeevat in his reconstruction of Heim's theory in update semantics. Irene Heim (p.c.) informed me that she is indeed committed to the prediction that all else being equal, the preferred accommodation for a sentence like (26a) is the global accommodation of *If John made coffee, he has a wife*. She suggests, however, that the global/local hierarchy is not the only (or even the most important) factor to determine accommodation. Factors like (un)controversiality and having adequate grounds for believing the proposition in question might play an equally

important role. Similar defences which shift the burden to a (Gricean) pragmatics are found in Karttunen & Peters (1979), and Soames (1982). I will not go into this question here but refer to the authors mentioned and the criticism of this view in Gazdar (1979) and van der Sandt (1988).

- 20 I assume some coding of the fact that someone who has grandchildren has children. For the present argument it is irrelevant whether this is taken to be world knowledge or results from the lexical content of *grandchildren*. David Beaver (p.c.) objected to this example on the grounds that someone having grandchildren entails having at least one child and not having children in general. Note first that this does not greatly improve the predictions of the satisfaction view. Instead of the presupposition that John has children we still get the weaker 'If John has grandchildren, he has children'. Note furthermore that it is easy to adapt this example to circumvent his difficulty. Firstly, the more grandchildren someone has the less plausible it is that he has only one child. But *If John has 100 grandchildren, his children must be very fertile* suggests even more strongly that John has children. The same happens if we adapt our example so as to exclude the possibility that they all spring from the same parent, which excludes the possibility that he has only one child: *If John has grandchildren from different parents, his children will compare their qualities*.
- 21 For me the non-presuppositional reading is strongly preferred for this particular example and so it was for most people whose intuitions I asked.
- 22 See van der Sandt (1988: 158–60).
- 23 Contrastive stress partially disambiguates:
- (i) If John has an **ORIENTAL** girlfriend, his girlfriend won't be happy.
 - (ii) If John **MURDERED** his wife, he will be glad that she is dead.

- (iii) If someone **AT THE CONFERENCE** solved the problem it was Julius who solved it.

In view of this fact Henk Zeevat (p.c.) objected to this picture and claimed that the presupposing reading comes about as a result of projecting a presupposition triggered by the intonation pattern in the antecedent. This requires the assumption that the (a)-sentences trigger the putative presuppositions in the (b)-sentences:

- (iva) John **MURDERED** his wife
- (ivb) John's wife is dead
- (va) Someone **AT THE CONFERENCE** solved the problem
- (vb) Someone solved the problem.

I am far from sure that intonation patterns induce resolution presuppositions in the sense of this paper, but even if they do this argument certainly cannot be upheld for the second example. According to the standard view its intonation patterns would induce the presupposition that John did something to his wife, not that she is dead. It is easy to check that the latter is not a presupposition of (iva). Modal embedding or questioning (iva) gives no suggestion whatsoever as to the truth of the putative presupposition:

- (vi) Did John **MURDER** his wife?
- (vii) It is possible that John **MURDERED** his wife.

- 24 A formulation of the actual construction procedure is beyond the scope of this paper. The notion of sentence-DRS derives from Asher (1989) and Asher & Wada (1988). Alternative bottom-up versions are, among others, found in Reyle (1985) and Zeevat (1989); van der Sandt & Geurts (1991) contains a construction algorithm for sDRSs in a CUG-style grammar incorporating an explicit coding of presuppositional anaphors.
- 25 See van der Sandt & Geurts (1991) for details.
- 26 We do not therefore introduce proper names at the highest level of representa-

- tion as is standard in DRT to account for the fact that proper names normally escape any depth of embedding. Nor are they considered to be rigid, which would force us to treat them as external anchors. I will here ignore Kripke's (1972) rather forceful arguments and not go into the question whether proper names are directly referential in the same sense indexicals are. Instead we treat them, as is common in presupposition theory, on a par with other presupposition inducers. When we come to the treatment of the resolution algorithm we will see that their tendency to accommodate at the highest structural level can easily be explained by their relative lack of descriptive content. This feature makes them insensitive to the constraints on accommodation, which might otherwise push them back to subordinate levels of representation. The way the resolution mechanism is set up will nearly always give proper names the widest scope possible. This has the advantage that we do not need a stipulation to the effect that discourse markers for proper names should always be inserted at top level, as Kamp (1981) requires.
- 27 I have to put in one caveat here. We need the additional constraint that no marker should occur free in a condition. We will discuss this constraint in detail in the next section. In this paper I furthermore assume the standard extensional semantics for the DRS language, which is set out well in the literature; see e.g. Kamp (1981) or Kamp & Reyle (forthcoming). One consequence is that when a 'failing' presupposition is accommodated the resulting discourse is false, and not undefined as Frege or Strawson would have it. Undefinedness will only ensue when a presupposition can neither be bound nor accommodated so that the construction algorithm will come to a halt. The Fregean institution can, however, be restored by explicitly marking accommodated material as such and making the embedding function dependent on the status of the relevant markers.
- 28 See Asher & Wada (1988) for a similar approach to pronoun resolution.
- 29 Cooper (1983) predicts an existential presupposition for (51). For the other cases his predictions coincide with Heim's.
- 30 See van der Sandt (1988).
- 31 The notion of local context envisaged here is just the DRT counterpart of Karttunen's and Heim's notion. It is, however, important that this notion plays a very different role in this theory than in Karttunen's or Heim's. Contrary to Karttunen's and Heim's theory, it is not required that a presuppositional expression originating in a subsentential constituent be satisfied by its local context. In the current theory the local context has the function of constraining the process of accommodation. The requirement put forward here is not that a presupposition should be entailed by its local context, but merely that it should be *accommodable* without violating the acceptability requirements.
- 32 Note that a local violation of consistency or informativeness need not give rise to uninformativeness of the whole utterance processed. It often signals that the information carried by the utterance is conveyed in an unnecessarily redundant and complex way. Suppose, for example that φ has already been established in the incoming DRS. In this situation the utterance of 'If φ then ψ ' is clearly informative since it tells us that ψ is the case. However, the same information could have been conveyed in a shorter and thus more efficient way simply by stating ψ . Or suppose that we want to convey the information that χ when $\neg\psi$ is already established. 'If not ψ , then χ ' or ' $\psi \vee \chi$ ' are two candidates. But again, the mere utterance of χ would be a more straightforward and efficient way. Efficiency and informativeness are thus distinct notions. If ψ is contextually

given, an utterance of 'if φ then ψ ' may be informative, but the very same utterance would simultaneously be inefficient, since there is a simpler way of getting this message across, namely the mere utterance of ψ .

33 A further reading which I ignore here

results from accommodating the presuppositional expression in the antecedent of the conditional. This gives the interpretation that if he has children, part of them are sons and that the sons are happy. See van Deemter (1991) for a different view of how this reading comes about.

REFERENCES

- Asher, N. (1989), 'Abstract objects, semantics and anaphora', MS, Department of Philosophy and Center for Cognitive Science, University of Texas, Austin.
- Asher, N. & Wada, H. (1988), 'A computational account of syntactic, semantic and discourse principles for anaphora resolution', *Journal of Semantics*, 6, 3/4: 272-309.
- Cooper, R. (1983), *Quantification and Syntactic Theory*, Reidel, Dordrecht.
- Deemter, K. van (1991), 'Towards a generalization of anaphora', *Journal of Semantics* 9, 1: 27-51.
- Fraassen, B. van (1969), 'Presuppositions, supervaluations and free logic', in K. Lambert (ed.), *The Logical Way of Doing Things*, Yale University Press, New Haven, Conn., 67-91.
- Gazdar, G. (1979), *Pragmatics: Implicature, Presupposition, and Logical Form*, Academic Press, New York.
- Heim, I. (1982), 'The semantics of definite and indefinite noun phrases', Ph.D. thesis, University of Massachusetts, Amherst.
- Heim, I. (1983), 'On the projection problem for presuppositions', *Proceedings of the West Coast Conference on Formal Linguistics*, 2: 144-26. Reprinted in S. Davis (ed.) (1991), *Pragmatics*, Oxford University Press, Oxford, 397-405.
- Heim, I. (1992), 'Presupposition projection and the semantics of attitude verbs', *Journal of Semantics*, 9, 3: 183-221.
- Kamp, H. (1981), 'A theory of truth and semantic representation', in J. A. G. Groenendijk, T. M. V. Janssen & M. B. J. Stokhof (eds), *Formal Methods in the Study of Language*, Mathematical Centre Tracts 135, Amsterdam, 277-322. Reprinted in J. A. G. Groenendijk, T. M. V. Janssen & M. B. J. Stokhof (eds) (1984), *Truth, Interpretation, and Information: Selected Papers from the Third Amsterdam Colloquium*, Foris, Dordrecht, 1-41.
- Kamp, H. & Reyle, U. (1990) 'From discourse to logic', MS, Institute for Computational Linguistics, University of Stuttgart, Stuttgart.
- Karttunen, L. (1973), 'Presuppositions of compound sentences', *Linguistic Inquiry*, 4: 167-93.
- Karttunen, L. (1974), 'Presupposition and linguistic context', *Theoretical Linguistics*, 1, 1: 181-94.
- Karttunen, L. & Peters, S. (1979), 'Conventional implicature', in C.-K. Oh & D. Dinneen (eds), *Syntax and Semantics 11: Presupposition*, Academic Press, New York, 1-56.
- Klein, E. (1986), 'VP ellipsis in DR theory', in J. Groenendijk, D. de Jongh & M. Stokhof (eds), *Studies in Discourse Representation Theory and the Theory of Generalized Quantifiers*, Foris, Dordrecht, 161-87.
- Kripke, S. (1972), 'Naming and necessity', in D. Davidson and G. Harman (eds), *Semantics for Natural Language*, Reidel, Dordrecht, 253-355.
- Lewis, D. (1979), 'Scorekeeping in a language game', *Journal of Philosophical Logic*, 8: 339-59.
- McCawley, J. D. (1979), 'Presupposition and discourse structure', in C.-K. Oh & D.

- Dinneen (eds), *Syntax and Semantics 11: Presupposition*, Academic Press, New York, 371–88.
- Mates, B. (1973), 'Descriptions and reference', *Foundations of Language*, 10, 3: 409–18.
- Mercer, R. (1992), 'Default logic and presupposition', *Journal of Semantics*, 9, 3: 223–50.
- Neale, S. (1990), *Descriptions*, MIT Press, Cambridge, Mass.
- Reiter, R. (1980), 'A logic for default reasoning', *Artificial Intelligence*, 13: 81–132.
- Reyle, U. (1985), 'Grammatical functions, quantification and discourse referents', *IJCAI* 9: 829–831.
- Sandt, R. A. van der (1988), *Context and Presupposition*, Croom Helm, London.
- Sandt, R. A. van der (1989), 'Presupposition and discourse structure', in R. Bartsch, J. van Benthem & P. van Emde Boas (eds), *Semantics and Contextual Expression*, Foris, Dordrecht, 287–94.
- Sandt, R. A. van der & Geurts, B. (1991), 'Presupposition, anaphora, and lexical content', in O. Herzog & C.-R. Rollinger (eds), *Text Understanding in LiLOG*, Springer, Berlin, 259–96.
- Seuren, P. A. M. (1985), *Discourse Semantics*, Blackwell, Oxford.
- Soames, S. (1979), 'A projection problem for speaker presuppositions', *Linguistic Inquiry*, 10: 623–66.
- Soames, S. (1982), 'How presuppositions are inherited: A solution to the projection problem', *Linguistic Inquiry* 13, 483–545.
- Soames, S. (1989), 'Presupposition', in D. Gabbay & F. Guenther (eds), *Handbook of Philosophical Logic, Volume IV*, Reidel, Dordrecht, 552–616.
- Stalnaker, R. C. (1970), 'Pragmatics', *Synthese*, 22: 272–89. Reprinted in D. Davidson & G. Harman (eds), (1972), *Semantics of Natural Language*, Reidel, Dordrecht, 380–97.
- Stalnaker, R. C. (1973), 'Presuppositions', *Journal of Philosophical Logic*, 2, 4: 447–57.
- Stalnaker, R. C. (1974), 'Pragmatic presuppositions', in M. K. Munitz & P. K. Unger (eds), *Semantics and Philosophy*, New York University Press, New York, 197–213.
- Stalnaker, R. C. (1976), 'Indicative conditionals', in A. Kasher (ed.), *Language in Focus: Foundations Methods and Systems*, Reidel, Dordrecht, 179–96.
- Stalnaker, R. C. (1978), 'Assertion', in P. Cole (ed.), *Syntax and Semantics 9: Pragmatics*, Academic Press, New York, 315–32.
- Webber, A. (1978), *A Formal Approach to Discourse Anaphora*, Bolt, Beranek & Newman, Report 3761, Boston, Mass.
- Zeevat, H. (1989), 'A compositional approach to discourse representation theory', *Linguistics and Philosophy*, 12: 95–131.
- Zeevat, H. (1991), 'Aspects of discourse semantics and unification grammar', Ph.D. thesis, University of Amsterdam, Amsterdam.
- Zeevat, H. (1992), 'Presupposition and accommodation in update semantics', this volume.