The Importance of Presupposition*

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1 Generalities

1.1 Introduction

The title of this paper may seem presumptuous. But I have chosen it anyway, as a signal of what I see as the central insight that recent studies of presupposition in natural language have given us. Presuppositions are not what early discussions suggested and later ones have, I feel, still done too little to explicitly refute: obstacles to logical transparence, logical simplicity or well-definedness of meaning, and thus a thing that languages would have been better off without. On the contrary, presuppositions are valuable tools which language uses to guide the recipient of an utterance, discourse or text towards its intended meaning. In fact, given what we are beginning to understand about the ways in which presuppositions arise and the purposes they serve, it is hard to imagine how a natural language could exist without them.

This paper is part of a larger enterprise and the first of a series. So it would seem to be the right place for a general overview of the theory that has been the target of this enterprise and to say enough about it to give a clear idea of how it works, and how it differs from other presupposition theories. Unfortunately, this would have required a paper well in excess of what is acceptable in a collection like the present one. So I have had to temper my ambitions and to select some parts of the over-all account for special focus, while leaving out a good many others.

After some hesitation what to retain of earlier, much bulkier drafts I decided to focus on two aspects of presupposition theory which seem to me to have received comparatively little attention in the literature so far. The first is one that one might describe as 'presuppositional multiplicity': Natural language sentences often give rise not just to one presupposition but to several presuppositions at once. It turns out that combinations of presuppositions triggered within one and the same sentence pose problems that go beyond what we see when focusing on individual presuppositions, as much of the existing

*To appear in Christian Rohrer, Antje Roßdeutscher and Hans Kamp eds., *Linguistic Form and Its Computation*. CSLI presupposition literature has done. In fact, presuppositional multiplicity leads to complications both at the level of 'presupposition justification' — i.e. at the level where presuppositions are checked against the context in which the sentence generating them is being used — and at what I propose to call the level of 'presupposition computation' — the level at which the presuppositions due to the various triggers in a sentence are computed in a form which allows them to be checked.

The distinction between these two processing levels, that of presupposition computation and that of presupposition justification, may not be self-evident. But it is hard to see how a precise and computationally viable theory of presupposition could do without it. And as far as I can see, many current presupposition theories imply the distinction in some form. However, the level of presupposition computation is seldom discussed in detail, as if that part of the theory was too trivial to merit explicit articulation (or, alternatively, because articulating it is thought to be the business of someone else). As it turns out, even the computation of individual presuppositions poses problems that are far from easy.[1] But the true complexities of presupposition computation become visible only where different presuppositions interact.

A presupposition theory consisting of the two connected components of presupposition computation and presupposition justification requires a general framework in which language interpretation takes the form of establishing first, on the basis of syntactic (and prosodic) information, 'logically transparent' representations of individual sentences, and then subjecting these representations to further semantic and/or pragmatic operations, which relate them to the context in which the represented sentences are being used. In those cases where the sentence is part of a larger discourse, these operations should integrate the sentence representation with the discourse interpretation obtained thus far.

Given such a general architecture, it is possible to make sure that the representation of each individual sentence contains explicit representations of all presuppositions that the sentence generates. The process of integrating a sentence representation into the interpretation of the preceding discourse may then be made dependent on justification of all the represented presuppositions in their context, so that integration proceeds only when justification has been successful.

The term 'presupposition justification' is not a standard term of the presupposition literature. But it is one I use advisedly. Antje Roßdeutscher and I introduced the term in the early nineties to reflect our conviction that what we took to be the standard picture of presupposition checking is an oversimplification of what often actually happens.[2]There is general agreement that presuppositions should be satisfied in their contexts, but that satisfaction failure does

[1]Cf the growing literature on the presuppositions generated by words like *again, also, even, still* and many other 'discourse particles'. A good example of the problems that arise in connection with computing, according to linguistically 'clean' principles, the presuppositions generated by different occurrences of *again* is [Stechow 1996].

[2]See [Kamp and Roßdeutscher 1992][Kamp and Roßdeutscher 1994].

not lead to breakdown of the interpretation process automatically. For there often remains the possibility of 'accommodating' the context so that it satisfies a failing presupposition after all. However — and this is where we saw our views as diverging from the standard view — the relation between satisfaction and accommodation is in general not a matter of 'either or': either a presupposition is satisfied, or it isn't, and then it has to be accommodated whole-sale, much as when a new proposition is added to a given theory. In general, presupposition satisfaction and presupposition accommodation do not behave as mutually exclusive alternatives. The process of making sure that the context satisfies a given presupposition often involves a mixture of sóme satisfaction and sóme accommodation — of finding contextual information that goes some way towards satisfaction of the presupposition and then accommodating what is missing to make satisfaction complete. It is this combination of 'partial satisfaction' and (partial) accommodation for which we coined the term 'justification'.

Presupposition justification too is a process that proves to be much more intricate when it involves clusters of presuppositions than when we confine our attention to individual presuppositions. A story about presupposition in which presuppositional multiplicity holds a central place is thus seriously incomplete if it doesn't have anything to say about its effects at this level. For this reason an earlier version contained an abridged version of [Kamp 2001], which is devoted to an example of multiple presupposition justification. Unfortunately this abridged version had to go, and all that has remained is a mention, at the end of this introductory section, of the example itself. For anything more than that the reader has to consult the cited paper.

In its present version, then, the paper is devoted almost entirely to the computation of presuppositions.

Although I am inclined to see this as the less interesting half of an over-all account of presupposition, it is, as I have noted above, the one which is most in need of attention because it has thus far been so badly neglected. Moreover, without a proper account of presupposition computation, formally precise accounts of justification aren't really possible. For these must take their departure from the explicit articulation of presuppositions for which the theory of presupposition computation is responsible. Methodologically, it is presupposition computation which comes first and justification which comes second (and for all it is possible to tell, this is also the order in which things are done in the language-processing mind). So, if more than one paper is needed to tell the full story, computation would seem the proper end at which to begin it.

1.2 A Brief Look Back

The theory of presupposition has had a checkered history. This is not the occasion to retrace the often surprising gyrations of its winding path. But two of the milestones which mark its progression should be mentioned. Both of them signalled changes in focus and perspective which occurred about thirty years ago, when presupposition became the subject of active study within linguistics. First, linguists became conscious at that time of the wide variety of presupposition 'triggers' that are to be found in natural languages — that is, of the multitude of lexical items and grammatical constructions which give rise to presuppositions. As a consequence, the presuppositions generated by definite descriptions, which had been the exclusive concern of virtually the entire presupposition literature up to that point, now came to be seen as only one type of presupposition within a much larger class. Second, the famous paper of [Langendoen and Savin 1971] drew attention to the fact that sometimes a presupposition that is generated within a constituent of a logically complex sentence gets 'filtered' out, in the sense that the sentence as a whole behaves as if the presupposition wasn't there. Thus the *Projection Problem* was born, the problem which of the presuppositions that are generated within complex sentences get filtered and which 'survive'. Speakers' intuitions about presupposition filtering (which presuppositions get filtered and which do not) are on the whole quite sharp and consistent. These intuitions provide the linguist with a profusion of intricate linguistic data, many of which have proved remarkably robust. To the theoretically minded they present a natural challenge. It is not surprising, therefore, that so much of the literature on presupposition has been concerned with aspects of the Projection Problem ever since the time when the problem was discovered.

1.3 Presuppositions in Dynamic Semantics

A major advance in dealing with projection questions came with the development of Dynamic Semantics, initially in the two forms of File Change Semantics [Heim 1982] and Discourse Representation Theory [Kamp 1981]. In her seminal paper [Heim 1983], the author showed how the framework of Dynamic Semantics makes it possible to account for many of the most uncontroversial projection data (pertaining to the behaviour of presuppositions in conjunctions, conditionals and under quantification) virtually without need of any assumptions in addition to those which had already been made for independent reasons. In retrospect this is even less surprising than it was at the time. Dynamic Semantics is about interpretation in context. The projection data fall into place if for many presuppositions generated within parts of complex sentences it is assumed that the relevant context is provided by another part of the sentence itself. On that assumption the presupposition will get filtered just in case it is verified by its local, sentence-internal context alone. For in that case the presupposition will not interfere with the interpretation of the sentence as a whole irrespective of what the 'global' context, in which the sentence is being used, may be like.

Heim's paper paved the way for further studies which tackled some of the remaining, more recalcitrant, projection issues within a dynamic setting. Possibly the most difficult among those problems are questions which have to do with presupposition accommodation.

1.4 Presupposition within DRT

Of particular importance for the theory outlined in the present paper is the influential [van der Sandt 1992], referred to henceforth simply as 'vdS'. This paper too is centrally concerned with aspects of the Projection Problem (and specifically with the related issues of accommodation). But for us its central importance lies elsewhere. Van der Sandt makes use of DRT. But he adopted a form of it which differs significantly from early versions of the theory, like the ones of [Kamp 1981] or [Kamp and Reyle 1993]. Both in these earlier versions and in that of van der Sandt the basic interpretation strategy is cumulative: To interpret a discourse $< s_1, ..., s_n >$, begin by building a representation K_1 of s_1, then use this representation as context for the interpretation of s_2, which, when merged with K_1 yields a representation K_2 for $< s_1,\ s_2 >$; and so on. But below this most general level there is a difference. In van der Sandt's version of DRT processing of the next sentence s_{i+1} does not take the form (as it does e.g. in [Kamp and Reyle 1993]) of direct integration into the context representation K_i, but proceeds in two stages. First, one constructs a 'preliminary' representation K'_{i+1} for s_{i+1}, in which the presuppositions generated by s_{i+1} are explicitly represented, and then, in a second step, this preliminary representation K'_{i+1} is confronted with the context representation L_i. This confrontation involves justification of all the presuppositions represented in K'_{i+1}. If this succeeds, then the non-presuppositional part of K'_{i+1} is merged with K_i, yielding the new context representation K_{i+1}.

This two-step DRT-architecture has proved desirable for a number of reasons, and I have been for several years among those who are making use of it as a matter of course. In particular, I see it as the only viable option for a DRT-based theory of presupposition.

Within such a framework the division of the theory of presupposition into a component dealing with presupposition computation and another one dealing with justification arises quasi inevitably. Computation of presuppositions is part of the process of computing sentence representations; presupposition justification is an integral part of linking the sentence representation with the context.[3]

One of the central motivations behind vdS[4] was the conviction that the phenomena traditionally described as 'presupposition' and 'anaphora', respectively, are but different aspects of what should be seen as a single type of process, and

[3]The first of the two stages of the interpretation process just described might be said to embody what is usually understood by the *syntax-semantics interface*, whereas the second stage constitutes an interface between semantics and pragmatics. Thus presupposition computation is part of the syntax-semantics interface, whereas problems of presupposition justification are located at the semantics-pragmatics interface. Here semantic representations provide the input to mechanisms which traditionally have been counted as lying on the pragmatic side of the semantics-pragmatics divide.

[4]And similarly of [Zeevat 1992], a proposal which has close parallels with vdS and was developed roughly at the same time.

one of its aims was to present a unified account of presupposition and anaphora which makes clear in what sense this is so. This emphasis on a unifying perspective has been illuminating and fruitful, and it has been adopted also in the account presented here, which follows vdS in many of its innovating features.

Of course, a unified framework for presupposition and anaphora should not make us lose sight of the real differences which nevertheless exist between the principles for interpreting anaphoric expressions and those for dealing with presuppositions. But in fact, the problem of variation is a deeper one than that. There are important differences not only between the categories of 'presupposition' and 'anaphora' as they have been traditionally conceived, but also within the category of presuppositions itself. In particular, presuppositions differ in the constraints which govern the possible ways of their accommodation. At the present time our understanding of these constraints is fragmentary at best. This is not only a matter about nothing will be said in this paper, but which there is, as things stand, little I have to say about.

1.5 Preview

The paper is structured as follows.

Section 2 makes a start with the problem how presuppositions are represented. It begins by outlining, in very general terms, the general architecture of the theory, going over some of the things that have already been touched upon in the introduction. The section goes on to look at the form of sentence representations. Here, as throughout the rest of the paper, I limit myself to the analysis of particular examples.

Section 3 looks at the construction of preliminary sentence representations for the examples of Section 2. To set the scene for this, the section starts by outlining a general bottom-up construction algorithm for DRSs (still without explicit representation of presuppositions) in which lexical heads introduce variables (or 'discourse referents') representing the 'referents' of those heads, whereas the corresponding functional heads are responsible for the binding of those variables. (Since binding often occurs much higher up in the syntactic tree than where the variable that is to be bound gets first introduced, a storage mechanism is needed, were the variable is to be kept until the point has been reached where its binding can be made explicit.) This algorithm is then modified to yield *preliminary representations* in which the presuppositions generated by the sentence are explicitly represented. (In this section, where the only presupposition triggers considered are definite Noun Phrases, these rules convert store elements introduced by such NPs into representations of the presuppositional constraints that these NPs impose.)

In Section 4 we extend the construction algorithm of Section 3 by first looking at the problem of computing presuppositions that are generated by *again* and then considering the problems that arise when *again*-presuppositions interact with presuppositions stemming from definite Noun Phrases.

Although the discussion takes the form of looking in detail at particular examples and falls well short of the ideal of a fully general formulation of representations and rules for a significant fragment, I hope that they exemplify enough of the problems that such an algorithm will have to solve to show the way towards such a formulation. Section 5 concludes with a somewhat depressing list of the many things that remain to be done.

Here, to conclude this introductory section, is the promised example of simultaneous satisfaction of interacting presuppositions. Consider the following three sentence discourse (1):

(1) *I gave the workmen a generous tip. One went out of his way to thank me. The other one left without saying a word.*

An obvious conclusion from this discourse is that the set of workmen to whom the speaker gave a generous tip had two members. This conclusion, however, can be drawn only after getting both the second and the third sentence, and it is evident that all three sentences are involved in it. In fact, the inference rests on the justification of a number of different presuppositions and the presuppositions generated by the subject NP of the last sentence play a particularly prominent part. (The different elements of this NP which impose presuppositional constraints on the context that all contribute to the inference are (i) the singular definite article *the* of the description *the other one*; (ii) the word *other* occurring in that description and (iii) the word *one* occurring in it. The presupposition triggered by the occurrence of *one* in the second sentence also plays a significant role.) In a nutshell the story is this. Justification of the presuppositions associated with *the other one* requires from the context (a) a certain set X of at least two elements and (b) a (possibly singleton) subset Y of X. The referent of *the other one* is then the difference $X \setminus Y$. Since the singularity of this NP (the fact that it is in the singular rather than in the plural) requires that its referent be single individual rather than a set of two or more elements, $X \setminus Y$ must be a singleton. Since the only viable 'solution' to these context requirements that the context established by the first two sentences has to offer consists in the identification: X = the referent of *the workmen* and Y = the referent of *one*, and since the referent of *one* must be an individual, a coherent solution will emerge only if it is assumed that $|X| = 2$.

2 The Form of Preliminary Representations

2.1 Over-all Architecture of the Theory

Let me, before we start looking at any questions of detail, summarise once more the main features of the general theory. As said, in many respects the present theory follows earlier proposals within the framework of Dynamic Semantics, and there is a particularly close connection with [van der Sandt 1992].

1. The analysis of linguistic presuppositions is to be divided into two stages:

> (i) a *computation stage*, during which a *preliminary* representation is constructed of the current sentence, in which all the presuppositions it generates are explicitly represented; and
> (ii) a *justification* stage at which the presuppositions of this preliminary representation are justified relative to the context representation, after which the sentence representation is merged with the context representation.

2. The representation of a presupposition generated by a given trigger is attached to that part of the preliminary representation which represents the sentence part in which the trigger occurs.[5] Thus each presupposition gets its representation in its 'local context'.[6]
3. Some treatments of presupposition invite the interpretation that presupposition justification either takes the form of the presupposition being verified in the relevant context, or else of its being accommodated. But in general justification is not simply either one or the other, but consists of a mixture of 'verification' and 'justification'.
4. Each presupposition has to be justified in its 'extended' local context, which consists of the information in the local context representation itself together with all information located at those contexts to which the local context is subordinate (i.e. at the 'global' context as well as at contexts intermediate between the global context and the local one). Accommodation, when needed, is usually accommodation of the global context, but under special circumstances local or intermediate accommodation are possible too.

2.2 Presupposition Representation

We begin with a couple of examples drawn from familiar territory. (2) is verbatim from [van der Sandt 1992].

(2) *Walter has a rabbit. His rabbit is white.*

I assume that the first sentence of (2) gives rise to the DRS (3), which then functions as discourse context for the second sentence. Because of the importance which temporal information will play in later examples I have decided to

[5] E.g. a presupposition generated by (a trigger that is part of) the consequent of a conditional will be attached to the representation of the consequent rather than to the conditional as a whole, and analogously for presuppositions whose triggers occur within the scope of other scope-bearing elements.

[6] In this paper I will not give a precise definition of the notion of the local context of a given presupposition. The formal definition is closely connected with the notion of accessibility from DRT. (Cf [Kamp and Reyle 1993] .)

make it explicit right from the start. The two conditions $n \subseteq t$ and $t \subseteq s$ entail that the state of w having y holds at the utterance time n.[7]

$$(3) \quad \begin{array}{|c|} \hline \mathrm{n\ t\ s_0\ w\ y} \\ \hline \mathrm{Walter(w)\ rabbit(y)} \\ \mathrm{n} \subseteq \mathrm{t} \\ \mathrm{t} \subseteq \mathrm{s_0} \quad \mathrm{s_0\!:\ have(w,y)} \\ \hline \end{array}$$

(4) gives what we will assume as the preliminary representation of the second sentence of (2). [8] [9]

$$(4) \quad \left\langle \left\{ \left\langle \left\{ \begin{array}{|c|} \hline \underline{\mathrm{u}} \\ \hline \mathrm{male(u)} \\ \hline \end{array} \right\}, \begin{array}{|c|} \hline \mathrm{t_1\ s_1\ \underline{v}} \\ \hline \mathrm{rabbit(v)} \\ \mathrm{n} \subseteq \mathrm{t_1} \\ \mathrm{t_1} \subseteq \mathrm{s_1} \\ \mathrm{s_1\!:\ 's(u,v)} \\ \hline \end{array} \right\rangle \right\}, \begin{array}{|c|} \hline \mathrm{t_2\ s_2} \\ \hline \mathrm{n} \subseteq \mathrm{t_2} \\ \mathrm{t_2} \subseteq \mathrm{s_2} \\ \mathrm{s_2\!:\ white(v)} \\ \hline \end{array} \right\rangle$$

Two comments. The first one concerns the representation of temporal information. The mode of representing temporal information in (4) is the same as in (3). But there is nevertheless one important difference, in that in (4) we find an explicit representation of the temporal dependence of a non-verbal predicate (viz of the possessive relation expressed by the pronoun *his*). In [Kamp and Reyle 1993], to which we referred above when presenting (3), no provision is made for representing the temporal aspects of non-verbal predications. This obviously is a short-coming (which will be put right in the forthcoming [Kamp and Reyle ms]). In particular we need to be able to represent such information in order to be able to discuss many of the more interesting questions about the content and computation of presuppositions that will cross our path as we go along. The temporal aspects of non-verbal predications raise

[7] The representation of temporal information used here employs the coding of temporal information introduced in [Kamp and Reyle 1993] , Ch. 5.

[8] In official, set-theoretic notation the structure displayed in (4) has the following form: $\langle\{\langle\{\langle\{\mathrm{u}\}, \{\mathrm{male(u)}\}\rangle\}, \langle\{\ \mathrm{t_1}, \mathrm{s_1}\ ,\mathrm{v}\},\{\mathrm{rabbit(v)}, \mathrm{n} \subseteq \mathrm{t_1}, \mathrm{t_1} \subseteq \mathrm{s_1}, \mathrm{s_1\!:\ 's(u,v)}\}\}\rangle\ \rangle\}$,
$\langle\{\mathrm{t_2}, \mathrm{s_2}\}, \{\ \mathrm{n} \subseteq \mathrm{t_2}, \mathrm{t_2} \subseteq \mathrm{s_2}\ , \mathrm{s_2\!:\ white(v)}\}\rangle\ \rangle$

[9] (4) differs from the representations given in vdS in three respects. The first two of these — the explicit representation of temporal information and the underlining of the variables *u* and v, are discussed in the main text. Besides these there is a third difference, which, however, is more a matter of display rather than of substance: While van der Sandt puts presuppositions inside the boxes representing the sentence constituents that contain their triggers, we place them to the left of the representation of the relevant clause. The intuitive reason for this is that justification of the presupposition must logically precede assigning a definitive propositional content to the clause which generates it. In the present case, we see this twice over, as the presupposition generated by *his* is not just a presupposition of the second sentence as a whole, but in fact of the presupposition generated by *his rabbit*; in this regard too the present account follows van der Sandt.

a number of separate issues, none of them altogether trivial. First, there is the matter of how the temporal aspect of non-verbal predicates (nouns, adjectives, adverbs, prepositions) is to be represented in the lexicon. This is a matter we will ignore here. Second there is the question how the temporal dimension of non-verbal predications is to be represented. For this we have adopted the same device that is also used to represent the temporal dimension of stative verbal predications, assuming that each non-verbal predication can be understood as the claim that a certain state of affairs, viz the predication in question, holds at a certain time.

Thirdly, and this is by far the most intricate issue, there is the problem how the time of a non-verbal predication is determined. This question was first investigated by Enç, [Enç 1981], and then, more recently, by [Musan 1995]. [Tonhauser 2000] studies the issue within the setting of DRT and it is on this study that the present treatment is based. Primary attention has been given so far to the non-verbal predications expressed by the lexical heads of noun phrases which act as arguments to verbs. Here the principal possibilities for determining the predication time are (i) the time of the eventuality described by the verb; and (ii) the utterance time,[10] in case this time differs from the time of the eventuality.

Of course this is only a small part of the full story, which also has to deal with the times of all other forms of non-verbal predication. The only other case that we will have to deal with in this paper is that of a predicatively used prenominal adjective phrase. (I am assuming that the possessive relation expressed by *his* also belongs to this category.) For this case the answer is, as far as I can see, quite simple: The predication time of the prenominal AP is always identical with that of the noun to which it is prenominal. This principle will play a role in the analyses of Section 4, even if it will be left more or less implicit in what we will have to say.[11]

In the representations that will be shown from now on I will sometimes represent non-verbal predications in the way this is done in the familiar versions of DRT — e.g. representing that y is a rabbit as $rabbbit(y)$ rather than as s: $rabbbit(y)$. I will do this, however, only in those cases where the time of the predication doesn't seem to matter — for instance, because the predication is 'eternal', or because it is understood as invariant over the entire period of time that is relevant to the given discourse.

A second aspect of (4) that requires explanation is the underlining we have used to mark the discourse referents u and v. This is meant as a way of indicat-

[10] Or, more generally, the Temporal Perspective Time—see [Kamp and Reyle 1993].

[11] The case is different for prenominal adjectives that act as operators, such as *former* or *future*. Here the predication time of the adjective is to be identified with that of the entire nominal predication, while the predication time of the noun itself is shifted by the operator. Thus x satisfies *former president* at t when x satisfies *president* at some time before t. This is an issue, however, with which we won't have to deal in the remainder of this paper.

ing that the marked discourse referents have an anaphoric status, in the sense that justification of the presupposition representations which contain them as members of their DRS universe requires finding discourse referents in the context with which the underlined discourse referents can then be identified (and which thus act as their anaphoric antecedents). Note well that underlining is only a provisional device, which will have to be replaced eventually by a detailed statement of the principles of antecedent determination for the different types of expressions which give rise to 'anaphoric' presuppositions. The huge literature on the interpretation of different types of definite NPs (pronouns, definite descriptions, demonstratives, proper names) bears witness to the complexity of this task, even if our attention is limited to NP-triggered presuppositions alone.

Both presuppositions of (4) are justifiable in the context provided by (3). For the left-most presupposition justification involves identifying u with the discourse referent w which represents the bearer of the name *Walter*. This identification requires justifying that w represents a male person. We can see this either as supported by general (if defeasible) knowledge that *Walter* is normally used as a name for males, or as the result of accommodation. (The latter would have been a more likely strategy if the name had been *Hilary* or *Robin*). Given that u has already been identified with w, the justification of the second presupposition must necessarily involve identification of y with v.[12] To show that this identification is legitimate, we must verify that y satisfies the conditions associated with v. To do this we have to demonstrate (i) that y is a rabbit and (ii) that there exists a state s_1 surrounding the utterance time n which is to the effect that y is had by w. As it is, the context (3) contains both those conditions explicitly, so this second identification is legitimate as well.

Using these identifications we can integrate (4) into the context representation (3): We drop the presuppositions from (4), enter in their stead the 'resolution links' $u = w$ and $v = y$ and merge the resulting representation with the context DRS. Since u only figures in the presuppositional part of (4), it disappears altogether. The result is presented in (6):[13]

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[12] There are a number of factors which militate against linking u and v to the same antecedent. Arguably the most compelling of these is that such a resolution would violate the Binding Theory, which forbids formal coreferentiality between the head of the phrase ***his rabbit*** and the possessive pronoun *his*.

[13] I have simplified this representation somewhat by leaving out the redundant location times t and t_2.

A further simplification can be obtained by eliminating the discourse referent v, thus obtaining the representation in (5):

$$(5)\quad \boxed{\begin{array}{c} \mathrm{s_0\ w\ y\ s_2} \\ \mathrm{Walter(w)\ rabbit(y)} \\ \mathrm{n} \subseteq \mathrm{s_0}\ \mathrm{n} \subseteq \mathrm{s_2} \\ \mathrm{s_0\!:\ have(w,y)\ s_2\!:\ white(y)} \end{array}}$$

(6)
$$\boxed{\begin{array}{cc} \multicolumn{2}{c}{\mathrm{s\ w\ y\ s_2}\ v} \\ \mathrm{Walter(w)} & \mathrm{rabbit(y)} \\ \multicolumn{2}{c}{v = \mathrm{y}} \\ \mathrm{n} \subseteq \mathrm{s} & \mathrm{n} \subseteq \mathrm{s_2} \\ \mathrm{s{:}\ have(w,y)} & \mathrm{s_2{:}\ white(y)} \end{array}}$$

3 Presupposition Computation

In Section 2.2 we looked at the form of preliminary sentence representations. In the present section we consider how such representations are constructed from syntactic input.

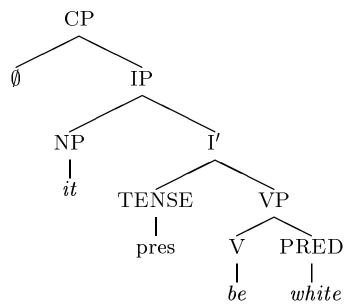
Our primary interest in this connection concerns the principles for computing the representations of presuppositions. But since these computations are interwoven with the construction of the non-presuppositional parts of preliminary representations, it will be necessary to say something first about this aspect of representation construction.

In the outline I will give of the algorithm, I will make use of syntactic structures that don't conform in every respect to the current demands of many syntacticians. I hope that none of the interface principles I will discuss, however, are seriously affected by this.

Let me show right away what syntactic trees we will be using. Before we look at the second sentence of (2) itself, we will first deal with the simpler sentence which we get when we replace the subject phrase *his rabbit* by the pronoun *it*. The simpler sentence is given in (7) and its syntactic tree in (8).

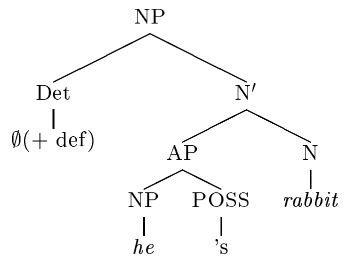
(7) *It is white.*

(8)



For the NP *his rabbit* we assume the structure given in (9). The syntactic tree for the second sentence of (2) results of substituting this structure for the subject NP of (7).[14]

(9)



In the next subsection I have stated, in succinct form, the central principles for constructing DRSs from syntactic representations. These principles apply both to the construction of presupposition-free DRSs and to the preliminary representations of which we will see examples later on.

3.1 General Principles of Bottom Up DRS Construction

(CP1) Each argument phrase α introduces a variable x_α, the so-called 'referential argument' of α. This variable becomes part of three different components of the representation to be built:
(a) x_α gets inserted into the argument position marked by α.
(b) x_α becomes the principal argument of the condition or conditions expressing the descriptive content of α. The descriptive content is given by the 'nominal part' (or 'common noun phrase') of α. If the common noun phrase of α consists just of a noun ν, then there usually is just one descriptive condition, viz $\nu(\alpha)$; if the CNP is complex, then there will be several conditions, one corresponding to the head noun and the others to prenominal adjective phrases, relative clauses or PPs. For the most part the details of how such condition complexes are constructed need not worry us here.
(c) x_α also enters into a third component, the so-called Binding Conditions associated with α. More about this under (CP2):

(CP2) The *Binding Conditions*, as we understand this term, that are associated with a given variable, are instructions that determine the quantificational or referential role this variable is to play in the sentence representation

[14]In this structure the possessive constituent is analysed as a prenominal adjective phrase consisting of the 'relational adjective' *'s* and to the left of it an NP representing the second argument of this relation. The other argument gets unified with the referential argument of the noun to which the AP is prenominal. The analysis of the possessive is thus reminiscent of those analyses of prepositional phrases according to which the preposition acts as a relation between the referential argument of the phrase to which the PP is adjoined and the referent of the PP's NP.

into which it gets introduced. We distinguish three main types of Binding Conditions and make a corresponding three-fold classification of noun phrases that give rise to these Binding Condition types:

(a) Quantificational NPs;
(b) Indefinite NPs; and
(c) Definite NPs.

QNPs are those NPs α where x_α gets bound by the quantificational operator that is introduced by the NP itself. Typical examples are NPs beginning with the determiners *every* and *most*.

¿From the perspective of the Syntax-Semantic Interface described here, QNPs are the simplest category. Their Binding Conditions are always unambiguous and they get implemented in a construction step which as a rule closely follows that in which the variable is introduced. Example: The subject NP of the sentence

(10) *Every prime number is odd.*

is assigned the representation (11)

(11) $\left\langle x, \boxed{\text{prime number(x)}}, \text{BiCo}_{every} \right\rangle$

This representation is then combined with the representation of the VP of (10), which we assume for now to have the simplified form in (12):

(12) $\langle \text{odd}(\text{y}_{subj}) \rangle$

The result of this combination, in which the Binding Conditions of *every* are converted into a quantificational structure, is the complex DRS-condition (13)

(13) $\boxed{\begin{array}{c} \text{x} \\ \text{prime number(x)} \end{array}} \left\langle \begin{array}{c} \forall \\ \text{x} \end{array} \right\rangle \boxed{\text{odd(x)}}$

The Binding Conditions of both INPs and DNPs differ from those for the QNPs in that they may have to be carried over by several construction steps before actual binding takes place. For INPs this is because their variables get bound by an operator introduced by some other part of the sentence, so the Binding Conditions will have to be carried along until this operator gets reached. The Binding Conditions that are of special interest here are those of the DNPs, as it is these which give rise to presuppositions. The point at which the Binding

Condition of a DNP gets converted into a presupposition is that where a semantic boundary is reached, at which point all presuppositions generated below it have to be made explicit.[15]

In the diagrams below which show the different construction stages of preliminary DRSs I will, partly for reasons of space, abbreviate the Binding Conditions associated with variables x_β as $BiCo_\beta$, where β identifies the type of the given Binding Condition, either by mentioning the type of phrase that introduced the variable, or, if that does not suffice, in some other way. In some cases these labels hide much complexity of detail. This is true in particular of the Binding Conditions associated with the different types of DNPs. We need only recall the barely surveyable literature on definite descriptions and pronouns, or the extensive debates on proper names that have preoccupied philosophers of language for centuries (and especially for the last three decades). Most of what these publications and debates have been about concerns details of the Binding Conditions for different types of DNP's in the sense in which the term 'Binding Condition' is intended here (see the remarks about *Walter* in Section 2.2). However, in a theoretical framework like the one adopted here these details pertain primarily to the second part of the theory, which deals with presupposition justification, and so are of no direct relevance to the particular topic of of this paper. The way in which I will represent the presuppositions generated by DNPs will leave all such details to be filled in at some later stage.

(CP1) and (CP2) cover those aspects of the construction of sentence representations that are of the most immediate importance to the concerns of this paper. However, as I already hinted, the temporal aspects of predication also have a significant role to play in the examples we will be looking at later. So the construction principles which govern the representation of temporal relations are important too. For the most part I will be making implicit use, as far as the representation of time is concerned, of the combination principles contained in [Kamp and Reyle 1993], Ch. 5. Still, the following two principles CP3 and CP4 may help the reader to better understand this aspect of the construction below.

(CP3) (CP1) stipulates that each NP α introduces a variable x_α, its 'referential argument'. A similar assumption is made for VPs: The referential argument of a VP (which strictly speaking originates with the verb that is its lexical head, just as the referential argument of an NP originates with its head noun) is always an eventuality — i.e. an event or a state, depending on the aspectual properties

[15] The notion of semantic boundary becomes important only where presuppositions may have to get attached to embedded positions. (These are the cases that give rise to the projection problem!) Since the section of the original manuscript which dealt with embedded presuppositions had to be cut, the notion is not important in what follows: all presuppositions we will encounter are attached to the highest possible position of the non-presuppositional part of the sentence representation.

of the VP. This variable comes with a Binding Condition too, which gets converted into a real binding at the node which carries the information about the verb's tense features — or, in the case of certain intervening operators such as temporal quantifiers or negation, at the point where these operators intervene. We assume moreover that the introduction of the referential argument of the verb is always accompanied by the introduction of a *location time*, a variable ranging over times to which the referential argument stands in a certain relation of inclusion or overlap. Strictly speaking it is this location time, and not the referential argument itself, which gets located along the temporal axis by the information provided by tense (as well as, sometimes, other temporal constituents of the sentence). The simplest case, to which the examples with which we will deal in this paper conform, is that where no operators intervene and where the finite tense (here assumed, somewhat old-fashionedly, to be located at 'Infl') existentially binds the referential argument while relating it to the utterance time n in accordance with the tense of the sentence.[16] Note that temporally locating the eventuality described by the verb is a way of indicating the time of a verbal predication. Thus, by representing *John loved Mary* as involving the conditions $s\colon love(j,m)$, $t \subseteq s$ and $t \prec n$ the information is captured that the condition (or: state) of John loving Mary held at some time before the utterance time.

(CP4) As we argued in Section 2.2, not only verbal predications are dependent on time; this is true for many non-verbal predications as well. This means that non-verbal predicates must allow for the introduction of several variables, like verbs. Consider for instance the lexical head noun *student* of the argument phrase *a student*. If the predication it expresses of its referential argument x is represented as temporally dependent, i.e. by means of the conditions $s\colon student(x)$ and $t \subseteq s$, then this means that the noun must introduce three variables, x, s and t, each with its own Binding Condition. The Binding Condition for t must reflect the possibilities mentioned in Section 2.2; that for s should treat it as existentially bound, while the Binding Condition for x will be determined by the Determiner of the NP. A similar story is to be told about other non-verbal predications. This is true in particular for the prenominal possessive relation expressed by *his*. I refrain from further details.

So much for the main construction principles. The representation construction, based on the principles (CP1)-(CP4), builds sentence representations by first attaching lexical representations to the lexical leaves of the syntactic tree.[17]

[16] In case the sentence contains one or more temporal adverbials, these will impose additional constraints on the temporal location of the VP's referential argument. See [Kamp and Reyle 1993], Ch. 5 for some details.

[17] These representations are semantic structures supplied by the lexical entries for the lexical

The lexical representations attached to the leaves are then step-wise put together as we make our way up the tree, each time combining the representations of daughter nodes into a representation for their mother. Roughly speaking, when the representation that is attached to the node with a lexical head is combined with the information present at a functional node, the representation typically undergoes a certain transformation; and the combining of two representations of constituents with lexical heads takes the form of some kind of merge. Again we skim over a number of details, hoping that the reader will be able to fill in the missing bits if he wants to from what the examples will show.

One last remark before we look at some actual representation constructions. We need a general format for the various kinds of information that the representation pieces which get attached to the tree nodes in the course of representation construction must be able to carry. The following notion — of a *semantic node representation* — will, at least within the context of our present requirements, answer those needs:

(14) A *semantic node representation* is a pair consisting of:

(i) a set of one or more *store elements*; and

(ii) a *content representation*.

The content representation will always be a DRS.

The store element is a triple consisting of:

(a) a variable;
(b) a constraint, again a DRS; and
(c) a Binding Condition.

Two examples:

(15) (i) (Representation of an occurrence of the verb *love*) [18]

$$\left\langle \left\{ \langle \mathrm{t},\ , \mathrm{BiCo}_{t.loc.} \rangle,\ \langle s,\ \boxed{\mathrm{t} \subseteq \mathrm{s}}\ , \mathrm{BiCo}_{m.ev} \rangle \right\},\ \boxed{\mathrm{s}\!: \mathrm{love}(\mathrm{v}_{subj}, \mathrm{v}_{d.obj})} \right\rangle$$

items appearing at those leaves. I will say nothing here about the form of the lexicon and the way in which the information it contains gets transferred to the lexical leaves of syntactic trees.

[18] The subscripts *loc.ti* and *m.ev.* are short for 'location time' and 'main eventuality'. For more on the rationale behind these annotations see the remarks on the following diagram (27), on page 26.

I should add that the practice adopted in this paper of simply labelling the different Binding Conditions for temporal variables hides much complexity from view, just as this was noted earlier for the Binding Conditions associated with the variables introduced by NPs. Some of our most recent thoughts about the system of Binding Conditions associated with the different temporal variables that get introduced in the course of the construction of sentence representations can be found in [Reyle et al. 2000].

In (15.i) the DRS on the right, consisting of the single condition: s: $love(_{subj}, v_{d.obj})$ contains the contribution which the verb will make to the non-presuppositional part of the representation. (The designations v_{subj} and $v_{d.obj}$ indicate that the argument places occupied by these variables are grammatically realised as subject and direct object. This information is part of the lexical entry of the verb.) In this case the store has two elements. The second of these consists of (a) the referential argument of the verb; (b) a constraint to the effect that the entity represented by the referential argument (the state of loving that the sentence describes) temporally includes its location time t; and (c) a reference to the Binding Condition for the referential arguments of verbs. The first store element concerns the location time t itself. This store element consists of (a) the variable t; (b) an empty slot, indicating that the verb imposes no constraints on t; and (c) a reference to the Binding Condition for location times of the referential arguments of verbs.

(16) (ii) (Representation of an anaphoric token of the pronoun *it*.)

$$\left\langle \left\{ \langle \mathrm{x}_{it},\ \boxed{\text{non-person(x)}}\ ,\ \text{BiCo}_{pron} \rangle \right\},\ \boxed{} \right\rangle$$

In this case the second component on the right is empty. This is so for all definite noun phrases. It reflects the circumstance that all material in such an NP serves the purpose of identifying the referent and thus belongs to the presupposition. Second, the store contains just one element in this case, consisting of (a) the variable which is introduced by the pronoun and represents its referent; (b) the pronoun's descriptive content, to the effect that its referent must be a non-person; and (c) a reference to the Binding Conditions for pronouns (with all that involves).

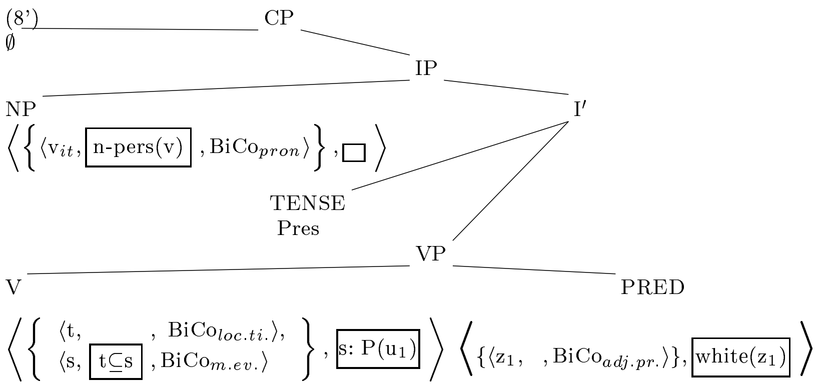
These preliminaries should enable the reader to follow, at least in outline, the construction of the preliminary representations for (7) and for the second sentence of (2). To these we now turn.

3.2 Construction of Preliminary Representations

In this section we show some of the successive stages in the construction of preliminary representations. We begin with the construction of the representation of (7).

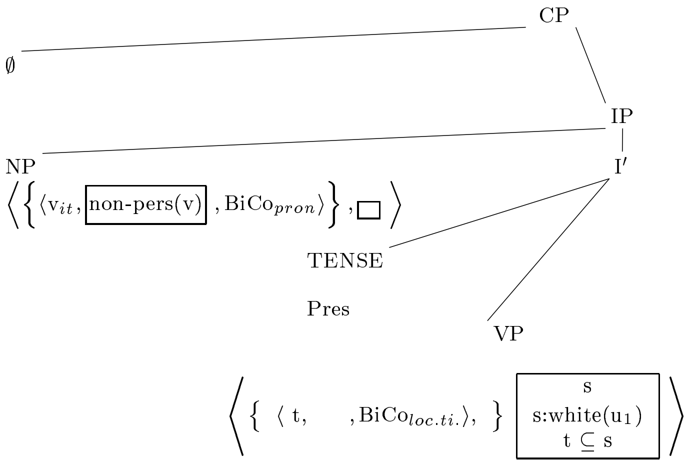
(8') presents the result of replacing the leaves of the tree (8) with the interpretations which the lexicon provides for the lexical items attached to those nodes.

(8')



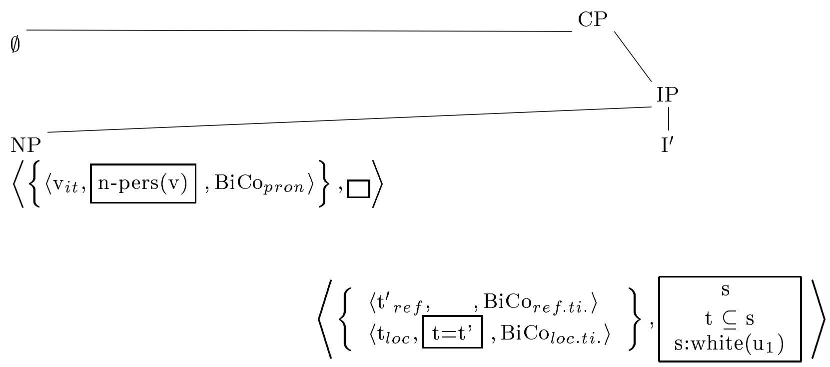
Putting the component representations together yields successively the structures (17) — (19).

(17) [19]

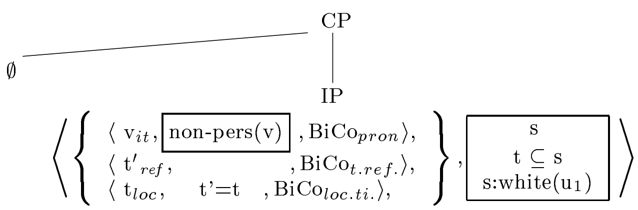


[19]Combining the representations for the copula and its complement takes the form of a kind of 'unification', with the predicate variable P 'unifying' with the predicate constant *white* and the placeholders u_1 and z_1 get unified with each other. (It is immaterial which of these two variables is retained.) This identification process is to be distinguished from what happens at the one but next step, where the referential argument v of the subject phrase gets inserted in lieu of the placeholder u_1 for the argument position of the (verbal) predicate to which the phrase is syntactically linked. Here we have a case of genuine 'argument filling'. (The distinction between 'placeholders' and 'true arguments' to which this informal description alludes could have been made explicit by using different symbols for the two categories, but I have abstained from that in order not to overload what is a fairly complex notation in any case). (For copula constructions s. (Roßdeutscher 2000).)

(18) [20]



(19)



From (19) we obtain a preliminary representation (20) for (7) by

(i) interpreting the represented sentence as a main clause, through identifying the location time t with the utterance time n.

(ii) dealing with the other elements in the store in accordance with their Binding Constraints; [21] this turns the store element for v_{it} into a presupposition.

(20)

[20] I have opted for a very simplified treatment of tense here. The two-dimensional analysis of [Kamp and Reyle 1993], Ch. 5, has been reduced to one dimension (that of TENSE, leaving out that of the Temporal Perspective), and it is assumed that "reference time" (= TPpoint) according to the terminology of [Kamp and Reyle 1993] always gets identified with n, when, at the level of CP node the sentence is recognised as main clause. For a more recent treatment of the temporal information conveyed by tense, also see [Reyle et al. 2000]. A matter that is often difficult to decide is at what stage the different temporal variables used in representing the temporal location of verbal predications (and others) are bound. I have here assumed that the eventuality variable (here s) gets bound at the level of VP, while both the location time and the reference time are bound only at the CP node. Binding the location time variable t_{loc} this late (i.e. after t_{loc} has been related to t_{ref}) may seem arbitrary. But it is necessary in certain cases we will encounter later on.

[21] We take this to be the information provided by the empty *Comp* node; it is assumed that the *Comp* of a subordinate clause always contains information which links it to some element of the clause in which it is embedded.

$$\left\langle \quad \left\{ \boxed{\begin{array}{c} \underline{\mathrm{v}} \\ \text{non-person(v)} \end{array}}_{pron} \right\}, \boxed{\begin{array}{c} \mathrm{t}'\ \mathrm{t}\ \mathrm{s} \\ \mathrm{t}' = \mathrm{n} \\ \mathrm{t} = \mathrm{t}' \\ \mathrm{t} \subseteq \mathrm{s} \\ \text{s: white(v)} \end{array}} \quad \right\rangle$$

At last we are ready to consider the construction for the preliminary representation of the second sentence of (2). As this sentence is identical with (7) except for its more complex subject phrase *his rabbit*, our principal concern will be with this phrase. It is here that we encounter for the first time the problem of 'one presupposition inside another'. And the question we need to consider is how the nested presupposition structure that this NP should yield comes about? The answer I propose runs as follows. In processing the N′ part of (9) we also have to deal with the pronoun *he* (recall that we have analysed the possessive as decomposable into *he* and the possessive relation *'s*). The representation of *he* is like that of *it* in (20), except that its descriptive content is that of a male rather than a non-person. When this representation gets merged with that of *'s*, we obtain a representation in which the possessive relation ends up in the DRS on the right.[22] Moreover, the store of this representation contains, besides the two store elements for the relational state introduced through making the possessive predication temporally dependent on the location time for that state, also the store element coming from the representation of the pronoun. Combining the representation attached to the AP node which is obtained in this way with that of the noun *rabbit* then leads to a representation with a right hand DRS which contains two conditions: (i) the condition that the referential argument of *he* and that of *his rabbit* stand in the possessive relation and (ii) the condition that the latter argument satisfies the predicate *rabbit*. (Once again, more should be said about the details of the combination principles than space permits.)

It ought to be clear from these remarks how the representation of *his rabbit* comes to contain a store element whose middle part is complex, involving a store of its own. The representation is given in (21).

[22] To be exact, the right hand side DRS of the representation of the AP of (18) is the result of merging the right hand side of the representation of *'s* with the right hand side DRS of the representation of the pronoun. As the latter is empty, the result is simply the first DRS.

(21) [23]

$$\left\langle \left\{ \left\langle v, \left\langle \left\{ \begin{array}{l} \langle \mathrm{u}, \boxed{\mathrm{male(u)}}, \mathrm{BiCo}_{pro}\rangle, \\ \\ \langle \mathrm{t}'', \qquad, \mathrm{BiCo}_{adj.pr.ti.}\rangle \end{array} \right\}, \boxed{\begin{array}{c} \mathrm{s}'' \\ \mathrm{s}'' \text{: 's(u,v)} \\ \mathrm{rabbit(v)} \\ \mathrm{t}'' \subseteq \mathrm{s}'' \end{array}} \right\rangle, \mathrm{BiCo}_{d.d.} \right\rangle \right\}, \boxed{} \right\rangle$$

The construction of the preliminary representation of the second sentence of (2) is largely similar to that of (19). In particular, the penultimate stage will be almost like (19) except that the representation of *it* is now replaced by (21). Conversion of this structure into the preliminary representation itself involves in particular dealing with the store elements which occur in (21). Of these the adjectival predication time t'' gets identified with the location time t of the main eventuality s and s'' is put into the universe of the non-presuppositional part of the preliminary representation.[24] That leaves the store elements connected with the referential argument v of *his rabbit* and the one associated with the referential argument u for *he*. Both these store elements are, according to their Binding Conditions, presuppositional, and thus have to be turned eventually into presuppositions. The conversion principle which is responsible for this is sensitive to the recursive structure of the store: the presupposition which corresponds to the descriptive component of a store element which is itself presuppositional gets attached as a satellite presupposition to the presupposition that results from that store element. In this way we obtain a nested presupposition structure which is essentially like the one proposed in vdS. The preliminary representation which comes about in this way is given in (22).

[23] *AP* is shorthand for Adjective Phrase. *adj.pr.ti.* stands for 'adjectival predication time'. The Binding Condition for such location times is special insofar as the location time of a prenominal AP must be identified with the predication time of the head noun (which we have here left implicit). In turn the temporal location of the head noun predication is often to be identified with that of the verb to which the noun's NP is an argument, but not always. For discussion see [Enç 1981] [Musan 1995] and [Tonhauser 2000]. Because of the special requirements to which the temporal location of such predications is subject, it seemed right to make this explicit by introducing a special Binding Condition label.

[24] Here we see the need to retain t in store, so that it remains available as the variable with which t'' gets identified. Existential binding of t at the level of the I$'$ node would have made this problematic from a logical-semantic perspective. See fn. 21.

(22)

$$\left\langle \left\{ \left\langle \left\{ \boxed{\begin{array}{c} \underline{\mathrm{u}} \\ \mathrm{male(u)} \end{array}}_{pron} \right\}, \boxed{\begin{array}{c} \mathrm{s}'' \ \underline{\mathrm{v}} \\ \mathrm{rabbit(v)} \\ \mathrm{t} \subseteq \mathrm{s}'' \\ \mathrm{s}'' \text{: 's(u,v)} \end{array}}_{def.desc.} \right\rangle \right\}, \boxed{\begin{array}{c} \mathrm{t}' \ \mathrm{t} \ \mathrm{s} \\ \mathrm{t}' = \mathrm{n} \\ \mathrm{t}' = \mathrm{t} \\ \mathrm{t} \subseteq \mathrm{s} \\ \mathrm{s}\text{: white(v)} \end{array}} \right\rangle$$

The set of the two nested presuppositions triggered by *his rabbit* and *his* is easily resolvable in the context provided by (3): u is identified with w and v with y. On these identifications the context (3) verifies the conditions of the presuppositions and after merging the non-presuppositional part of (22) with (3) we obtain, unsurprisingly, (23) as the discourse representation for the result of the two sentence 'discourse' (2).

(23) $$\boxed{\begin{array}{c} \mathrm{s}_0 \ \mathrm{w} \ \mathrm{y} \ \mathrm{t} \ \mathrm{s} \\ \mathrm{n} \subseteq \mathrm{s}_0 \quad \mathrm{t} = \mathrm{n} \quad \mathrm{t} \subseteq \mathrm{s} \\ \mathrm{Walter(w)} \quad \mathrm{rabbit(y)} \\ \mathrm{s}_0\text{: have(w,y)} \\ s\text{: white(y)} \end{array}}$$

4 Presupposition Interaction

As noted in the introduction, discussions of presupposition have tended to concentrate on cases where just one presupposition, or at best a couple, are being explicitly considered. But as a rule the number of presuppositions generated by a single sentence is bigger.

We have seen a comparatively simple form of this already in our discussion of van der Sandt's example *Walter's rabbit*. Indeed, the insight that presupposition nesting occurs is by no means new and goes back at least as far as vdS. But often the complexity of the interactions and of the representations resulting from them goes well beyond what we have seen so far in this paper, and also, if I am not mistaken, beyond what can be found in the existing literature.

In the remainder of this paper we will be looking more closely at this sort of complexity. Our ultimate aim in this section is to compute the preliminary representation of (24):

(24) *Walter's rabbit is on the loose again.*

This sentence gives rise to presuppositions connected with (i) the definite NPs *Walter* and *Walter's rabbit* and (ii) *again*.[25] Before we can address the question

[25] I am not claiming that these are all the presuppositions generated by occurrences of (24). However, for expository reasons they will be the only ones considered.

how the computations of different types of presuppositions interact, however, we have to know how those different types of presuppositions are computed when taken in isolation. As regards the presuppositions triggered by *Walter's rabbit*, we have seen enough in the preceding sections. But presuppositions triggered by *again* haven't yet been considered in this paper, and it will be helpful to first look into their computation by looking at a sentence in which there is no interaction between the presuppositional effects of *again* and those connected with the definite Subject NP of (24). This sentence, in which the definite subject has been replaced by the indefinite *some rabbit*, is given in (25).

(25) *Some rabbit is on the loose again.*

First a few words about the syntax of *again* and its consequences for the computation of the presuppositions connected with it. One important difference between the presuppositions we have considered up to now and those triggered by *again* has to do with the question of the trigger's *scope*. For instance, (25) is ambiguous in that it can be interpreted as presupposing that the rabbit which is on the loose now has been on the loose before, but also as presupposing that it has been the case before that some rabbit was on the loose, but not necessarily the same one that is on the loose now. The difference between these two presuppositions can be accounted for as the effect of two different scope assignments to *again*: In one case the scope of *again* only includes the subject NP, in the other it doesn't. Underlying this account is the obvious observation that the presuppositions generated by *again* result from its interaction with other material from the sentence in which it occurs; this other material serves to identify an eventuality type (i.e. a type of event or state) that is true of the main eventuality e the sentence describes; the presupposition generated by *again* is to the effect that one or more eventualities of that type occurred before the time of e. Given this general characterisation, we can identify the scope of an occurrence of *again* with the sentence material which defines the relevant eventuality type. In this respect *again* is one of a larger class of presupposition triggers, which also includes the already mentioned *too*, its close alternative *also*, a number of temporal presupposition triggers such as *still* and *already*, and various other particles.

Sometimes the position of *again* in the sentence determines its scope unambiguously. This is so for instance with sentence-initial *again* (e.g. when we move the word from its sentence-final position in (25) to the front of the sentence). But in other cases the surface position of *again* is not decisive. I take (25) to be a case of the latter kind.[26]

[26]Perhaps this is an arguable point. The narrow scope reading of (25) seems preferred and some people might perhaps want to argue that that is really its only reading. It appears that the relation between scope and surface position, for *again* and other presupposition triggers, has not yet been exhaustively investigated. As Roßdeutscher and I noted in our [Kamp and Roßdeutscher 1994], the surface positions of the German equivalent of *again*, the word *wieder*, tend to be much more determinative of its scope than they are for *again* (even if *wieder* too is subject to certain scope ambiguities).

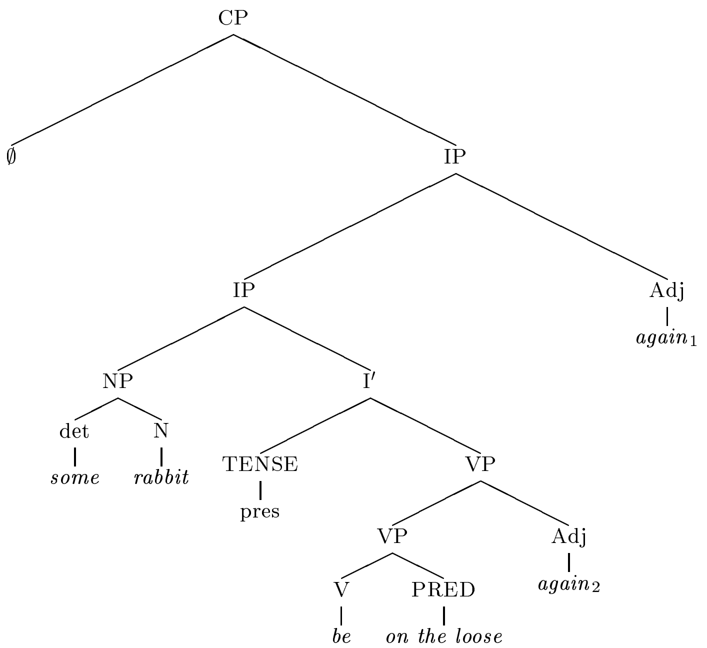
An exact treatment of scope ambiguities like that of (25) involves questions of syntax which go beyond the scope of this paper. For the case of (25) I will assume that its sentence-final *again* is a right-adjunct and that its possible adjunction sites are VP and IP, with VP-adjunction giving rise to the narrow scope reading and IP-adjunction to the wide scope one. But more careful syntactic considerations will have to decide the tenability and generalisability of these assumptions.

4.1 The wide scope reading for *again* in (25)

We just noted that the presuppositions triggered by *again* are claims to the effect that the time of the eventuality described by the sentence is preceded by one or more eventualities of the same type. So in fact, the problem of computing such presuppositions is in essence that of computing the representation of the relevant eventuality type. We will restrict our attention here to those cases in which the full content of the verb is part of the characterisation of this type.[27]

[27] I am passing over the notorious problem of the so-called restitutive interpretations of *again*, as one finds it in *The doctor cured the baby again*, where the baby had never been ill before contracting the disease from which the doctor is asserted to have cured it. Here the eventuality type of which the sentence is taken to describe a reinstantiation is that of a state of the baby being healthy, not that of an event of the doctor curing the baby.

(26)



(26) shows the two possible attachment sites for the *again* of (25). First we consider the construction of the preliminary representation corresponding to the higher site, where the adverb is adjoined to IP. Applying the bottom-up construction algorithm sketched in section 3 up to the level of the lower IP node we get, for the representation attached to this node, (27) (cf. (19)).

(27) [28]

$$\left\langle \left\{ \begin{array}{l} \langle \mathrm{y}, \boxed{\mathrm{rabbit(y)}}, \mathrm{BiCo}_{indef} \rangle, \\ \langle \mathrm{t'}_{ref}, \qquad\qquad \mathrm{BiCo}_{ref.ti.} \rangle, \\ \langle \mathrm{t}_{loc}, \boxed{\mathrm{t} = \mathrm{t'}}, \mathrm{BiCo}_{loc.ti.} \rangle \end{array} \right\}, \boxed{\begin{array}{c} \mathrm{s}_{ev_m} \\ \mathrm{t} \subseteq \mathrm{s} \\ \mathrm{s{:}\ on\ the\ loose(y)} \end{array}} \right\rangle$$

[28] *Some rabbit* is represented here as an ordinary indefinite, and no distinction is being made between *some* and *a*. N.B. $\mathrm{BiCo}_{indef.}$ stands for the Binding Condition for indefinites, which requires that the referential argument be introduced into some appropriate DRS universe. In the present example this universe is the main universe of the non-representational part of the preliminary representation of the full sentence, and I am assuming that the discourse referent is placed in this universe at the level of CP. For more on this problem — and more generally on the scope of indefinites see in particular [Abusch 1994] and also my forthcoming [Kamp 2000b].

It is from this structure that the presupposition has to be computed which is triggered by *again*. As we noted, this presupposition involves the computation of the right eventuality type. In principle this computation is easy, as the type can be extracted from (27) straightforwardly. However, in order to do this we need to be able to recognise which element in (27) is the main eventuality; and we also need to be able to identify its location time. The source of this information is clear enough: The main eventuality is introduced as the referential argument of the main verb of the sentence, and the location time is introduced in tandem with it. Since this information has to be available when we need it, it has to carried up the tree. So the two variables must be somehow marked at the time of introduction, and these marks carried upwards. In fact, we already made this information explicit, when discussing the construction algorithm in Section 3, where the location time was explicitly marked as t_{loc} and the main eventuality variable got the subscript ev_m. (Cf. footnote 18 on p. 17).

Let us call the structure associated with the sister node of the given occurrence of *again* the *source structure* (for the presupposition triggered by *again*). The extraction operation can now be described as follows:

(28) (i) For each of the marked variables (here t_{loc} and s_{ev_m}) we introduce new variables (here, say, t^p and s^p).

(ii) The representation of the content of the *again*-presupposition is obtained in the following way:

(a) Replace in the source structure the marked variables by their new counterparts.
(b) Introduce fresh copies also for all other variables occurring in the source structure.
(c) Add to the store an element for the 'presupposed location time' t^p. This store element contains a new type of Binding Condition, specific to the location times of *again*-presuppositions. I will assume here that this Binding Condition is like that of indefinite phrases in that its variable eventually gets placed into a suitable DRS universe. But see the discussion towards the end of this section.
(d) The store element for the reference time (here t_{ref}) gets deleted, and similarly the DRS condition $t = t'$ from the second component of the store element for t_{loc}, in which t'_{ref} is mentioned. The intuition behind this last requirement is that t'_{ref} plays a part in locating the asserted eventuality on the time axis, and plays no part in the interpreation of the presupposition structure generated by *again*. The need for deleting such information that has to do with the temporal location of the asserted eventuality is particularly prominent in conditions with adverbs like *yesterday*, *at 11:30 this morning*, etc. For instance, *Walter's rabbit was on the loose again yesterday* does not presuppose that there was an earlier event of Walter's

rabbit being on the loose *which also occurred yesterday*, but only that there was such an earlier event.

Note well that the resulting structure is a copy (modulo the modifications mentioned under (a)–(d) of the entire source structure, including the store (as well as previously constructed full-scale presuppositions, should the source structure contain such). In this way an *again*-presupposition can produce, as we will see later in this section, 'reduplications' of other presuppositions.

The construction of an *again*-presupposition involves a further operation which affects the right hand DRS of the source structure. Somewhere it has to be made explicit that the presupposed eventuality (here represented as s^p) precedes the time of the main eventuality (here s). We add this condition, $t^p \prec t'$, in the DRS to the right in (29), which will eventually turn into the non-presuppositional part of the representation. (The condition should not be added to what will become the presupposition; for the presupposition should be justifiable independently of the content of the non-presuppositional part, which presents what the utterance asserts, queries, etc., since that content is defined only if and when justification has taken place. Thus the variable t is, from this point of view, not accessible from the perspective of the presupposition.)[29]

[29]The conditions $t^p \prec t'$, $t^p \subseteq s'$ and $t \subseteq s'$ do not exclude the possibility that s^p and s overlap. It might be thought that disjointness is part of what *again* means and thus that failure to entail it is a fault in the analysis. Actually for states (as opposed to events) the matter of disjointness isn't straightforward, as shown by the following example, due to Manfred Bierwisch (p.c). I can say, watching the news, *Hilary is standing by Clinton again*, not wanting to imply that Hilary was standing by Clinton at some earlier occasion, then did not stand him for some time and now is standing by him again, but rather that the present occasion is another one at which she is standing by him, without suggesting that she ever ceased to stand by him. In this case the stative condition described in the sentence does not seem to have two temporally disjoint instantiations. In the light of examples like this one I have decided to ignore the disjointness problem here. Note that in the case of events temporal disjointness is guaranteed in our representations, since events represented as included in their location times $t^p \prec t'$, $e \subseteq t'$ and $e^p \subseteq t^p$ jointly entail that $e^p \prec e$.

(29)

(Representation associated with the upper IP node of (26)) [30]

$$\Bigg\langle \Bigg\{ \Bigg\langle \left\{ \begin{array}{l} \left\langle \mathrm{y}^p, \boxed{\mathrm{rabbit}(\mathrm{y}^p)}, \mathrm{BiCo}_{indef} \right\rangle \\ \langle \mathrm{t}^p, \qquad\qquad\qquad , \mathrm{BiCo}_{pres_{again}} \rangle \end{array} \right\}, \boxed{\begin{array}{c} \mathrm{s}^p \\ \mathrm{s}^p : \text{on the loose}(\mathrm{y}^p) \\ \mathrm{t}^p \subseteq \mathrm{s}^p \end{array}} \Bigg\rangle \Bigg\},$$

$$\Bigg\langle \left\{ \begin{array}{l} \left\langle \mathrm{y}, \boxed{\mathrm{rabbit}(\mathrm{y})}, \mathrm{BiCo}_{indef} \right\rangle \\ \langle \mathrm{t}'_{\mathrm{ref}}, \qquad\qquad , \mathrm{BiCo}_{ref.ti.} \rangle \\ \langle \mathrm{t}_{\mathrm{loc}}, \qquad\qquad , \mathrm{BiCo}_{loc.ti.} \rangle \end{array} \right\}, \boxed{\begin{array}{c} \mathrm{s} \\ \mathrm{t} = \mathrm{t}' \\ \mathrm{t} \subseteq \mathrm{s} \\ \mathrm{s}: \text{on the loose}(\mathrm{y}) \\ \mathrm{t}^p \prec \mathrm{t} \end{array}} \Bigg\rangle \Bigg\rangle$$

(29) prompts a further remark. It is plain that its presupposition representation, with its non-empty store, requires further operations, which empty its store while turning the Binding Conditions of the elements in that store into proper bindings or presuppositions. For the first store element, introduced by the indefinite subject *some rabbit*, conversion is straightforward: its binding condition is converted into a proper (existential) binding of the variable y^p.[31] The remaining two elements of the presupposition store in (29), which concern the presupposed eventuality s^p and its location time t^p, are more problematic. The question that needs an answer here is whether these store elements are to be converted into existential bindings, like the first element, or into (anaphoric) presuppositions.

This question arises for many store elements belonging to representations that will be turned into presuppositions eventually. Answers to this type of question are delicate. Here too I refrain from a detailed discussion of the issues and simply state the decision I have reached for this particular case: Both t^p and s^p are to be bound existentially; more precisely, they are to be existentially

[30] It is merely for reasons of lay-out that the presupposition set is displayed above the 'non-presuppositional part' and not to the left to it, as in earlier diagrams.

[31] Strictly speaking conversion of this store element will take place when the right level in the bottom-up construction of the presupposition-generating sentence is reached. In the present case this point is the clause boundary marked by the CP node. At that point both the store element for y and that for y^p are eliminated and the two variables are introduced into the appropriate universes. The time of the conversion of the store element for y^p is thus determined (strictly speaking) by that part of the tree (26) which extends above the IP node at which *again* introduces the structure that will turn into the definitive representation of its presupposition by the time when we are done with the construction of (25)'s preliminary representation. We will presently see a more illuminating example of what happens when a presupposition gets introduced below the top node of the tree, when we consider the narrow scope interpretation of *again* in (25). I am assuming that the other two elements of the store of the presuppositional part of (29) are also taken out of it at the processing stage identified by the CP node.

bound at the point where the representation to which they belong is turned into the definitive representation of the presupposition it is destined to become.[32]

This concludes my description of the last round of operations that are needed in order to complete the construction of the wide-scope preliminary representation of (25). Applying these operations to (29) yields (30)

$$(30) \quad \left\langle \left\{ \boxed{\begin{array}{c} \mathrm{y}^p\ \mathrm{t}^p\ \mathrm{s}^p \\ \mathrm{rabbit}(\mathrm{y}^p) \\ \mathrm{t}^p \subseteq \mathrm{s}^p \\ \mathrm{s}^p\text{: on the loose}(\mathrm{y}^p) \end{array}} \right\}, \boxed{\begin{array}{c} \mathrm{t}\ \mathrm{t}'\ \ \mathrm{s}\ \ \mathrm{y} \\ \mathrm{t} = \mathrm{t}'\ \ \mathrm{t}' = \mathrm{n} \\ \mathrm{rabbit}(\mathrm{y}) \\ \mathrm{t} \subseteq \mathrm{s} \\ \mathrm{s}\text{: on the loose}(\mathrm{y}) \\ \mathrm{t}^p \prec \mathrm{t} \end{array}} \right\rangle$$

The content of (30) should be clear: Its claim is that at the utterance time n there obtains a state to the effect that some rabbit is on the loose; and this claim is made under the presupposition that a similar state — of some rabbit being on the loose — obtained at some time before n.

4.2 The narrow scope reading

The narrow scope reading of (25), generated by the VP attachment site for *again*, leads to the creation of a non-empty presupposition set at the level of the upper VP. (31.i) displays the structure that application of the construction operation triggered by *again* causes to be attached to the upper VP node; (31.ii) shows that part of the syntactic tree which is still relevant to the remainder of the construction.

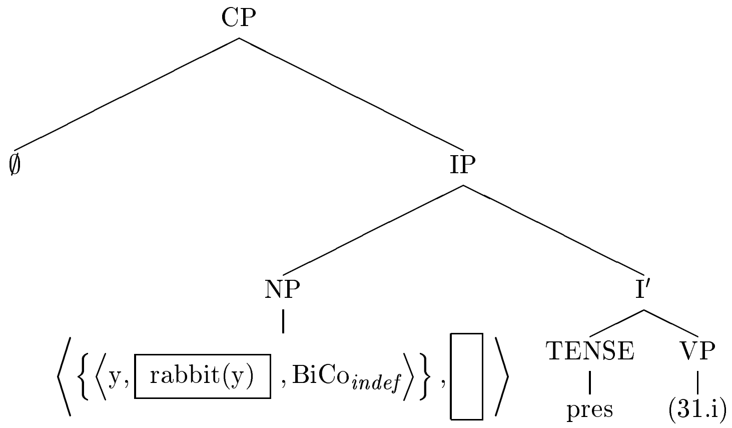
[32] The decisive issue is whether the presupposition whose representation is being built can be accommodated without any requirement that a specific antecedent be found for its distinguished variable in the given context. If this is so, then it indicates that the variable has an existential status within the presupposition. It appears to me that this condition is satisfied for the case we are considering: Inasmuch as accommodation of an *again*-presupposition is possible, it can always take the form of assuming that there was an eventuality of the required type at some time before the location time of the asserted eventuality. Questions of this sort tend to get obscured by the circumstance that in those cases where the context contains information which verifies the presupposition, this often has the effect of binding the variable to an element that is part of that information. E.g. an *again*-presupposition may be satisfied in the context because it contains information to the effect that there was an eventuality s of the required type at some earlier time t. In this case justification of the presupposition has the effect of identifying t^p with t and s^p with s. Observations of this sort might tempt us to think that t^p and/or s^p play(s) some sort of anaphoric role, but by themselves they not enough to establish this.

(31)

(i) $$\left\langle \left\{ \left\langle \{ \langle t^p, \quad , \mathrm{BiCo}_{pres_{again}} \rangle \} , \boxed{\begin{array}{c} s^p \\ \\ t^p \subseteq s^p \\ s^p\text{: on the loose}(u_1) \end{array}} \right\rangle \right\} , \right.$$

$$\left. \left\langle \left\{ \langle t_{loc}, \quad , \mathrm{BiCo}_{loc.ti.} \rangle \right\} , \boxed{\begin{array}{c} t \ s_{ev_m} \\ \\ t \subseteq s \\ s\text{: on the loose}(u_1) \\ t^p \prec t \end{array}} \right\rangle \right\rangle$$

(ii)



The next steps are needed to (i) combine the result of this operation with the subject interpretation, (ii) relate t to the reference time t', and (iii) anchor t' to n and convert the remaining 'indefinite'-marked Binding Conditions into actual bindings.[33] The first operation is much like the instances of relating t to t' that we have seen before (but now with the new qualification that in the case of (31.ii) the operation only affects the non-presuppositional part, while leaving the presuppositional component untouched). The second operation is of more interest. Thus far, combining the representation of a predicate with

[33]Note that this time the remaining operations are connected with different nodes of the syntactic tree (those above the upper VP node, where the *again*-presupposition gets generated). Thus operation (i) must be performed to get the representation associated with the IP node while (ii) and (iii) are performed at the level of CP. Here we get a taste of the construction complexities connected with certain presuppositions that get introduced lower down in the tree.

the representation of one of its argument phrases took the form of inserting the variable representing the argument phrase into the relevant argument slot of the predicate. But now, when combining the representation of the subject phrase of (25) with that of the representation of the I′ node in the structure derived from (31.ii), we find ourselves in a different situation. For the placeholder u_1 now occurs in two places, once inside the non-presuppositional part and once inside the presupposition. Intuitively it is clear, however, that in this case substitution should apply to both occurrences of the placeholder. So substitution is for <u>all</u> occurrences of the relevant placeholder.

I have dwelt on this point because of the impact it has on the representation which will result. First, if the variable y gets inserted inside the presupposition as well as the non-presuppositional part of the VP- interpretation, then both should be within the scope of the store element introduced by the subject phrase. For otherwise we would end up, after conversion of this store element into a proper binding, with an unbound occurrence of y. This means that the representation structure associated with the IP node should now have the form given in (32).

(32) $$\Bigg\langle \Big\{ \Big\langle \mathrm{y}, \boxed{\mathrm{rabbit(y)}}, \mathrm{BiCo}_{indef.} \Big\rangle \Big\},$$
$$\Bigg\langle \Bigg\{ \Bigg\langle \Big\{ \big\langle \mathrm{t}^p, \quad , \mathrm{BiCo}_{pres_{again}} \big\rangle \Big\}, \boxed{\begin{array}{c} s^p \\ \mathrm{t}^p \subseteq s^p \\ s^p\text{: on the loose(y)} \end{array}} \Bigg\rangle \Bigg\},$$
$$\Bigg\langle \Bigg\{ \begin{array}{l} \Big\langle \mathrm{t}'_{ref}, \quad , \mathrm{BiCo}_{ref.ti.} \Big\rangle, \\ \Big\langle \mathrm{t}_{loc}, \boxed{\mathrm{t} = \mathrm{t}'}, \mathrm{BiCo}_{loc.ti.} \Big\rangle \end{array} \Bigg\}, \boxed{\begin{array}{c} \mathrm{s} \\ \mathrm{t} \subseteq \mathrm{s} \\ \text{s: on the loose(y)} \\ \mathrm{t}^p \prec \mathrm{t} \end{array}} \Bigg\rangle \Bigg\rangle \Bigg\rangle$$

In (32) the *again*-presupposition and the part that presupposes it are both within the scope of the Binding Condition on y, and so they will both be within the scope of the bound variable y when this Binding Condition gets converted.

To turn (32) into a preliminary representation of (25) we also have to deal with its other Binding Conditions. This business is more delicate than might appear at first sight. As will be even plainer from the next example we will look at, the subject phrase may require temporal binding to t_{loc}, so t_{loc} must be available at the top level. Thus it, and with it the reference time t', have to be 'lifted' beyond the *again*-presupposition. Otherwise, the remaining operations produce the same effects as in earlier examples (t' identified with n, etc.).[34] The result is (33).

[34] As it stands, this is just a stipulation. I am unsure how a general principle governing such variables lifting should best be stated.

(33)

$$
\boxed{\begin{array}{c} \mathrm{t}'\ \mathrm{t}\ \mathrm{y} \\ \mathrm{t} = \mathrm{t}' \\ \mathrm{t}' = \mathrm{n} \\ \mathrm{rabbit(y)} \\ \left\langle \left\{ \boxed{\begin{array}{c} \mathrm{t}^p\ s^p \\ \mathrm{t}^p \subseteq s^p \\ s^p\text{: on the loose(y)} \end{array}} \right\}, \boxed{\begin{array}{c} \mathrm{s} \\ \mathrm{t} \subseteq \mathrm{s} \\ \text{s: on the loose(y)} \\ \mathrm{t}^p \prec \mathrm{t} \end{array}} \right\rangle \end{array}}
$$

Note that the presupposition of (33) occurs not at the top level, but is within the scope of the implicit existential quantifiers represented through the presence of the discourse referents t', t and y in the main universe of the representation.

Here we encounter, for the first time in this paper, a presupposition in subordinate position, and therewith an instance of the Projection Problem. The problems connected with this particular kind of subordinate occurrence are well-known from the literature and various suggestions for its solution exist. [35] The nature of the problem becomes clearly visible when we compare the question of justifying the *again*-presupposition in (33) with that of justifying the *again*-presupposition of (30). Accommodation of the presupposition of (30) is unproblematic. It involves the simple assumption that the presupposition holds in the given context, and the total gain in information, through presupposition accommodation and then adding the non-presuppositional information of (30), can be represented as in (34):

(34)

[35]The problem was first explicitly discussed in [Karttunen and Peters 1979] , who note a difficulty with their compositional account of presupposition within an extension of standard Montague Grammar. Karttunen and Peters observe that *Someone managed to succeed George III on the throne of England.* carries the presupposition that whoever succeeded George III must have made an effort in that direction. This presupposition is not satisfied if someone else tried to succeed George III, but failed, while the person who did succeed him didn't make any effort at all. [Heim 1983] notes a similar problem for sentences such as *A fat man was pushing his bicycle. His bicycle* carries the presupposition that someone had a bicycle. But *again*, the presupposition is really that the man who was pushing his bicycle had a bicycle, and not somebody else. It is worth emphasising how easily and frequently such situations arise; the present case, where *again* is construed as excluding from its scope a phrase which introduces at least one variable, is one of many which require this type of binding into presuppositions. Because cases of binding into presuppositions are so very common, the problem of how the resulting presuppositions are to be justified is of the first importance.

y^p t^p s^p y t' t s
rabbit(y^p)   rabbit(y)
$t^p \subseteq s^p$ $t' = n$ $t = t'$ $t \subseteq s$
s^p: on the loose(y^p)   s: on the loose(y)
$t^p \prec t$

Justification of the presupposition of (33) is not so straightforward. In fact, on the widely accepted theory that indefinite NPs (like the noun phrase *a rabbit*), convey novelty,[36] we seem to be faced with a real puzzle: If the discourse referent y (which is contributed by the indefinite *a rabbit*) stands for something unknown, how can the condition s^p: *on the loose(y)*, in which y occurs as an argument, be presupposed? The solution of this puzzle involves, I believe, a reassessment of the notion of novelty, which draws a sharp distinction between what is new to the hearer and what is unknown, (that is, not uniquely identifiable) to the speaker. It is legitimate, and very common, for a speaker to refer to an individual about which he takes himself to have uniquely identifying knowledge by means of an indefinite NP, thereby conveying to the addressee that he takes the referent to be unknown to him.[37] Moreover, since such uses of indefinites are common practice, the addressee will also often be prepared to assume that there is a particular individual which the speaker is talking about. In connection with a representation like (33) this assumption allows the hearer to further suppose that the speaker is speaking about a particular rabbit, of which he knows that it had been involved in an earlier escape, at a time previous to the event that the statement (25) reports. In this way, and as far as I can see, only in this way, is it possible for the hearer to accommodate this presupposition.

A consequence of this analysis is that presuppositions like that of (33) always require accommodation. To be precise, whenever an indefinite with an existential interpretation — i.e. its referential argument ends up in the main universe of the representation — governs a presupposition in which it figures as an argument, then (a) on the one hand the indefinite must be interpreted as 'specific' (in the sense that the speaker must know which individual he is talking of) so that it is possible to impute knowledge of the presupposition to him; and (b) on the other hand, the individual spoken of and, a fortiori, the presupposition in which it figures as an argument, must be unknown to the addressee, and thus it cannot be part of the context as it is available to the hearer at that point. Hence accommodation is inevitable.[38]

[36] See [Heim 1982].

[37] See [Kamp 2000a].

[38] (33) is also compatible with a slightly different scenario, in which the speaker does not have uniquely identifying knowledge of some particular rabbit, but knows that the rabbit is one of a set of rabbits all of which have had previous escapes. It seems to me that in this case too the use of *some rabbit* (as opposed to, say, *one of the rabbits*) conveys to the addressee that the speaker does not take him to be familiar with the set in question. In that case it will be true once more that the presupposition is unknown to the addressee, so that accommodation will be necessary. Perhaps, however, the rules for use of the phrase *some rabbit* are not as

4.3 Walter's rabbit is on the loose again

We now turn to (24), repeated as (35)

(35)

Walter's rabbit is on the loose again.

As with (25) there are two possible attachment sites for *again*, giving rise to two different *again*-presuppositions in the preliminary representation. This time we start with the narrow scope case (= VP attachment). The representation for this case is in most respects like that in (33). The only difference is that now the representation of the subject phrase also gives rise to presuppositions (or, more accurately, to a structure consisting of two nested presuppositions). These presuppositions end up in front of the representation structure that occupies the space below the top two lines in (33). (Of course, the discourse referent y and the condition *rabbit(y)* have to be removed from (33)).

(36) gives the representation that gets attached to the subject node as part of constructing the intended preliminary representation of (35).[39] [40]

strict in this case, and compatible with the assumption that the addressee knows the set over which the variable introduced by the phrase is intended to range. Then, if it is also known to the addressee that all rabbits in that set had previous escapes, accommodation would not be necessary.

[39]This time I have given the condition that y is a rabbit in its time-dependent form. This is not because of a sudden concern with the possibility that what is a rabbit at one time need not be one at another, but to allow for greater transparency of the process of temporal binding to which the interpretation of the subject term of (24) gives rise: the time t'' of the prenominal possessive predication gets identified with the time t' of the predication expressed by the lexical head *rabbit*, while t' can be bound either to the location time of the corresponding event or to the utterance time n.

[40]*nom.lex.h.* indicates that the Binding Condition thus annotated is that for the state of the predication of the nominal lexical head of an argument NP. *nlh. pr.ti.* annotates the corresponding predication time. Similarly, the annotations *AP* and *adj.pred.ti.* identify the Binding Conditions they label as those for the state of a prenominal adjectival predication and for its predication time. Except for operator-like APs this second time always gets identified with that of the lexical head. See the preceding footnote and the discussion of prenominal adjectives in Section 3.

(36)

$$\left\langle \left\{ \left\langle \mathrm{v}, \left\{ \begin{array}{l} \left\langle \mathrm{w}, \boxed{\mathrm{Walt(w)}}\ , \ \mathrm{BiCo}_{pr.na} \right\rangle, \\ \langle \mathrm{t}', \qquad\qquad\quad , \mathrm{BiCo}_{n.pr.t.} \rangle\ , \\ \langle \mathrm{t}'', \qquad\qquad\quad , \mathrm{BiCo}_{a.pr.ti.} \rangle \end{array} \right\}, \boxed{\begin{array}{c} \mathrm{s}' \ \mathrm{s}'' \\ \mathrm{t}' \subseteq \mathrm{s}' \\ \mathrm{t}'' \subseteq \mathrm{s}'' \\ \mathrm{s}'\text{: rab(y)} \\ \mathrm{s}''\text{: 's(w,y)} \end{array}}\ , \ \mathrm{BiCo}_{df.d.} \right\rangle \right\} \boxed{} \right\rangle$$

When (36) is combined with the representation attached to the I′ node of the syntactic tree of (24), the location time and reference time for the non-presuppositional part are lifted to the top (cf. the transition from (32) to (33) above). Intuitively, the location time t' of *rabbit(y)*, and with it the location time t'' of the possessive predication of the subject term, should be identified with the location time t of the main eventuality of the non-presuppositional part of the representation attached to I′. It is not entirely clear whether this identification is to be taken as the direct result of converting the Binding Condition for t' or whether conversion is to yield a presupposition first, which the identification of t' with t (or n) can then subsequently resolve. I have chosen the second option here, with an eye on the analysis of the other interpretation of (25) we will consider.

The considerations which have led me to choose the second option for t' do not apply to the state variable s' and I can see no good reason against converting its Binding Condition directly into an existential binding when the subject representation and the I′ representation are put together. The same applies to s''. Finally, I have treated the time t'' of the prenominal predication also as bound at this point, through identification with t'.

Given these decisions, the preliminary representation of (25) comes to look as in (37):

(37)

$$\boxed{\begin{array}{c} \mathrm{t}^3\ \ \mathrm{t} \\ \mathrm{t} = \mathrm{t}^3 \quad \mathrm{t}^3 = \mathrm{n} \\[1ex] \left\langle \left\{ \left\langle \left\{ \begin{array}{l} \boxed{\begin{array}{c} \mathrm{w} \\ \mathrm{Walt(w)} \end{array}}_{\,pr.na} \\ \boxed{\begin{array}{c} \mathrm{t}' \\ \\ \end{array}}_{\,nlh.pr.ti.} \end{array} \right\}, \boxed{\begin{array}{c} \mathrm{s}'\ \mathrm{s}''\ \underline{\mathrm{y}} \\ \mathrm{t}' \subseteq \mathrm{s}' \\ \mathrm{t}'' \subseteq \mathrm{s}'' \\ \mathrm{t}'' = \mathrm{t}' \\ \mathrm{s}' : \mathrm{rab(y)} \\ \mathrm{s}'' \text{: 's(w,y)} \end{array}}_{\,def.desc.} \right\rangle \right\}, \right. \\[1ex] \left. \left\langle \left\{ \boxed{\begin{array}{c} \mathrm{t}^p\ s^p \\ \mathrm{t}^p \subseteq s^p \\ s^p\text{: on the loose(y)} \end{array}} \right\}, \boxed{\begin{array}{c} \mathrm{s} \\ \mathrm{t} \subseteq \mathrm{s} \\ \text{s: on the loose(y)} \\ \mathrm{t}^p \prec \mathrm{t} \end{array}} \right\rangle \right\rangle \end{array}}$$

If in (37) the presupposition involving t' is resolved by identifying t' with t and the other three presuppositions, connected with *Walter*, with *Walter's rabbit* and with *again*, are accommodated, while the present tense anchors the location time t once again to n, we get the representation in (38).

(38)

$$\boxed{\begin{array}{cccc} \multicolumn{4}{c}{\mathrm{t}^p\ \mathrm{s}^p\ \mathrm{w\ t\ s\ s'\ s''\ y}} \\ \mathrm{t}^p \subseteq s^p & \mathrm{t} = \mathrm{n} & \mathrm{t} \subseteq \mathrm{s} & \mathrm{t} \subseteq \mathrm{s}' \\ \multicolumn{2}{c}{\mathrm{s}'\text{: rabbit(y)}} & \multicolumn{2}{l}{\text{Walter(w)}} \\ \multicolumn{2}{c}{\mathrm{t}^p \prec \mathrm{t}} & \multicolumn{2}{l}{\mathrm{s}''\text{: 's(w,y)}} \\ \multicolumn{2}{c}{s^p\text{: on the loose(y)}} & \multicolumn{2}{c}{\text{s: on the loose(y)}} \end{array}}$$

4.4 Narrow scope for Walter's rabbit

It is the wide-scope interpretation of *again* in (25), which gives a proper taste of the complexities to which presupposition interaction can give rise. As we just saw in dealing with the wide scope reading of *again* in (25), the subject term is now within *again*'s scope and a copy of its representation will therefore appear within the representation of the *again*-presupposition. But this time the representation of the subject term involves presuppositions of its own, which now appear embedded within the presupposition generated by *again*. What consequences this has for the final representation depends crucially on the binding of the duplicates $t^{p\prime}$ and $t^{p\prime}$ of the predication times t' and t'' for the lexical head and the possessive AP. The first stage we display of the construction for the corresponding preliminary representation is the one reached after (i) combining the representations attached to the subject node and to the I′ node and (ii) transforming the representation of the lower IP node into that of the higher one, by performing the construction step dictated by *again*. The display is given in (39)

(39)

$$\left\langle \left\{ \left\langle \{\ (1)\ , \langle t^p, \quad , \mathrm{BiCo}_{pres_{again}} \rangle \}\ , \boxed{\begin{array}{c} s^p \\ \\ t^p \subseteq s^p \\ s^p\!: \text{ on the loose}(y^p) \end{array}} \right\rangle \right\}, \right.$$

$$\left. \left\langle \left\langle \left\{ \begin{array}{l} \langle t'''_{ref}, \quad , \mathrm{BiCo}_{ref.ti.} \rangle\ , \\ \left\langle t_{loc}, \boxed{t = t'''}\ ,\ \mathrm{BiCo}_{loc.ti.} \right\rangle , \\ (2) \end{array} \right\} , \boxed{\begin{array}{c} s \\ \\ t \subseteq s \\ s\!: \text{ on the loose}(y) \\ t^p \prec t \end{array}} \right\rangle \right\rangle \right\rangle$$ where (2) is

the structure (40.i) and (1) the result of replacing all the relevant variables α by 'fresh copies' of the form α^p, displayed in (40.ii):

(40)

(2) [41]

$$\left\langle \left\{ \left\langle v, \left\langle \left\{ \begin{array}{ll} \langle w, \boxed{\mathrm{Walt}(w)} & , \mathrm{BiCo}_{pr.na.} \rangle, \\ \langle t', & , \mathrm{BiCo}_{nlh.pr.} \rangle, \\ \langle t'', & , \mathrm{BiCo}_{adj.pred.ti.} \rangle \end{array} \right\} , \right. \right. \right. \right.$$

$$\left. \left. \left. \left. \boxed{\begin{array}{c} s'\ s'' \\ \\ t' \subseteq s' \\ t'' \subseteq s'' \\ s''\!: \text{'s}(w,y) \\ s'\!: \mathrm{rab}(y) \end{array}} \right\rangle\ ,\ \mathrm{BiCo}_{def.desc.} \right\rangle \right\} , \boxed{} \right\rangle$$

[41]This time I have given the condition that v is a rabbit in its time-dependent form. This is not because of a sudden concern with the possibility that what is a rabbit at one time need not be one at another, but to allow for greater transparency of the the process of temporal binding to which interpretation of the subject term of (24) gives rise: the time t'' of the prenominal possessive predication gets identified with the time t' of the predication expressed by the lexical head *rabbit*, while t' can be bound either to the location time of the corresponding event or to the utterance time n.

(1)

$$\left\langle \left\{ \left\langle y, \left\langle \left\{ \begin{array}{l} \langle w^p, \boxed{\text{Walt}(w^p)}\ , \ \text{BiCo}_{pr.na}\rangle, \\ \langle t^{p'}, \qquad\qquad , \text{BiCo}_{nlh.pr.t.}\rangle, \\ \langle t^{p''}, \qquad\quad , \text{BiCo}_{adj.pred.t.}\rangle \end{array}\right\}, \right.\right.\right.\right.$$

$$\left. \boxed{\begin{array}{c} s^{p''}\ s^{p'} \\ \\ s^{p''} \subseteq t^{p''} \\ s^{p''} \subseteq t^{p''} \\ s^{p''}: \text{'s}(w,y) \\ s^{p'}: \text{rab}(y)\end{array}} \right\rangle ,\ \text{BiCo}_{def.desc.} \Big\rangle \Big\} ,\ \boxed{} \Big\rangle$$

Conversion of the Binding Conditions of (38) according to the same principles that we applied to (36) gives rise to (41):

(41)

$$\boxed{\begin{array}{c} t''' \ t \\ t = t''' \quad t''' = n \\ \\ \left\{ \langle\{\langle \left\{ \begin{array}{l} \boxed{\begin{array}{c} w^p \\ \text{walt}(w^p) \end{array}}_{pr.na.} \\ \boxed{\begin{array}{c} t^{p\prime} \\ \\ \end{array}}_{nlh.pr.ti.} \end{array} \right\}, \boxed{\begin{array}{c} s^{p'}\ t^{p'}\ s^{p''}\ \underline{y^p} \\ t^{p'} \subseteq s^{p'} \\ t^{p''} \subseteq s^{p''} \\ t^{p'} = t^{p''} \\ s^{p'}: \text{rab}(y^p) \\ s^{p''}:' s(w, y^p) \end{array}}_{df.d.} \rangle\}\ ,\ \boxed{\begin{array}{c} t^p\ s^p \\ t^p \subseteq s^p \\ s^p\text{: o-t-l}(y^p) \end{array}} \rangle \right\} \\ \\ \langle\{\langle \left\{ \begin{array}{l} \boxed{\begin{array}{c} \underline{w} \\ \text{walt}(w) \end{array}}_{pr.na} \\ \boxed{\begin{array}{c} t' \\ \\ \end{array}}_{nlh.pr.ti.} \end{array} \right\}, \boxed{\begin{array}{c} s'\ t''\ s''\ \underline{y} \\ t' \subseteq s' \\ t'' = s'' \\ t'' = t' \\ s': \text{rab}(y) \\ s'':' s(w, y) \end{array}}_{df.d.} \rangle\}\ ,\ \boxed{\begin{array}{c} s \\ t \subseteq s \\ s\text{: o-t-l}(y) \\ t^p \prec t \end{array}} \rangle \end{array}}$$

The bracketing structure of this representation takes a while to unravel, so let me try to give an informal explanation. (To this end (42) repeats (41) in a schematic form, in which the different components of (41) have been replaced by labels K_1,..., K_8.)

(42)

$$
\boxed{
\begin{array}{c}
\mathrm{t}^3 \;\; \mathrm{t} \\
\mathrm{t} = \mathrm{t}^3 \quad \mathrm{t}^3 = \mathrm{n} \\
\left\{ \left\langle \left\{ \left\langle \left\{ \begin{array}{l} \boxed{K_7}_{\,pr.na.} \\ \boxed{K_8}_{\,nlh.pr.ti.} \end{array} \right\}, \boxed{K_6}_{\,def.desc.} \right\rangle \right\}, \boxed{K_5} \right\rangle \right\} \\
\left\langle \left\{ \left\langle \left\{ \begin{array}{l} \boxed{K_3}_{\,pr.na.} \\ \boxed{K_4}_{\,nlh.pr.ti.} \end{array} \right\}, \boxed{K_2}_{\,def.desc.} \right\rangle \right\}, \boxed{K_1} \right\rangle
\end{array}
}
$$

The non-presuppositional part of (42) is the DRS K_1; all else is presupposition. The top part of the diagram in (42), consisting of $K_5 - K_8$, represents the presupposition generated by *again*. The non-presuppositional part of this presupposition is K_5; it is preceded by a single presupposition whose non-presuppositional part is K_6. K_6 is in turn preceded by a set consisting of two presuppositions, K_7 and K_8. The *again*-presupposition as a whole is attached to the structure consisting of K_1 – K_4, which contains additional presuppositions, given by the part consisting of K_3, K_4 and K_2. The structure consisting of K_1 – K_4 mirrors that of the *again*-presupposition: It assigns to K_1 a single presupposition, whose non-presuppositional part is K_2, preceded by the pair of presuppositions K_3 and K_4.

What is to be done with the presuppositions of (41)? Let us assume once more that (24) has been uttered in a situation in which the hearer's context is initially empty. In such a situation all presuppositions need accommodation, except for those connected with the predication times t' and $t^{p\prime}$. To see what representation will result when the remaining presuppositions are accommodated, we need to reflect on the justification principles for presuppositions generated by proper names and by definite descriptions.

First the presuppositions associated with w and with w^p. Though we are now dealing with two presuppositions connected with *Walter* rather than one, justification of these presuppositions (whether by direct verification or accommodation) must nevertheless be to a single individual which the context contains (or is assumed to contain). This requirement is a reflection of the now generally acknowledged fact about proper names that they do not refer through unique satisfaction of descriptive content, but by some other 'direct' reference mechanism. Given this constraint, we can be sure that the two eventualities of a rabbit being on the loose, the asserted one and the presupposed one, concern the same proprietor Walter.

The second point has to do with the presuppositions for y^p and y. In the context of this paper this point is of greater interest; and it is of greater interest precisely because the reference conditions for definite descriptions are different from those for proper names. Definite descriptions need not refer directly, but can also refer via unique satisfaction of their descriptive content (usually within some contextually demarcated domain).

For the two representations derived from the definite description *Walter's rabbit* that are contained in (41) the effect of descriptive reference is connected with the Binding Conditions of the predication times t' and $t^{p\prime}$ As we observed earlier, the presuppositions connected with t' and $t^{p\prime}$ can be 'internally' resolved, by identifying these variables with times represented within the preliminary representation itself. In fact, when discussing the 'narrow scope' interpretation of (25) I claimed that identification with the location time of the main eventuality was something of a default strategy for such predication times. In the setting presented by (41), however, it isn't entirely clear what this comes to. For t' only one internal identification is possible, that with the location time t. But what are the options for $t^{p\prime}$?

As far as I can judge, there are two possibilities in this case, (i) identification with t and (ii) identification with the location time t^p of the presupposed eventuality.[42] The possibility that is of special interest is identification with t^p. This identification has the effect that the two representations deriving from the subject NP have distinct descriptive contents - the one which contains t'' being to the effect that the rabbit in question is Walter's now while the one containing $t^{p\prime}$ is to the effect that the relevant rabbit was Walter's at the time t^p of the presupposed eventuality s^p. This difference in descriptive content makes it possible for the two representations to determine different denotations, (i) Walter's present rabbit and (ii) the rabbit Walter had at the earlier time t^p. Thus we get the effect that on the wide scope reading of *again* (24) can be understood as involving two distinct rabbits. In this (24) resembles what we saw in connection with the wide scope reading of (25), but the analyses that the two examples have been given here should have made it clear that the way in which this possibility arises for (24) = (35) is significantly different from the way in which it arises for (25).

It follows from what has been said that the wide scope reading is also compatible with the scenario of a single rabbit that has escaped twice. In fact, this compatibility can take different forms. First, the identification of $t^{p\prime}$ with t^p does not exclude the possibility of a single rabbit. If, as a matter of fact, Walter

[42]This gives a maximum of 6 options in toto, 2 for t' times 3 for $t^{p\prime}$. The two options for t' — identification with t and identification with n — come to the same thing in this case, and the same is true of two of the three options for identifying $t^{p\prime}$ — with t and with n. As a matter of fact, I don't believe that all six options are admissible. It is well-known, in particular from the work on ellipsis, that the interpretation of duplicates (such as the one that was created in representing the *again*-presupposition in (41)) is generally subject to stringent parallelism constraints. Parallelism seems to play a role in the case before us, in that an utterance-time-bound interpretation of one of the duplicates requires the same binding for the other duplicate. With this constraint only three options remain of the original six. A further possible option — but it is one of which I am not sure that it really exists — is that where both t' and $t^{p\prime}$ are identified with t^p.

has had only one rabbit throughout the period which includes both the presupposed eventuality and the asserted one, then that rabbit will be the unique satisfier of both descriptions. Moreover, the options for resolving t' and t^p as both identified with t or n also lead to a unique rabbit, though this time as a matter of semantic necessity rather than real world contingency. For each of the two combinations: $t' = n$, $t^{p\prime} = n$, $t' = t$, $t^{p\prime} = t$[43] leads to identical descriptive contents for the two duplicates (according to either the denotation must be Walter's at n).

Note that there is nevertheless an important difference between these last two options and the one discussed above. The last two allow for the possibility that the rabbit in question wasn't Walter's at the time of the presupposed state of having escaped. (E.g. the rabbit first belonged to Susie and drove her nuts by its habit of getting out of its compound. So she gave it to Walter. But now the rabbit has done it again.)

There remains one further possibility, mentioned at the end of footnote 42: both t' and $t^{p\prime}$ are identified with t^p. This option would entail that the unique rabbit involved in both escapes was Walter's at the time of the first, but need not be his any longer now. While I think that there are contexts in which (24) allows for such an interpretation, I am uncertain that the interpretation strategy under discussion is really involved there. For if the context contains explicit information about an earlier escape by a rabbit of Walter's, then the NP *Walter's rabbit* might also be interpreted as anaphoric to the rabbit to which that information points.

This last observation shows how extraordinarily flexible interpretation is even for so simple a sentence as (24). Not only do we have to reckon with the possibilities which have been explicitly discussed in this section. As soon as definite descriptions come into play, we have to worry in addition about the possibilities that arise when these are interpreted as trans-sententially anaphoric. (And similar additional options are likely to arise for sentences containing other types of anaphoric expressions.) Thus there is at least one moral we can draw from this exploration of the principles of presupposition computation. That natural languages contain a very large amount of lexical ambiguity is by now a commonplace. Computational linguists have often and rightly stressed that this constitutes one of the principal challenges for a computationally viable account of compositionality. The experience with syntactic parsing has shown, moreover, that the ambiguity problem for parsers which operate on the basis of syntactic information only is hardly less daunting. What we have seen in this section suggests that at the level of semantics the range of structural ambiguities is very considerable as well, and significantly larger than some of us suspected. In the light of this the ability of human interpreters to understand what others are trying to understand them seems an even greater marvel than

[43] For the range of options see the previous footnote. As a matter of fact, even the options which were excluded there, will all lead to the same conclusion as the two options considered in the text. In particular, the dubious option: $t' = t^{p\prime} = t^p$ would lead to a single rabbit.

the one we knew it to be already. Formulating and implementing algorithms which emulate this extraordinary ability is, it seems to me, the central problem which computational linguistics has to solve. It is among the tasks of linguistic theory to identify the multiple ways in which ambiguities arise and the different forms they take. But that, surely, is only the lesser part of the story.

5 Conclusion

In more than one way this paper is just a beginning. In the light of all that has been said about presupposition over the past thirty years and the progress that has been made especially during the past decade, this may seem an odd thing to say. In fact, I hope I have managed to make clear to what extent the theory sketched here builds on what has been accomplished in the course of those many years by others. Nevertheless, the analyses presented in this paper cannot pretend to more than being pointers in a certain direction. Even if one assumes that the direction is right, it will have become evident that much more will have to be done before the sketch that has been offered here could be called a theory.

Such a theory should offer, for a non-trivial, well-defined part of at least one natural language that includes a fair sample of different types of presupposition triggers: (i) a general account of syntactic structure; (ii) a general definition of the "syntax" (i.e. the possible forms) of preliminary representations; (iii) a formulation of the rules which enable us to construct preliminary representations from syntactic structures; and (iv) the principles which guide and constrain the justification of (the presupposition of) preliminary representations in context. Particularly urgent is a detailed articulation of the different Binding Conditions, which in the examples presented here only appear as labels, accompanied at best by informal descriptions of the actual binding rules they stand for. (This of course is a task which concerns not just the theory of presupposition computation I have outlined, but the over-all account of the syntax-semantics interface in which the theory is embedded.)

In addition, semanticists of a model-theoretic persuasion may want to see a formal semantics for the structures that are postulated by the account of presupposition I have sketched, in the first place for the preliminary representations, and, if possible, also for the node representations which arise in the course of building the preliminary representation from the syntactic analysis of the sentence. Unfortunately, the possibility of such a semantics is limited. To define a syntax of preliminary representations (for some reasonable fragment of English), which characterises them as the expressions of a given representation formalism (or as data structures of a certain form) is not too difficult. Moreover, for those preliminary representations (according to such a syntax) in which all presuppositions appear in the highest possible position (so that their local context coincides with the global context of the entire sentence) an intuitively plausible model-theoretic semantics can be stated without too much difficulty. But for representations with presuppositions in subordinate positions I haven't yet been able to find a satisfactory semantics, and I very much doubt that one is to be had. Similar obstacles stand in the way of a plausible model theory for the node representations with which syntactic trees are decorated in the course of representation construction.

¿From a computational perspective this does not appear as a serious drawback. For the justification of presuppositions has to be subject in any case to rules which we can't expect to be derivable from the model-theoretic values of preliminary representations. (For instance, these rules must distinguish between the justification of "anaphoric" and that of "non-anaphoric" presuppositions. It is hard to see how such a difference could be recovered from the semantic values that are assigned to anaphoric and non-anaphoric presuppositions). But on the other hand there are many more computational issues that have to be addressed before a theory of the kind I have outlined can be of practical use to computational linguistics. To name just one such issue: The theory of presupposition will have to be integrated into a general theory of underspecified representation. I mention this matter, as it is one to which a fair amount of thought has already been given, for even in this case we are still at a considerable distance from seeing our way through to a systematic solution. Other computational questions, e.g. those which have to do with the kind of inferences used in anaphora resolution and in presupposition justification generally, haven't made it to centre stage yet. But we may be sure they are waiting in the wings.

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