Ups and Downs in the Theory of Temporal Reference

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1 Purpose and Framework

This paper proposes an algorithm which computes the temporal aspects of the interpretations of a variety of German sentences. The algorithm is strictly modular in the sense that it allows each meaning-bearing sentence constituent to make its own, separate, contribution to the semantic representation of any sentence containing it. The algorithm is to be seen as part of a larger one which computes all aspects of semantic representation, non-temporal as well as temporal ones.

The semantic representation of a sentence is reached in several stages. First, an 'initial semantic representation' is constructed, using a syntactic analysis of the sentence as input. This initial representation is then transformed into the definitive representation by a series of transformations which reflect the ways in which the contributions from different constituents of the sentence interact. In this paper it is the temporal interactions on which we focus.

Since the different constituents which make their respective contributions to the meaning of the sentence are in most instances ambiguous, the initial representations are typically of a high degree of underspecification. Usually these ambiguities can be resolved in the context provided by the sentence as a whole. But to resolve them we have to start from a sentence representation which identifies this context. This representation must have the form of a semantic representation, but it must be one in which the ambiguities are yet to be resolved, thus it will be an 'underspecified' representation.

The framework we will be using is that of UDRT (Underspecified Discourse Representation Theory). The general implications of this are, we take it, known well enough: To construct the semantic representation of a sentence one first establishes, on the basis of an underlying syntactic representation of the sentence in question, an Underspecified Discourse

Representation Structure (UDRS), and this representation is then transformed into a succession of less ambiguous representations. In the ideal case the final result of these transformations is a semantic representation of the sentence which is free of ambiguity (a Discourse Representation Structure, or DRS), but there are also cases where certain ambiguities cannot be eliminated, so that the end product of the transformations is still a UDRS (though usually one of a lower degree of ambiguity than the initial UDRS). Sometimes the remaining ambiguities are eliminable in the wider context of the discourse to which the sentence belongs or the external conditions under which the sentence is used. Important for what we will propose is also that UDRSs have the form of partially ordered sets of DRS-like component representations.

The choice of UDRT as a general framework does not entail much by way of commitments to the details of how exactly the interpretation of temporal expressions should be handled. A decade of experience with underspecification has made us increasingly alert to the fact that ambiguity comes in many different forms and that for each new type of ambiguity both its representation and the mechanisms for resolving it present a challenge that has to be met in its own way. We have found this to be true also for the temporal aspects of meaning which are the theme of this paper: The problems connected with the representation and resolution of time-related ambiguities differ significantly from others, and in particular from those for which UDRS-based proposals have been around for some time (certain scope ambiguities, certain lexical ambiguities, collective-distributive ambiguities and more. See [55], [66], [56], [35] [31].)

The representation-disambiguation algorithm that is proposed in this paper thus looks quite different from earlier proposals we have made for the ambiguity types just mentioned. The mode of underspecified representation that we will present, and the form of the resolution mechanisms connected with it, are shaped to a large extent by the assumption that different elements of temporal interpretation get introduced in different places in the initial representation, but must nevertheless be connected with each other in order that the intended temporal relations can be established. The most salient instance of this problem concerns the connection of the information contributed by the tenses and that which is associated with the lexical verbs which bear them. We assume that a lexical verb introduces a representation of the eventuality (state or event) it is being used to describe while its tense introduces information which serves to locate the eventuality within some temporal frame and that the bits of information that verb and tense introduce end up in different places of the initial representation. This separation can be seen as a reflection, at the level of initial semantic representation, of the familiar assumption in generative syntax that tense information is located at a node fairly high up in the syntactic tree (referred to in the literature variously as 'AUX', 'Infl', 'I' or 'T'), whereas the verb itself is found at some quite different node lower down. And just as it is assumed by many involved in current syntactic theory that the lexical contribution made by the verb and the information contributed by tense have to be brought into contact by movement (of the verb to the higher 'tense' node) in the course of constructing LF, so it is a central function of the temporal resolution mechanism we will present here to link the eventuality introduced by the lexical verb with the conditions introduced by its tense.

In the algorithm we present in this paper the temporal links that the resolution mechanism must establish are always between a 'lower' and a 'higher' UDRS-component (in the sense of the partial ordering of the UDRS). This has led us to adopt a form of initial representation of temporal information which makes use of two types of temporal variables, those which carry a requirement of linking with a temporal variable farther down (indicated by the downward arrow $\downarrow$) and those which must be linked with a variable higher up (indicated by the upward arrow $\uparrow$). The resulting notation is reminiscent of that used in Lexical Functional Grammar to compute F-structures from C-structures, though admittedly the analogy is not a deep one.

2 Ambiguity, Compositionality and Underspecification

When in the sixties Montague showed that many aspects of meaning in natural language are governed by general principles of compositionality, which determine how the meanings of syntactically complex expressions depend on the meanings of their constituents, this was a true revelation to many. Since then we have come to see compositionality as a property which natural languages possess as a matter of course, and which in fact they could not fail to possess given how people learn and use them. And much of the work within natural language semantics that has been done from that time onwards has followed Montague in trying to uncover the principles which govern the systematic, compositional relationship between meaning and syntactic form.

There is one aspect of the compositionality of natural languages, however, which much of this work has systematically neglected. Many of the ultimate meaning-carrying constituents of natural language sentences – the words and morphemes of which the sentences are made up – are ambiguous. Therefore, to interpret an incoming sentence S one must not only know the principles according to which the meanings of the ultimate constituents are integrated into the meaning of S, one must also be able to determine *which* of the different possible meanings of the ambiguous constituents are to be selected for integration into the meaning of S. In many contributions to natural language semantics of the past decades the focus has been on finding the compositional principles which yield the intuitively correct sentence meanings when applied to the 'right' word and morpheme meanings; how these 'right' meanings of the ambiguous words and morphemes are selected has usually been taken as given by fiat. A theory of this sort leaves it a mystery how language users normally succeed – effortlessly, it seems – in zeroing in on the correct interpretation of the sentences they hear or read.

It is clear that the linguistic knowledge a language user brings to this task consists of (i) knowledge that enables him to assign an incoming sentence a syntactic 'parse'; and (ii) knowledge that allows him to associate with each syntactically parsed sentence a representation of its meaning. Knowledge of this second kind is generally assumed to be of two sorts: (a) knowledge of the 'lexicon', i.e. of the meanings of the individual words and morphemes; and (b) knowledge of the 'compositional' principles which make it possible to construct a meaning representation for a sentence from its syntactic parse and lexically based information about its constituent morphemes and words. The lexicon will specify for each ambiguous word or morpheme the range of different meanings that tokens of it can have. So to arrive at the interpretation for a given sentence, the interpreter will have to select the intended meaning from the meaning ranges that the lexicon specifies for each of the ambiguous words and morphemes that the sentence contains.

In addition to the lexical ambiguities associated with their words and morphemes, many sentences are also the source of structural ambiguities – either ambiguities of the syntactic structure itself, or else ambiguities which arise when certain syntactic configurations are interpreted. (The best known examples of such structural ambiguities are scope ambiguities, which result when the syntactic structure of the sentence underdetermines the order in which the meanings of different sentence constituents are to be put together.) Structural ambiguities have been the subject of explicit attention in semantic theory, but here too the focus has been mostly on identifying what the possible readings of structurally ambiguous sentence types are, and much less on how the ambiguities between them are resolved when instances of those sentence types are used in actual contexts. As we now know, disambiguation is often the effect of the ways in which ambiguities from different sources, structural and/or lexical, interact.

When one looks into desambiguating interactions more closely, one notices that disambiguation depends as a rule on some kind of conflict – some form of incoherence or inconsistency – that renders an unwanted interpretation untenable. Most combinations of meanings for the ambiguous minimal constituents of a given sentence (and/or solutions to cases of structural ambiguity) lead to some such conflict, and hence, since they cannot lead to a viable interpretation, are filtered out. In many such cases the conflict takes the form of an inconsistency in the traditional sense of deductive logic, and perhaps it is possible to analyse all relevant kinds of conflict ultimately as inconsistencies in this sense. However, the kinds of inconsistencies that have been found to play this role tend to be quite special. In the light of this it seems a plausible assumption that human interpreters make use of special filtering mechanisms that are attuned to these particular kinds of inconsistencies, – mechanisms which are used to test for just that kind of inconsistency and which, presumably, can do that very efficiently. Similarly, it seems a reasonable working hypothesis in the context of designing computational systems for natural language interpretation that they should be equipped with purpose detectors that are attuned to just the inconsistencies of these special types.

It is in the more general context of developing a theory which deals simultaneously with the compositional synthetisation of meaning and the elimination of ambiguity that the proposals of this paper should be seen. As indicated in Section 1, these concern (a) novel representational devices, to be used both in initial sentence representations and in some of the representations into which the initial ones get transformed on the way towards the final representations; and (b) special mechanisms designed to operate on these novel representation components. We also mentioned in Section 1 that the mechanisms which operate on the initial representations not only serve to eliminate ambiguity but also must secure the correct 'binding' of the temporal variables which are introduced into the representation by various sentence constituents. Before we get down to showing the actual representations and transformation mechanisms in explicit detail, we want to say a little more about this 'binding' component of the theory, since it is crucial to the architecture we will be assuming. In particular, it is in its treament of the binding of temporal variables that the present treatment differs most strikingly from earlier proposals we have made ourselves for the treatment of temporal reference within the simpler setting of DRT, in which there are no provisions for the representation and subsequent elimination of underspecification. (See [34], Ch. 5.)

As will be explained in detail in Section 1, bits of temporal information get introduced into the initial sentence representation in different places, and must then be brought into contact with each other. In particular, the eventuality variables introduced by lexical verbs must be linked with the information introduced by tense, and some kind of linking or 'binding' mechanism is needed for this. As it stands, this may seem to have nothing to do with questions of disambiguation. But in fact, there is a close connection. For as we will see in more detail below, the temporal linking of eventualities can take different forms – it can be direct, as in a sentence like (1.a). But it can also be indirect, as in (1.b), where there is an interfering aspectual operator (the perfect); or as in (1.c) which contains a temporal quantifier (*oft*); or as in (1.d), where we find both.

(1) a. *Fritz rief an.*
"*Fritz rang*"

b. *Fritz hat angerufen.*
"*Fritz has rung.*"

c. *Fritz rief oft an.*
“*Fritz rang often.*”

d. *Fritz hat oft angerufen.*
“*Fritz has often rung.*”

In each of (1.b-d) the eventuality has to be linked directly to a time that is made available by the quantificational or aspectual operator; this operator is then linked in its turn to the tense information, and this link too may be either direct, as in (1.b) or (1.c), or indirect, as in (1.d).

Questions of linking become more intriguing in ambiguous sentences like (2), where the temporal adverbial *am Montag* can either be understood as referring to one particular Monday (during which Fritz rang many times), or as referring to different Mondays, all lying within the period over which *often* quantifies.

(2) *Am Montag rief Fritz oft an.*
“*On Monday Fritz often rang.*”

UDRT, in the form in which it will be used in this paper, serves on the one hand to provide unified treatments for sentences like those in (1) and (2). When such sentences are ambiguous, the UDRT formalism makes it possible to represent the ambiguity within a single UDRS; this UDRS can then be resolved to any of the DRSs which represent the different possible readings of the sentence. However, our choice of UDRT as theoretical framework is motivated not only by the structural ambiguities we find in sentences such as (1.d). As noted earlier, the most frequent source of ambiguity in natural language are lexical items and semantically relevant morphemes such as tenses. We turn to this kind of ambiguity in Section 5, which is devoted to the different possible interpretations of the German present tense, or *Präsens*. The Präsens has besides its use as a “genuine present”, which expresses overlap between the described eventuality and the utterance time n, also a prospective use, which situates the described eventuality in the future of n. (In this respect the German Präsens differs from the English present tense, which can be interpreted prospectively only under quite special conditions, exemplified by the so-called “time table” uses of sentences like *The train arrives at 10.14.*).

Here are some examples of the kinds of present tense sentences we will consider in Section 4:

(3) a. *Paulchen ist krank.*
‘Paulchen is ill.’

b. *Paulchen kommt.*
‘Paulchen comes.’

c. *Paulchen schreibt den Brief.*
‘Paulchen writes the letter.’

d. *Paulchen kommt morgen.*
‘Paulchen comes tomorrow.’

e. *Paulchen ist morgen krank.*
‘Paulchen is tomorrow ill.’

f. *Paulchen ist morgen gesundet.*
‘Paulchen is tomorrow cured.’

We conclude this section by listing some of the facts concerning the possible interpretations of these sentences which will be relevant to what we will have to say about them.

(i) (3.a), when used as a complete sentence on its own, only seems to have the interpretation that Paulchen is ill at the utterance time n. In contrast, (3.b) only has a prospective interpretation, according to which Paulchen will arrive at some time in the future of n, whereas (3.c) allows for both a prospective interpretation and one which locates the writing episode as overlapping with n. The ambiguitiy of (3.c) is apparently connected with the circumstance that German does not have an obligatory distinction between progressive and non-progressive forms. Because of this, simple tenses such as the present tense *schreibt* (*lit.: writes*) allow for both a progressive and a non-progressive interpretation, which English explicitly distinguishes through the use of the progressive or non-progressive form of the verb. The non-prospective interpretation of the Präsens in (3.c) goes hand in hand with the progressive interpretation of the verb phrase *schreib den Brief* (*lit.: write the letter*) while the prospective interpretation of the Präsens, which situates the writing episode after n, is linked to the non-progressive interpretation of the VP; moreover, there appears to be a preference for the first interpretation over the second. (In contrast, for (3.b), with its achievement verb *kommen*, the only possible interpretation appears to be the prospective one, presumably because progressive interpretations of German achievement verbs are hard or impossible to obtain.[1] This difference correlates with the familiar observation that in English progressive forms of achievement verbs describe periods which precede the events described by the non-progressive forms of those verbs.)

(ii) In (3.d)-(3.f) the presence of the adverb *morgen*, which denotes a period of time disjoint from n, forces a prospective interpretation. That such interpretations are not only possible but perfectly natural for these sentences is one proof of the easy accessibility of prospective interpretations for the German Präsens, as opposed to the English present tense: the English translation of (3.d) is very marked (if perhaps not outright ungrammatical), and the same goes for the English translations of (3.e) and (3.f) that we get by reversing the last two words of the given transliterations.

An interpretation theory which accounts for these facts must at a minimum accomplish the following:

(a) It must specify a lexical entry for the German Präsens which makes its different possible interpretations explicit, and specify how the interpretations specified in this entry are made available as prima facie options for the interpretation of German sentences in which the verb bears this tense form.

(b) It must specify a mechanism, or range of mechanisms, which is/are capable of disambiguating the lexical contribution made by the Präsens, so that only those alternatives which are considered possible by a competent speaker pass the filter which the mechanism or mechanisms impose.

As regards (b), it is clear from what has been said about the examples in (3) that the disambiguation mechanisms must do justice to at least two facts that our examples made visible: first, they must be able to "coerce" the correct interpretation by checking for compatibility between particular readings of the Präsens with constraints that are contributed by other parts of the sentence (e.g. the adverb *morgen* or the aspectual properties of an achievement verb such as *kommen*); second, the prospective and non-prospective interpretations of the Präsens must be treated as ranked,

[1] In order to express the progressive of a verb like *kommen* it is necessary to use paraphrases like *Paulchen kommt gerade.* (*lit.: Paulchen comes just*).

in the sense that the prospective interpretation is admissible only when the non-prospective interpretation is blocked; for it is only through such a ranking that we can account for the non-existence of a prospective reading for (3.a) and for the facts relating to (3.c). (3.c) is especially interesting in this connection insofar as it illustrates a general tendency to keep marked interpretations to a minimum. Given that non-progressive, non-prospective interpretations of present tense VPs like *schreibt einen Brief* are impossible (except when the present tense is used in some special way such as the reportive present, see Section 5), assigning a coherent interpretation to (3.c) requires that its tense form must be interpreted either as a progressive or as a prospective present. Both these possibilities exist (with as we noted some preference for the former option). It is very hard, however, (though not impossible) to get an interpretation for (3.c) which is prospective and progressive at the same time – i.e. to interpret as "Paulchen will be writing the letter".

The ambiguities of tense forms and the ways in which they are resolved in context present a vastly more complex issue than the few things we will say about the German Präsens can reveal – or, for that matter than is revealed by anything we have to say about tense in the entire paper. (For one thing there is nothing here about the complexities which we ourselves have tried to address in earlier work in terms of "temporal perspective" (see [34]) and that others have dealt with using kindred notions, such as e.g. the "topic time" in the work of W. Klein. (See in particular [39].) In these as in all other cases where we discuss particular sentences, words or morphemes, what we have to say is intended primarily as exemplary of the general approach the present paper advocates.

There is however a reason why we have singled out the German Präsens for special attention. On a first perusal, the Präsens may appear to be "ambiguous" to the point of imposing no constraints on interpretation at all: For any point t on the time axis – whether at or including the utterance time n, preceding n or lying in its future – it is possible to find German sentences in which the Präsens is used to express that a certain predication holds at t. Some have taken this as indicating that the temporal information conveyed by the Präsens is essentially empty (cf. e.g. [3]). A closer look, however, reveals that the conditions under which the Präsens can be used to refer to times other than those which include n are non-trivial and that they are by no means always satisfied.

This means that while it is true that the Präsens is "ambiguous" to a very high degree, that is an observation which can be no more than a point of departure. The real problem which the German Präsens presents us with is to state the conditions under which its different "meanings" are possible; and, to describe, on the basis of this articulation, the strategies which are used to arrive at those interpretations of German present tense sentences which speakers consider possible.

What goes for ambiguity and disambiguation of the German present tense, goes equally for much else in this paper. As we have come to see it, the principal challenge to semantic theory that virtually all sentences we discuss present is not so much that they have the meanings they have, but that it is just those meanings they have, and no others. To repeat, the real problem for semantics is not simply to account for why these and other sentences mean what they do mean, but also – and more so – why the don't mean what they don't. We ourselves feel this to be a real shift in perspective, and it is this, most of all, that we are anxious to get across.

2.1 What this paper doesn't do and what it does

As implied in the last paragraph, there is much that we do not do in this paper, although it is evident – to us as much as it will be to anyone else – that it will have to be done at some point.

Most importantly, we do not go in for large, or even moderate, coverage. We consider only a few of the German tense forms, few temporal adverbs, only one temporal preposition (*an*), and no temporal conjunctions (expressions such as *wenn* (*when*) or *während* (*while*) or temporal adjectives (such as *next*, *current*, *earlier* and the like); and our examples involve no more than a handful of lexical verbs, without a real effort to include instances of all the important aspectual patterns. It should be emphasised once more in this connection that the main thrust of this paper is not empirical. Of course it is as important for us as it would be for anyone that for those sentences that we do consider we have got the semantic facts right: what interpretations they can have and what interpetations they can't. But the *emphasis* lies in all cases on the methods of computing the right interpretations, while blocking the wrong ones.

Secondly, we do not explicitly specify a fragment of German – not even a toy one, with a lexicon consisting just of the words and morphemes which figure in our examples. (We suspect, though, that it should not be too difficult to define such a fragment, as long as we are content with syntactic structures of the expressions in the fragment that can do their job as inputs to the construction of semantic representations of the sort proposed here and do not insist on deep syntactic explanations.)

Thirdly, since there is no explicitly described fragment, there cannot be a fully explicit algorithm for the construction of semantic representations either. We have tried, however, to be as explicit as is possible within the given setting about those aspects of representation construction which are central to our present concerns: the introduction and subsequent unification of temporal variables. One section (Section 7) is devoted in large part to the formulation of the general principles which govern the kind of unification we are proposing, and which thereby constrain the conversion of UDRSs into DRSs.

When compared with all that will be needed to deal with the full range of temporal expressions in unrestricted text, the proposal of this paper is thus very modest. We have tried, however, to make our account reflect as closely as possible the modularity which we believe is one of the important features of how natural language works. In view of this we have good hopes that the theory we present here will prove quite robust. Even though it covers only a small part of the phenomena at present, it should be possible to extend its coverage by adding further modules rather than through wholesale revision.

The remainder of the paper is organised as follows. Section 3 introduces the basic principles of the construction algorithm. It explains the representation format of the preliminary UDRS representations and defines the unification algorithm that establishes the temporal links between 'lower' and 'higher' UDRS-components. Moreover, it looks at the interaction of temporal locating adverbs like *yesterday* or *on Monday* with adverbial quantifiers. For reasons of space the role of information structure (more specifically focus-background articulation, see e.g. [57], [58], [4]) which was discussed in considerable detail in an earlier draft of the paper is only mentioned (in Section 3). We refer the reader to the forthcoming [36]. Section 4 concentrates on the interaction of the perfect operator with tense as well as non-quantifying and quantifying temporal adverbs. Section 5 addresses the questions connected with the present tense mentioned earlier in Section 2. In Section 6 we discuss some of the more general issues concerning ambiguity, underspecification and disambiguation; and we extend the representation formalism of the preceding section with a new underspecification device, suited in particular for the representation of lexical ambiguities, among them the ambiguities of the German Präsens. Section 7 concerns the formal specification of the resolution algorithm for ups- and downs-variables and its place within comprehensive construction algorithm for semantic representations (from syntactic structures via UDRSs to DRSs). Section 8 compares our approach with other theories of tense and aspect.

3 Ups and downs

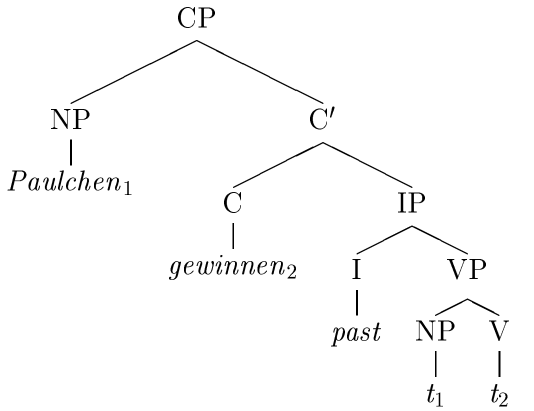
We proceed on the widely accepted assumption that main verbs serve to describe eventualities (that is, events or states) (cf. [34], Ch 5). Each main verb V of a clause introduces into the UDRS for that clause a variable ev (or discourse referent; we use the terms interchangeably in this paper) for the eventuality it is used to describe. Part of the information the sentence provides about ev will concern its location in time. This information may be contributed by various elements of the clause or sentence of which V is a constituent. One of these – but often it is not the only one – is the finite tense of V (assuming that V has finite tense). Other elements are temporal location adverbs (such as *yesterday* or *(on) Monday*), frequency adverbs (such as *often* or *never*) and aspectual operators like the perfect or the progressive. When more than one such element is present, the total location information about ev results from the ways in which the constraints imposed by these different sources interact. One of the aims of this paper is to specify these constraints in such a way that the interactions are predicted correctly.

As announced in Section 1, the framework within which we will formulate these specifications is that of UDRT (see [55], [56]). This entails that some of the principles which govern the interaction between the different constraints are principles constitutive of UDRT as such. But in addition we will need principles that deal specifically with the processing of temporal information. These principles are all concerned with the "management" of "temporal variables", i.e. variables which either range over eventualities or over instants and periods of time. An important part of this "temporal variable management" are the rules which govern the unification of two types of temporal variables, the "ups-variables", marked by an upwards pointing arrow, and the "downs variables", marked by an arrow pointing downwards. Since the ups- and downs-variables which are unified with each other always belong to different components of the initial UDRS, and unification entails merging of the UDRS components to which the unified variables belong, unification of temporal variables is an important factor in the transition from the initial UDRS to a specified representation (i.e. a DRS).

The basic case, from which the general unification procedure has been developed, is that of a simple tensed sentence like (4).

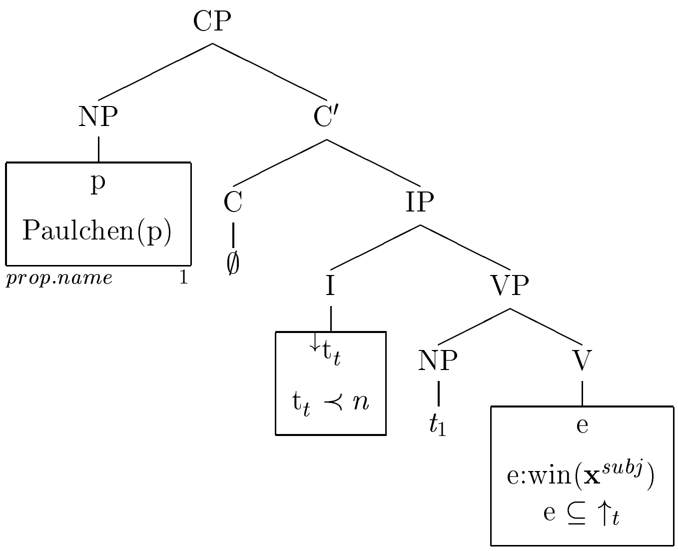
(4) *Paulchen gewann.*
"*Paulchen won.*"

We assume that the initial UDRS for this sentence (as for all other sentences) is constructed from a syntactic representation in which the information connected with tense is located at a node which is at some distance from the node of the lexical verb, and which dominates the latter (in the sense familiar from generative syntax; we adopt the somewhat old-fashioned terminology of I(NFL) to denote the former node, and refer to the latter as V). Suppose that (4) has the syntactic analysis given in (5).

(5)


The construction procedure will at first associate with the INFL node of this representation, with its V node and with its subject node, the part representations shown in (6). As said, the verb at V introduces a variable ev for the eventuality it describes, together with a variable $\uparrow_t$ for its location time and a relation between the two which captures the nature of the location ("ev $\subseteq \uparrow_t$" in case ev is an event and "$\uparrow_t \subseteq$ ev" in case it is a state (viz. [9], [61] and others)). (In the case of our example, where the verb is the event verb *gewinnen* (*win*), we get the relational condition "e $\subseteq \uparrow_t$", where e represents the event of Paulchen winning). INFL introduces a discourse referent $^{\downarrow}\mathrm{t}_t$ that is related to the speech point n. The downs-arrow indicates that this discourse referent is a potential binder for a variable of the type $\uparrow_t$ introduced by the verb at node V; we will come back to this shortly. In the present example the tense is the "Präteritum" (corresponding roughly to the English simple past) and the information connected with $^{\downarrow}\mathrm{t}_t$ is given by the condition "$\mathrm{t}_t \prec$ n", expressing that the time denoted by t_t lies before the utterance time n, which is given by the lexical entry for *past*. (We assume that this is the only "reading" which the entry for *past* specifies.) The proper name *Paulchen* contributes a part representation that is marked with *prop.name*. This representation is an abbreviation for a more complex set of conditions which capture the contributions which *Paulchen* and other proper names make to the sentences in which they occur. (This contribution involves, like the contributions of all other definite NPs, a presupposition that the referent can be identified in some appropriate way in the context in which the sentence is uttered.) In this paper we bypass the details and simply assume that the ultimate result of a name's interpretation is always representation at the highest possible level of the semantic representation (of the sentence, or the discourse of which the sentence is part).

(6)



Note that we have 'reconstructed' the verb into its base position by interpreting its argument (the subject NP *Paulchen*) at the site to which it has moved. This reflects the intuition that the predication whose predicate is the verb is always at the bottom of the UDRS into which such a decorated tree can be converted, whereas the surface position of argument phrases often indicates the scope relations in which they stand to other parts of the sentence, including in particular the verbal (or non-verbal) predicate of which they are argument phrases.

Independent of the question whether the verb and its arguments are interpreted in their base positions or the positions to which they have moved is the question of argument instantiation. Intuitively, it is clear that it ought to be part of integrating the different semantic components of (6) into a single representation for the sentence that the 'subject' variable $\mathbf{x}$ in the semantic representation of *gewinnen* is instantiated by the discourse referent p for the subject phrase. The instantiation of $\mathbf{x}$ by p rests on two bits of information: (i) the fact that the NP *Paulchen*, whose referent p represents, is the subject phrase of the sentence (and thus fills that argument slot of the verbal predicate which is syntactically realised as subject phrase); and (ii) the fact that the argument of *gewinnen* which is marked as $\mathbf{x}$ is to be filled by the grammatical subject of the sentence (in case the verb is used in the active voice; for details see [38] and [22]).

In (7) the part representations of (6) have been put together into a UDRS. The ordering between the components of this UDRS reflects the following principles: (i) the contribution made by the V constituent of the syntactic structure is ordered below the representation of each of the verb's arguments (here there is exactly one such, viz. the subject); and (ii) the information attached to I (and contributed by tense) is not below any other constituent in the order.[2] Note well that the edges of UDRS-diagrams like (7) represent a weak ordering: the upper one of the two components connected by an edge may end up in a genuinely higher position than the lower one in the final representation derived from the UDRS, but it is also possible for the two components to get merged. In the case of (7) this is what happens for both of its edges (see (8)).

(7)
$$\begin{array}{c} \mathrm{l}_\top: \boxed{\begin{array}{c} \mathrm{n}\ {}^{\downarrow}\mathrm{t}_t \\ \mathrm{t}_t \prec \mathrm{n} \end{array}} \\ | \\ \mathrm{l}_1: \boxed{\begin{array}{c} \mathrm{p} \\ \mathrm{Paulchen(p)} \end{array}} \\ \textit{prop.name} \\ | \\ \mathrm{l}_\perp: \boxed{\begin{array}{c} \mathrm{e} \\ \mathrm{e{:}gewinnen(p)} \\ \mathrm{e} \subseteq \uparrow_t \end{array}} \end{array}$$

The partial ordering of the components will constrain the possible unifications of the ups-variables $\uparrow_t$ and the downwards pointing discourse referents of the form ${}^{\downarrow}\mathrm{t}_t$. In the case at hand only one such unification is possible: $\uparrow_t$ must be unified with a matching variable ${}^{\downarrow}\mathrm{t}_t$ that is introduced by tense at INFL. Unification of ${}^{\downarrow}\mathrm{t}_t$ with $\uparrow_t$ yields the condition that the event e (of Paulchen winning) occurred at some time before the speech time. The downwards pointing arrow will be eliminated once the unification has been carried out. The final result is given in (8). (From now on we will for the most part limit ourselves to presenting stages in

[2]We will always assume that the discourse referent n representing 'now' is declared at the top level UDRS-component, i.e. belongs to the universe of this component.

the representation construction corresponding to (7), (8) and, when appropriate, intermediate stages between these, but refrain from showing fully or partially decorated syntactic trees.)

$$(8)\quad \boxed{\begin{array}{c} \text{n } \text{t}_t \text{ e p} \\[4pt] \text{Paulchen(p)} \\ \text{t}_t \prec \text{n} \\ \text{e:gewinnen(p)} \\ \text{e} \subseteq \text{t}_t \end{array}}$$

N.B. As usual in UDRT, the components of the UDRS (7) have each been given a label. $l_\top$ and $l_\bot$ are used to label the highest and the lowest component of the UDRS, respectively; this implies that all components stand in the relation $\leq$ to $l_\top$ and in the relation $\geq$ to $l_\bot$. Further processing of a UDRS will often have the effect that its partial order is strengthened. One instance of such a strengthening is the one triggered by the presuppositional feature *prop.name* of the part representation labelled l_1 in (7). This feature yields identification of l_1 with $l_\top$. Other instances are connected with the resolution of structural ambiguities, and in particular with those processing steps which involve unification of temporal variables. Thus the unification which leads from (7) to (8) above has the effect that the components labeled with $l_\top$ and $l_\bot$ are merged. (The given condition $l_\bot \leq l_\top$ is extended to the condition set $\{l_\bot \leq l_\top, l_\top \leq l_\bot\}$.) For details see [55] and Section 8 below.)

To go from (5) to (6) we need semantic specifications for each of the three "lexical items" occurring in (5) – the verb *gewinnen*, the Präteritum attached to INFL and the proper name *Paulchen*. We already mentioned that the ultimate result of a name's interpretation is always a representation of its bearer at the highest possible level. But we need to say something more about the lexical entries of the verb and the tense. A first, simplified entry for the verb *gewinnen*, which will be adjusted below under (13), is given in (9).

$$(9)\quad \textit{gewinnen} \quad \rightsquigarrow \quad \boxed{\begin{array}{c} \text{e} \\[4pt] \text{e:gewinnen}(\mathbf{x}^{subj}) \\ \text{e} \subseteq \uparrow_t \end{array}}$$

Here the bold face $\mathbf{x}^{subj}$ serves as a place holder for the argument of *gewinnen* which is supplied by the subject NP of the clause of which *gewinnen* is the main verb. The actual supplying takes place only when the representation of the verb is combined with that of the subject NP; at that point the place holder $\mathbf{x}^{subj}$ gets replaced by the discourse referent p which represents the subject's denotation.

For the three "simple tenses" of German – the Präsens (present tense), Präteritum (simple past) and Futurum (the simple future tense) we start by adopting the lexical entries in (10). According to (10) the Präteritum locates the eventuality described by its verb in the past of the utterance time n, the Präsens locates it as including n, and the Futurum as being located after n. Note well that these entries represent considerable simplifications of the semantic characterisations of these tenses that are needed to cover the full range of their possible uses; but they will do for our immediate purpose. (We will return to the semantics of the Präsens in Section 5, where we will adopt an entry that also covers those uses in which it refers to past or future times.)

(10)

$$\text{TENSE} = \quad \begin{array}{c} \textit{past} \\ \boxed{\begin{array}{c} {}^{\downarrow}\mathrm{t}_t \\ \mathrm{t}_t \prec n \end{array}} \end{array} \quad \begin{array}{c} \textit{pres} \\ \boxed{\begin{array}{c} {}^{\downarrow}\mathrm{t}_t \\ \mathrm{t}_t = n \end{array}} \end{array} \quad \begin{array}{c} \textit{fut} \\ \boxed{\begin{array}{c} {}^{\downarrow}\mathrm{t}_t \\ n \prec \mathrm{t}_t \end{array}} \end{array}$$

3.1 Temporal Unification and Temporal Locating Adverbs

(4) is an exceptionally simple sentence in that the information about the temporal location of the event e described by the verb comes from only one source, viz. the past tense. A first complication arises with sentences in which temporal location is further constrained by a locating adverb, such as *gestern* (*yesterday*) in (11):

(11) *Gestern gewann Paulchen.*
"Yesterday Paulchen won".

Construction of the semantic representation of (11) must do justice to the requirement that the time designated by the adverb imposes an additional constraint on the location of e.

There is more than one way in which one might think such adverbial constraints could be incorporated into the formalism we have developed so far, and we have no conclusive argument that the one we have chosen is the only one possible, or even that it will prove the best one in the end. Perhaps the first option that comes to mind is to identify the denotation of the adverb with the downs variable ${}^{\downarrow}\mathrm{t}_t$ contributed by tense. This, however, leads to problems in cases where a present tense combines with adverbs like *today*, *this week* etc., whose denotations include the utterance time but extend substantially beyond it. Given our characterisation of the present tense as contributing the condition "${}^{\downarrow}\mathrm{t}_t = \mathrm{n}$", this leads to a conflict if we assume that n represents the utterance time. For instance, it would force us to identify the utterance time of a present tense sentence containing the adverb *today* with the entire day on which the utterance is made. So, it would force us to give up the idea that n always stands for the utterance time in any natural sense of the term. More seriously this would prevent us from getting consistent interpretations for sentences like *Paulchen gewann heute.* ("Paulchen won today.") and *Paulchen wird heute gewinnen.* ("Paulchen will win today.") given the assumptions about past and future tense made in (10). The alternative would be to replace the condition "${}^{\downarrow}\mathrm{t}_t = \mathrm{n}$" introduced by the present tense by the weaker condition "$\mathrm{n} \subseteq {}^{\downarrow}\mathrm{t}_t$". But this second alternative has its unwanted consequences too. In particular, a present tense sentence like

(12) *Paulchen kommt heute.*
"Paulchen comes today."

will now be true as long as an event of Paulchen's coming is included within the day on which it is uttered. So, in particular, (12) is predicted to be true if Paulchen came on the day of the utterance time but preceding it, and that is clearly at variance with what (12) means.[3] In order to stave off these undesirable effects, other changes would have to be made. Although we are not absolutely certain that this is impossible, we do not know how it might be achieved, and in any case it is likely to alter the approach of this paper beyond recognition. We will therefore not

[3]Even worse, a present tense sentence without a temporal adverb, such as the simple *Paulchen kommt.*, would now impose no constraint on the time of Paulchen's coming whatsoever.

pursue the option identifying the time denoted by the adverb with that introduced by tense any further.

The considerations of the last paragraph also argue against accounting for the interaction beween tense and temporal adverb by letting each introduce its own downs variable, but to allow both to unify with the ups-variable $\uparrow_t$ introduced by the verb. For obviously that too would have the effect that the denotation of the adverb and ${}^{\downarrow}\mathrm{t}_t$ are identified.

The stratagem we have chosen to escape this predicament is to assume that the eventuality introduced by the verb comes with a double location requirement, the old requirement that its location be governed by tense, which we still represent by means of the ups-variable $\uparrow_t$, and a further location requirement, represented by a new variable $\uparrow_{loc}$. In sentences with temporal adverbs the unification requirement represented by $\uparrow_{loc}$ can be satisfied through unification with the downs-variable introduced by the adverb. In sentences without such adverbs $\uparrow_{loc}$ cannot be resolved in this way and in such cases the resolution will depend on the context in which the sentence is used.[4]

It is clear that in general $\uparrow_t$ and $\uparrow_{loc}$ should not be identified; for then we would be back with the difficulties explained above. However it will be assumed that they always stand in the relation $\uparrow_t \subseteq \uparrow_{loc}$. The intuition behind this is that $\uparrow_t$ is still to be considered as representing the location time of the discribed eventuality. $\uparrow_{loc}$ serves to identify the position of this location time along the time line more closely, by linking it to the interval which it ends up representing after unification.

We already saw that the relation between the eventuality ev and its location time depends on whether ev is an event or a state – if ev is an event, then ev $\subseteq \uparrow_t$, and if ev is a state, then $\uparrow_t \subseteq$ ev. Now that we have introduced $\uparrow_{loc}$, a similar question arises with regard to ev and it. For events the matter has already been settled by the assumptions we have made: ev $\subseteq \uparrow_t \subseteq \uparrow_{loc}$. But not so for states. In the literature on tense and aspect two proposals are prominent. According to the weaker one

[4]In the case of past tense sentences this requirement matches the intuition that such sentences tend to sound odd unless the context makes it possible to locate the described eventuality more closely. (Cf. the tendency to add "dummy adverbs" like *once upon a time* when no real restriction is intended. See [19] and [65].)

With future tense sentences this sense of oddity is not as strong. We suspect that this is connected with the modal dimension of the future. For present tense sentences there is a default resolution of $\uparrow_{loc}$ to n.

all that can be said in general about the relationship is that state and $\uparrow_{loc}$ overlap; according to the stronger one the latter is included in the former. A perusal of state-describing sentences with temporal adverbs shows that both possibilities occur. So what one would want eventually is a more refined theory, which distinguishes between those cases where inclusion holds and those where there is overlap but no inclusion. Such a theory is beyond the grasp of the present proposal. We have opted for the simplifying assumption that when ev is a state, then it always includes $\uparrow_{loc}$.

These assumptions are exemplified in the lexical entries for the event verb *gewinnen* (*win*) and the state verb *schlafen* (*be asleep*).

$$\text{(13)}\quad \textit{gewinnen} \rightsquigarrow \boxed{\begin{array}{c} \mathrm{e} \\ \hline \mathrm{e{:}gewinnen}(\mathbf{x}^{subj}) \\ \mathrm{e} \subseteq \uparrow_t \subseteq \uparrow_{loc} \end{array}} \qquad \textit{schlafen} \rightsquigarrow \boxed{\begin{array}{c} \mathrm{s} \\ \hline \mathrm{s{:}schlafen}(\mathbf{x}^{subj}) \\ \uparrow_t \subseteq \uparrow_{loc} \subseteq \mathrm{s} \end{array}}$$

(14) gives the entry for the adverb *gestern*.

$$\text{(14)}\quad \textit{gestern} \rightsquigarrow \left\langle \left\{ \boxed{\begin{array}{c} \mathrm{t}'\ \mathrm{t}'' \\ \hline \mathrm{day}(\mathrm{t}') \\ \mathrm{day}(\mathrm{t}'') \\ \mathrm{n} \subseteq \mathrm{t}' \\ \mathrm{t}'' \supset\!\subset \mathrm{t}' \end{array}} \right\}, \boxed{\begin{array}{c} {}^{\downarrow}\mathrm{t}^g_{loc} \\ \hline \mathrm{t}^g_{loc} = \mathrm{t}'' \end{array}} \right\rangle$$

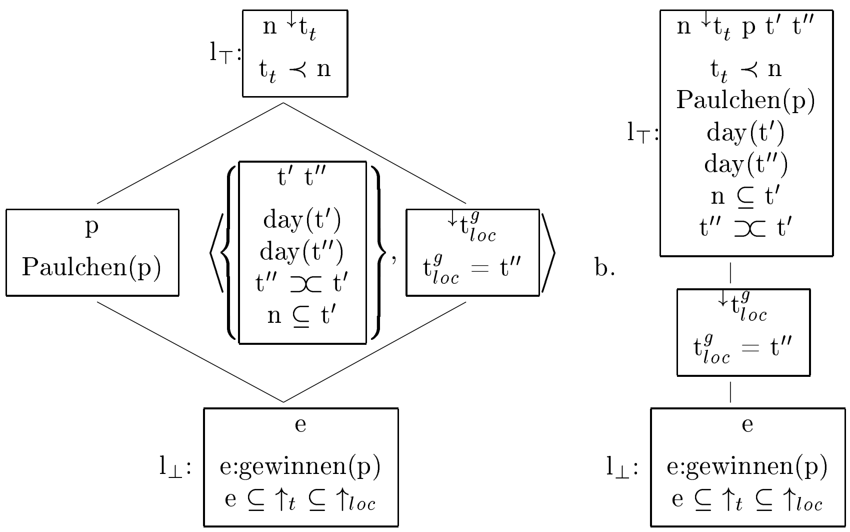
The component to the right is typical for the representations of temporal adverbials in general. This component introduces the downs-variable ${}^{\downarrow}\mathrm{t}^g_{loc}$ which in the case of (11) will unify with the $\uparrow_{loc}$ introduced by the verb *gewinnen*. It represents the time which is provided by the temporal adverb *gestern*. The use of *gestern* as an adverb must be distinguished from its uses as NP, as we find it e.g. in *Gestern war ein schöner Tag.* (Engl.: *Yesterday was a beautiful day*). We analyse the adverb *gestern* as a kind of prepositional phrase with silent preposition and an occurrence of *gestern* as NP which is governed by this preposition. The discourse referent t″ in (14) represents the referent of this NP, and the silent preposition expresses identity – much like the English temporal preposition *on* – and its contribution to (14) is the identity condition '$\mathrm{t}^g_{loc} = \mathrm{t}''$'.[5]

[5] Note that although the discourse referent t′ is declared in the universe of the presupposed DRS it will not be a possible antecedent for anaphoric expressions and

The component on the left in (14) is a presupposition to the component on the right. It is the presupposition which the NP *gestern* introduces in virtue of its being a definite noun phrase.[6] But it is a presupposition whose satisfaction is quasi guaranteed. An occurrence of *gestern* denotes the day immediately preceding the day on which the utterance is made. So the variable t'' representing this day will be uniquely determined provided the day t' is determined which it immediately precedes, and t' will be determined if and when the utterance time is n, which t' includes. If, as we have been assuming, every utterance determines its utterance time, then the presupposition of (14) will be invariably fulfilled. So the entry functions as if there was no presupposition and its contribution to the representations of sentences in which *gestern* occurs is the merge of its presuppositional and its non-presuppositional component.

In the same way as we derived (7) from the decorated syntactic structure of (6) of (4), we get for (11) the representation in (15.a), which after justification of the presuppositions of *Paulchen* and *gestern* turns into (15.b):

(15) a.



must therefore be classified as "implicit". Since this paper doesn't deal with questions of extra-sentential anaphora, we have made no effort to distinguish between anaphora-accessible discourse referents like t'' and non-accessible variables like t' (viz. [38]).

[6] We assume that every type of definite NP comes with a presupposition to the effect that its referent can be determined in the manner appropriate for that type (viz. [27], [28], [23], [22]).

Unification of $\uparrow_t$ with ${}^{\downarrow}\mathrm{t}_t$ and $\uparrow_{loc}$ with ${}^{\downarrow}\mathrm{t}^g_{loc}$ turns this UDRS into the DRS (16).

$$
(16)\quad
\begin{array}{|c|}
\hline
\mathrm{n}\ \mathrm{t}'\ \mathrm{t}''\ \mathrm{t}_t\ \mathrm{t}^g_{loc}\ \mathrm{e}\ \mathrm{p} \\
\\
\mathrm{Paulchen(p)} \\
\mathrm{t}_t \prec \mathrm{n}\ \ ;\ \ \mathrm{t}^g_{loc} = \mathrm{t}'' \\
\mathrm{day(t')}\ \ ;\ \ \mathrm{n} \subseteq \mathrm{t}' \\
\mathrm{day(t'')}\ \ ;\ \ \mathrm{t}'' \supset\!\subset \mathrm{t}' \\
\mathrm{e{:}gewinnen(p)} \\
\mathrm{e} \subseteq \mathrm{t}_t \subseteq \mathrm{t}'' \\
\hline
\end{array}
$$

Before we discuss quantifying adverbials let us point to a difference between the interpretation of frame adverbials like *gestern*, which do not include the speech time, and adverbials like *heute*, *diese Woche* etc., which do. Consider the sentence *Paulchen schlief heute.* This sentence is true iff Paulchen slept during the part of today which precedes n; there is no requirement that he goes on sleeping after the utterance time. But this is what our proposal would predict if *heute* is taken to refer to all of today. We therefore adopt a representation of *heute* according to which what it refers can vary and in particular is a function of tense. More precisely, we translate *heute* into a disjunction saying that either t^h_{loc} is included in the past part or in the future part of today, or that it includes the speech point. We represent this alternative meaning of *today* by means of an ambiguity operator, $\overset{!}{\vee}$, about which more will be said in Section 6.

$$
(17)\quad \textit{heute} \leadsto \left\langle \left\{ \begin{array}{|c|} \hline \mathrm{t}' \\ \\ \mathrm{day(t')} \\ \hline \end{array} \right\},
\begin{array}{|c|} \hline {}^{\downarrow}\mathrm{t}^h_{loc} \\
\begin{array}{|c|} \hline \mathrm{t}^h_{loc} \subseteq \mathrm{t}' \\ \mathrm{t}^h_{loc} \prec \mathrm{n} \\ \hline \end{array}
\ \overset{!}{\vee}\
\begin{array}{|c|} \hline \mathrm{t}^h_{loc} = \mathrm{t}' \\ \hline \end{array}
\ \overset{!}{\vee}\
\begin{array}{|c|} \hline \mathrm{t}^h_{loc} \subseteq \mathrm{t}' \\ \mathrm{n} \prec \mathrm{t}^h_{loc} \\ \hline \end{array}
\\ \hline \end{array} \right\rangle
$$

The intuition behind this entry is that *heute* refers to (i) a part of t′ before the speech point, (ii) all of today, or (iii) a part of t′ after the speech point. In cases (i) and (iii) its interpretation thus differs from that of *gestern* in that it refers only to a part of t′ and not to the whole past or future period of today.

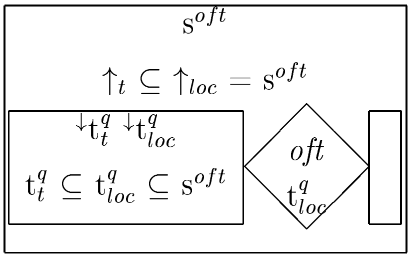
3.2 Temporal Quantifying Adverbials

Like the feature TENSE and locating adverbs, temporal adverbial quantifiers and aspectual operators such as the perfect (which will be discussed in Section 4) introduce binders for the ups-variables that are part of $l_{\perp}$. When several such binders are present within a given sentence, the question which of them will bind a given ups-variable will depend in part on the hierarchical relations between the components of the initial UDRS to which the sentence gives rise. Adverbial quantifiers such as *oft* (*often*) introduce their own components into the UDRS.[7] In our present treatment of *oft*, the central constituent of this component is a duplex condition whose middle component is the actual quantifier denoted by the adverb and whose restrictor and nuclear scope, on the left and the right, respectively, require filling with material that is to be supplied by the sentence (and, as regards the restrictor often, also by the context in which the sentence is used). This can be seen in (19), which gives the non-presuppositional part of the semantic representation that *oft* contributes to the UDRSs of the sentences in which it occurs. We further assume that *oft* introduces a "quantificational state" s^{oft}. This state is characterised by the condition that the quantification holds when restricted to its duration – more explicitly, the proportionality relation denoted by the quantifier should hold between the set of relevant satisfiers of its restrictor which lie within this duration and the set of satisfiers within the duration of its nuclear scope.

Note that the duration of a quantificational state is often completely specified by an accompanying adverb. For instance, the force of *gestern* in (20) is that it was the period it denotes, i.e. the day before that of the speech-time, which is characterised by the fact that Paulchen often won, and not some longer period including this day. For instance, if Paulchen had on the whole many wins during the past three days, but none or only very few of those took place yesterday, then (20) would count as false. This means that the temporal relation which we assume to hold generally between states and their location times, viz. that the latter are temporally included in the former, is insufficient for states of this particular, quantificational, sort. The best way to capture this further

[7] In this paper we only consider the interpretation of *oft* as proportional quantifier, ignoring its interpretation as "cardinality quantifier" (viz. [52]).

constraint is to require that the duration of a quantificational state be the same as $\uparrow_{loc}$. To this end we strengthen the condition "$\uparrow_t \subseteq \uparrow_{loc} \subseteq$ s^{oft}" to "$\uparrow_t \subseteq \uparrow_{loc} = s^{oft}$".[8]

(19) *oft* "often" $\rightsquigarrow$ 

,

(21) shows the stage of UDRS-construction for (20) before unification of ups- and downs-variables takes place.

---

[8]One problem with the condition "$s^{oft} \subseteq \uparrow_{loc}$" arises for sentences without temporal adverbs, such as *Paulchen rief oft an.* (Engl.: *Paulchen rang often.*). As we have set up the unification mechanism and the various constraints on temporal variables it would be possible for the sentence to get a representation in which s^{oft} straddles n and thus overlaps with the future as well as with the past. In that case the quantification expressed by *oft* would characterise a period that is not wholly in the past, with some of the relevant calls by Paulchen being future rather than past calls. Clearly such a situation is not covered by what the sentence says. In order to avoid this it must be stipulated that when $\uparrow_{loc}$ is not unified sentence-internally and thus requires resolution in context, it must be resolved to a period that is located wholly in the past when the corresponding $\uparrow_t$ is unified with a variable ${}^{\downarrow}t_t$ representing a past time (and analoguously for present and future tenses).

A similar problem arises for sentences in which a past tense combines with an adverb which denotes a period that contains n. Compare for instance (18.a) and (18.b):

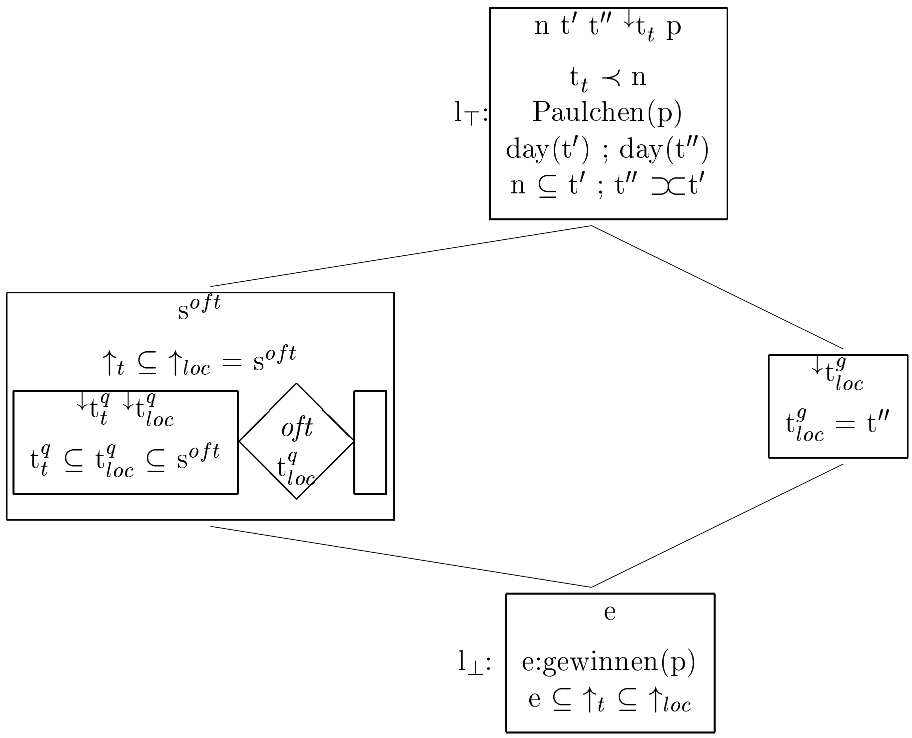
(18) a. *Heute rief Paulchen oft an.*
"*Today Paulchen often called.*"

b. *Heute ruft Paulchen oft an.*
'Today Paulchen often calls.'

(18.b) makes a statement about all of today. (18.a) differs in that it only speaks about the past part of *heute*, which lies before n – calls that Paulchen may make later today are irrelevant for its truth conditions. To get a correct representation of (18.a) the occurrence it contains of *heute* will have to be construed as referring to the part of today before n. If we take it as a general constraint on $\uparrow_{loc}$-resolution that the period it thereby comes to represent 'fits' the tense of the verb, then this constraint will block the default interpretation of *heute* as referring to the entire day which contains n. Some coercion mechanism would then be responsible for the 'past' part of today as back-up interpretation which is consistent with the mentioned constraint. (Cf. (17) and the remarks motivating it.)

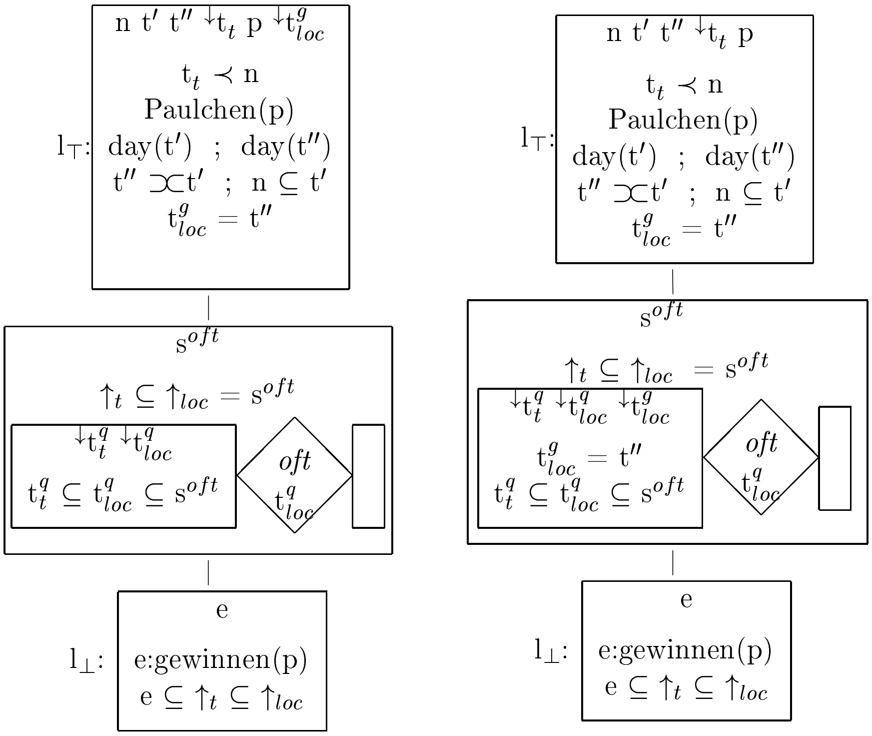
(20) *Paulchen gewann gestern oft.*
'Paulchen won yesterday often.'
"Yesterday Paulchen often won."

(21)



In (21) the presupposition of the part representation for the proper name *Paulchen* as well as the presupposition of *gestern* have already been justified and their contributions have been incorporated into the top level component $l_\top$. Instantiation of the ups- and downs-variables in (21) will produce a strengthening of the UDRS ordering, to the effect that the part representation containing the downs-variable ${}^{\downarrow}t^{g}_{loc}$ is either given wide or narrow scope wrt. the quantification. The left hand side in (22) represents the case where unification of ${}^{\downarrow}t^{g}_{loc}$ has not yet taken place but the adverbial contribution of *gestern* has been assigned wide scope; similarly, in the right hand side structure this contribution has been given narrow scope and moreover it has been assumed to contribute to the restrictor of the quantifier. We will discuss cases where an adverb contributes to the nuclear scope of a quantifier in [36].

(22)



As there is no structural ambiguity left in either of the representations of (22), the unification of the ups- and downs-variables is uniquely determined in each case. We start with the structure on the left hand side. The unification algorithm is most easily described as proceeding bottom-up. The ups-variables $\uparrow_t$ and $\uparrow_{loc}$ occurring in the bottom box must be matched with the first accessible downs-variables one encounters going up. In the structure on the left hand side of (22) the first accessible downs-variables are the ones declared in the restrictor of the duplex condition. Likewise the ups-variables in the representation of *oft* will be matched with the closest accessible downs-variables ${}^{\downarrow}\mathrm{t}_t$ and ${}^{\downarrow}\mathrm{t}^{g}_{loc}$. These instantiations yield the interpretation in (23), according to which all the winning events took place yesterday.

(23)

$$\boxed{\begin{array}{c} \mathrm{n}\ \mathrm{t}'\ \mathrm{t}''\ \mathrm{t}_t\ \mathrm{t}^g_{loc}\ \mathrm{p}\ \mathrm{s}^{oft} \\ \hline \mathrm{t}_t \prec \mathrm{n} \\ \mathrm{Paulchen(p)} \\ \mathrm{day(t')}\ \ ;\ \ \mathrm{day(t'')} \\ \mathrm{t''} \supset\!\subset \mathrm{t'}\ \ ;\ \ \mathrm{n} \subseteq \mathrm{t'} \\ \mathrm{t}^g_{loc} = \mathrm{t''} \\ \mathrm{t}_t \subseteq \mathrm{t}^g_{loc} = \mathrm{s}^{oft} \\ \boxed{\begin{array}{c} \mathrm{t}^q_t\ \mathrm{t}^q_{loc} \\ \hline \mathrm{t}^q_t \subseteq \mathrm{t}^q_{loc} \subseteq \mathrm{s}^{oft} \end{array}} \ \left\langle \begin{array}{c} oft \\ \mathrm{t}^q_{loc} \end{array} \right\rangle \ \boxed{\begin{array}{c} \mathrm{e} \\ \hline \mathrm{e{:}gewinnen(p)} \\ \mathrm{e} \subseteq \mathrm{t}^q_t \subseteq \mathrm{t}^q_{loc} \end{array}} \end{array}}$$

The structure on the right hand side of (22) is different in that there are two possible binders, ${}^{\downarrow}\mathrm{t}^q_{loc}$ and ${}^{\downarrow}\mathrm{t}^g_{loc}$, for the ups-variable $\uparrow_{loc}$ occurring in the bottom box. Where two ${}^{\downarrow}\mathrm{t}_{loc}$-variables belong to the universe of the same compound of the representation the unification requirements may be satisfied by identifying them both with the same $\uparrow_{loc}$-variable.[9] For the case of (23) this results in the identification of ${}^{\downarrow}\mathrm{t}^q_{loc}$ and ${}^{\downarrow}\mathrm{t}^g_{loc}$, as shown in (24). (We record the identification by adding the condition "$\mathrm{t}^q_{loc} = \mathrm{t}^g_{loc}$" to the DRS whose universe contains the two downs-variables, rather than by replacing one of them by the other.)

(24)

$$\boxed{\begin{array}{c} \mathrm{n}\ \mathrm{t}'\ \mathrm{t}''\ \mathrm{t}_t\ \mathrm{p}\ \mathrm{s}^{oft} \\ \hline \mathrm{t}_t \prec \mathrm{n} \\ \mathrm{Paulchen(p)} \\ \mathrm{day(t')}\ \ ;\ \ \mathrm{day(t'')} \\ \mathrm{t''} \supset\!\subset \mathrm{t'}\ \ ;\ \ \mathrm{n} \subseteq \mathrm{t'} \\ \mathrm{t}_t \subseteq \uparrow_{loc} = \mathrm{s}^{oft} \\ \boxed{\begin{array}{c} \mathrm{t}^q_t\ \mathrm{t}^q_{loc}\ \mathrm{t}^g_{loc} \\ \hline \mathrm{t}^q_t \subseteq \mathrm{t}^q_{loc} \subseteq \mathrm{s}^{oft} \\ \mathrm{t}^g_{loc} = \mathrm{t''} \\ \mathrm{t}^q_{loc} = \mathrm{t}^g_{loc} \end{array}} \ \left\langle \begin{array}{c} oft \\ \mathrm{t}^q_{loc} \end{array} \right\rangle \ \boxed{\begin{array}{c} \mathrm{e} \\ \hline \mathrm{e{:}gewinnen(p)} \\ \mathrm{e} \subseteq \mathrm{t}^q_t \subseteq \mathrm{t}^q_{loc} \end{array}} \end{array}}$$

[9] This possibility only exists for variables of type 'loc'. For variables of type 't' unification is always one-to-one. See Section 7 for details.

Note that the identification of t^q_{loc} with t^g_{loc} results in a violation of a familiar principle, to which we will refer as *quantificational variety.* The identification of the quantified variable t^q_{loc} with the discourse referent t^g_{loc} representing *gestern* restricts the possible values of the quantified variable to a single one, viz. the day preceding that of the utterance time. Such quantifications are odd. The conditions in the restrictor ought to be weak enough to make it possible for the quantified variable to adopt more values than just one. (24) is ruled out because it violates this principle.

> (Principle of Quantificational Variety)
> Natural language quantifications presuppose that their restrictors do not entail that they can be satisfied by at most one value for the quantified variable.[10]

3.3 A Scopally Ambiguous Locating Adverb: *am Montag*

In contrast to *yesterday* locating adverbials like *am Montag* can be interpreted as contributing to the restrictor of a quantificational adverb without contradicting the priciple of Quantificational Variety. Consider (25).

(25) *Paulchen gewann am Montag oft.*
‘Paulchen won on Monday often.’

Besides a reading which corresponds to the interpretation (23) of (20) – on the particular Monday referred to by the phrase *am Montag* there were many occasions when Paulchen won – (25) also has an interpretation in which *am Montag* has narrow scope with respect to the frequency adverb *oft*. On such an interpretation the period of time over which the quantification expressed by *oft* ranges – i.e. the period of time we have indicated in (19) as $\uparrow_{loc}$ – must be one within which the adverbial *am Montag* can pick out more (preferably substantially more) than one

[10] This formulation is somewhat loose in so far as we do not say exactly what is meant by “entail” here. In the case at hand it is intuitively clear what a case of entailment we are dealing with: the condition $t^q_{loc} = t'$, where t' is bound outside the duplex condition clearly entails that t' is the only possible value for t^q_{loc}, on any reasonable definition of entailment.

referent; in other words, s^{oft} should include several different Mondays. Exactly what interpretation (25) gets in case *am Montag* is taken to have narrow scope wrt. *oft* will then still depend on further factors, which have to do with information structure. Taking *am Montag* to be the focus of the clause will give rise to the interpretation that within the period denoted by s^{oft} many of the occasions when Paulchen won were on a Monday. In this case the condition of there being an event e of Paulchen winning within t^q_{loc}, where t^q_{loc} is the variable bound by the quantifier expressed by *oft*, will be part of the restrictor of the quantifier, and the condition that e occurred on the Monday within t^q_{loc} will constitute the nuclear scope. (This interpretation implies that the quantification is over periods t^q_{loc} each of which contains exactly one Monday, e.g. over calendar weeks.)[11] A second interpretation with narrow scope of *am Montag* is that within s^{oft} there were many Mondays on which Paulchen won. In this case the information that the time was a Monday is in the restrictor and the information that it was the time of an occasion when Paulchen won is in the nuclear scope. Our discussion of (25) will focus on the last of the three readings mentioned, in which *am Montag* becomes part of the restrictor of *oft* and the verbal predication part of its nuclear scope. We will ignore the other narrow scope interpretation for *am Montag* as well as the role of information structure in deciding between that interpretation and the one we will consider. These issues will be discussed in [36].

The possibility of narrow scope interpretation of *am Montag* is due to the fact that the presupposition of the definite NP *der Montag* allows for a reading that depends on the value of the quantified variable. We adopt the "neo-classical" treatment of singular definite descriptions according to which each description comes with an existence-and-uniqueness presupposition (cf. [29], [32], as well as the hints in [34], Ch. 3). This account can be called "neo-classical" in that it adopts the existence-and-uniqueness presupposition familiar from the logical and philosophical literature from Frege to Donnellan, Kripke and beyond, but with the proviso that the descriptive content for which the presupposition requires

[11] The reading just described is a little easier to get when *am Montag* is at the end of the sentence, as in *Paulchen gewann oft am Montag.*. This is in keeping with what we know about the way in which focus is realised in German (as well as, in this case, in English). To get this reading for (25) itself seems to require special stress on *am Montag*; again this is consistent with what is known about focus realisation.

unique instantiation is reinforced by an additional constraint C(x), where x represents the unique satisfier and C is a predicate variable which must be resolved in context. C serves to delimit the set within which the unique satisfier is to be found and thus allows for satisfaction of the uniqueness condition in many cases where definite descriptions are intuitively acceptable, but where the explicitly given content of the description allows for more instances than one. The requirement that C be resolved in context is assumed to take the form of a secondary presupposition, which represents C as an "anaphoric" element for which a value in context is to be found. It should be noted that our analysis of the way in which definite descriptions denote agrees with the classical one in that the presupposition is "purely propositional". This means that there is no need for stipulating identity between any of the discourse referents occurring in this presupposition and the discourse referent representing the referent of the description in the non-presuppositional part K_{Ass} of the representation. For when the restricting predicate C is resolved in such a way that the existence-and-uniqueness presupposition is satisfied, then the referent of the description is the unique satisfier within the extension of C. This means, however, that the information that the referent satisfies C should also be part of K_{Ass}. In other words, the discourse referent x representing the referent in the non-presuppositional part must be accompanied by the condition "C(x)" which expresses this.

When a definite description is time-denoting, the restricting predicate often takes the form of determining temporal bounds within which the descriptive content is uniquely instantiated. In the case of the description *der Montag* this frame must be large enough to include a Monday, and it must not be in excess of 13 days, for then it would contain at least 2 Mondays and hence not a unique one. In typical cases it will be something like a week. In the 'lexical entry' for the phrase *der Montag* given in (26) we have accounted for this special, frame-like character of the restricting predicate C by representing it as the temporal inclusion predicate '... $\subseteq \mathrm{t}^m_{fra}$'. The presuppositional status of C is captured by the further condition '$\mathrm{t}^m_{fra} = \uparrow_{loc}$', since $\uparrow_{loc}$ comes with the requirement of sentence-internal or -external resolution. In the existence-and-uniqueness presupposition of *der Montag* the variable t' plays the role of t^m and is therefore also constrained by the condition "$\mathrm{t}' \subseteq \uparrow_{loc}$ ". We have also built into the presupposition a further constraint on t^m_{fra}, viz. that it must include other days besides the unique onday which the predicate *Montag* selects from it. This condition reflects the intuition that a natural use of *der Montag* is one in which the predicate *Montag* is made to do some real work in selecting the referent – so that it wouldn't have done, in relation to the given t^m_{fra}, to use e.g. *an dem Tag* ("on that day") to pick out the Monday one means to refer to. (It is this, we believe, that accounts for the intuition that when *am Montag* is given a narrow scope interpretation, then the *oft*-quantification must be over something like weeks.)[12]

The contribution of *der Montag* as we have just ascribed it can be cast in the form shown in (26).

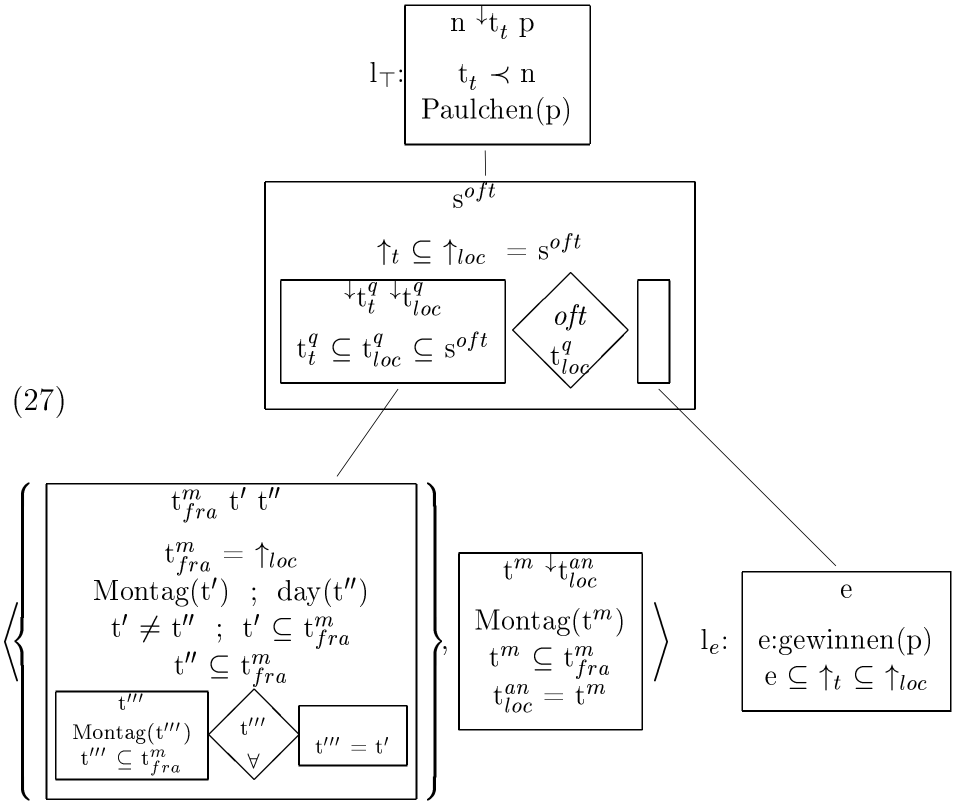
$$(26)\quad \textit{der Montag} \rightsquigarrow \left\langle \left\{ \begin{array}{|c|} \hline \mathrm{t}^m_{fra}\ \mathrm{t}'\ \mathrm{t}'' \\ \mathrm{t}^m_{fra} = \uparrow_{loc} \\ \mathrm{Montag}(\mathrm{t}')\ \mathrm{day}(\mathrm{t}'') \\ \mathrm{t}'' \neq \mathrm{t}' \\ \mathrm{t}' \subseteq \mathrm{t}^m_{fra}\ ;\ \mathrm{t}'' \subseteq \mathrm{t}^m_{fra} \\ \begin{array}{|c|} \hline \mathrm{t}''' \\ \mathrm{Montag}(\mathrm{t}''') \\ \mathrm{t}''' \subseteq \mathrm{t}^m_{fra} \\ \hline \end{array} \left\langle \begin{array}{c} \forall \\ \mathrm{t}''' \end{array} \right\rangle \begin{array}{|c|} \hline \mathrm{t}''' = \mathrm{t}' \\ \hline \end{array} \\ \hline \end{array} \right\}, \begin{array}{|c|} \hline \mathrm{t}^m \\ \mathrm{Montag}(\mathrm{t}^m) \\ \mathrm{t}^m \subseteq \mathrm{t}^m_{fra} \\ \hline \end{array} \right\rangle$$

The contribution made by the PP *am Montag* relates to that of *der Montag* in the same way that in the last section we assumed to obtain between *gestern* as adverb and *gestern* as NP. In the present instance the relation between the adverb time $\downarrow^m_{loc}$ and the referent t^m of *der Montag* is given overtly by the preposition *an*, but it is once more identity. So the contribution made by *am Montag* is like that of *der Montag* but with $\downarrow^{an}_{loc}$ and the condition $\mathrm{t}^{an}_{loc} = \mathrm{t}^m$ added. In the UDRS (27) for (25) this contribution is displayed as the component at the bottom on the left.[13]

[12]Some readers may baulk at this last constraint on t^m_{fra}. Those who prefer a treatment of this example in which the constraint is not part of the presupposition, can get one by dropping it. It would then be neccessary to find some other way of accounting for the intuition that on the reading under discussion quantification is over periods of several days.

[13]Note that in this case it would have been misleading to label the component contributed by the verbal predication as $\mathrm{l}_\perp$, as it is possible for this component to end up in the restrictor box of the duplex condition and the *Monday*-component in the nuclear scope box.

(27)



The presupposition of *am Montag* can be resolved either globally, i.e. at the top level DRS, or locally, within the restrictor of *oft*.[14] In case it is resolved globally, giving rise to the interpretation that resembles the one in (24) for (20), we again get a violation of the variety principle; variety

[14]It is worth noting how intimately this ambiguity depends on the exact form of the NP of the prepositional phrase. We see this when we compare (25) with the alternatives in (28.a) and (28.b).

(28) a. *An einem Montag gewann Paulchen oft.*
"On a Monday Paulchen often won."

b. *An diesem/jenem/dem Montag gewann Paulchen oft.*
"On this/that/the Monday Paulchen often won."

The ambiguity we have noted in connection with (25) is found also in (28.a) but in none of the three sentences in (28.b). The reason for this is no doubt that each of the NPs *diesem/jenem/dem Montag* only allows for a referential interpretation, according to which it refers to one particular Monday. (Remarkable in this connection is the difference between *am Montag* and *an dem Montag*.) See also [36].

is violated because once again the domain of quantification is reduced to a singleton. (This is so because (i) both ${}^{\downarrow}\mathrm{t}^{q}_{loc}$ and ${}^{\downarrow}\mathrm{t}^{an}_{loc}$ are unified with the ups-variable $\uparrow_{loc}$ of l_e and thus are unified with each other; (ii) global justification of the $\uparrow_{loc}$ of the presupposition of *der Montag* means that its $\uparrow_{loc}$ gets resolved at the global level to a single frame within which there is, according to this presupposition, a single Monday. (i) and (ii) entail that this single Monday is the only possible value for ${}^{\downarrow}\mathrm{t}^{q}_{loc}$.)

Suppose on the other hand that the presuppostion of *der Montag* is to be justified locally. This is most naturally achieved by unifying its $\uparrow_{loc}$ with the quantified variable ${}^{\downarrow}\mathrm{t}^{q}_{loc}$. In this case the $\uparrow_{loc}$ of l_e will be unified only with ${}^{\downarrow}\mathrm{t}^{an}_{loc}$. Furthermore the $\uparrow_t$ of l_e must unify with the ${}^{\downarrow}\mathrm{t}^{q}_{t}$ in the restrictor of *oft*. The remaining unifications are as before. On the assumption that the constituent *am Montag* becomes part of the restrictor of *oft* l_e goes into its nuclear scope. The resulting DRS is that in (29).

(29)

$\mathrm{n}\ \mathrm{t}_t\ \mathrm{p}\ \mathrm{s}^{oft}$

$\mathrm{t}_t \prec \mathrm{n}$
Paulchen(p)
$\mathrm{t}_t \subseteq \uparrow_{loc} = \mathrm{s}^{oft}$

$\mathrm{t}^q_t\ \mathrm{t}^q_{loc}\ \mathrm{t}^m_{fra}\ \mathrm{t}^m\ \mathrm{t}^{an}_{loc}\ \mathrm{t}''$

$\mathrm{t}^q_t \subseteq \mathrm{t}^q_{loc} \subseteq \mathrm{s}^{oft}$
$\mathrm{t}^m_{fra} = \mathrm{t}^q_{loc}$
$\mathrm{Montag}(\mathrm{t}^m)$
$\mathrm{t}^m \subseteq \mathrm{t}^m_{fra}$
$\mathrm{t}^{an}_{loc} = \mathrm{t}^m$
$\mathrm{day}(\mathrm{t}'')\ ;\ \mathrm{t}'' \neq \mathrm{t}^m$
$\mathrm{t}'' \subseteq \mathrm{t}^q_{loc}$

oft t^q_{loc}

e

e:gewinnen(p)
$\mathrm{e} \subseteq \mathrm{t}^q_t \subseteq \mathrm{t}^{an}_{loc}$

Note that in (29) the values of t^q_{loc} must include those of t^m and at least one other day. As noted above, a natural assumption regarding (29) would be that t^q_{loc} ranges over weeks. In this case t^m will select for each of the week-values for t^q_{loc} the unique Monday that this week contains.

4 The Perfect Operator

There is an extensive literature on the semantics of the so-called "perfect tenses". A good part of it has been motivated by the intriguing properties of the present perfect in English ([44], [43], [10]). These properties are special in that they are not shared by the other "perfect forms" of English (past perfect, future perfect and infinite perfects), nor by any of the perfect tenses of most other languages which have perfects, the present perfect included. One of these other languages is German.

An analysis of the German perfect, which doesn't display the peculiarities of the English present perfect, can, it seems, be simpler than any account of the perfect in English. This is true in particular of the analysis we adopt in this paper, and we stress that as it stands it is an analysis which wouldn't do for English. Our analysis follows earlier accounts of the German tense and aspect system ([39], [40], [63], and [47]) in assuming that all perfect tenses have the structure TENSE(PERF(VP)), where PERF is an aspect operator. Within the UDRT-architecture of the present proposal it is natural to assume that PERF introduces a UDRS component which is located between $l_\top$ and $l_\perp$ (so that it is within the scope of tense and has scope over the contribution made by the main verb). The scope relations between the PERF component and other UDRS components are left open. This allows in particular for scope ambiguities between PERF and temporal adverbs (locating adverbs as well as quantificational adverbs).

As a first example of a scope ambiguity between PERF and a temporal adverbial consider the two sentences in (30).

(30) a. *Am Ostermorgen war Paulchen abgereist.*
'On Easter morning be$_{past}$ Paulchen away travelled.'
"Paulchen had departed on the morning of Easter Sunday".

b. *Paulchen war am Ostermorgen abgereist.*

Both (30.a) and (30.b) can be understood as saying either (i) that Paulchen's departure occurred on the morning of Easter Sunday or (ii) that on the morning of Easter Sunday his departure had already taken place – i.e. he left before that morning.[15]

[15]There is a preference for reading (i) in the case of (30.b) and for reading (ii) in the

That this ambiguitiy is indeed a scope ambiguity between the perfect operator and the adverb is indicated by a comparison beween (30) and (31).

(31) a. *Gestern ist Paulchen abgereist.*
'Yesterday is Paulchen departed.'

b. *Paulchen ist gestern abgereist.*

The sentences in (31) are not ambiguous. The difference between (30) and (31) can be explained as follows. The present tense in (31.a,b) locates what it takes to be the described eventuality at the utterance time n. If *gestern* served to locate this same eventuality, then its denotation would have to include n, which it doesn't. (It denotes the day immediately before the day of n.) Therefore, the eventuality located by *gestern* must be distinct from the eventuality that is located by the present tense, and moreover, the former eventuality must precede the latter one. The only way in which this requirement can be met is to take *gestern* to be within the scope of PERF. Then *gestern* will serve to locate the departure event. PERF forms out of the event description *Paulchen depart yesterday* the corresponding perfect state and this state is then located by the present tense as holding at n.

Thus only one of the two readings of the sentences in (30) survives. The reason why we do find the ambiguity with (30.a,b) is that the temporal relation between the adverb *am Ostermorgen* and the past tense *war* is underspecified. The past tense refers to some time in the past of n and the adverb can be interpreted as referring to a past time as well. This is compatible with each of the following three possibilites: (i) the adverb time precedes the tense time, (ii) the adverb time includes the tense time, (iii) the adverb time follows the tense time. So we obtain a consistent interpretation not only when we take the adverb to have narrow scope with respect to PERF and assume that the adverb time precedes the tense time, but also when we give the adverb wide scope and assume that adverb time and tense time overlap.[16]

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case of (30.a), something that should have been expected given the general tendency for scope relations to align with left-to-right order. But it is a tendency only; both readings are available for both sentences; the less prominent one can be made salient by appropriate prosody or by choice of a suitable context. (Compare footnote (11)).

[16]The third option – adverb time follows tense time – does not yield a possible

At first sight it may look as if this explanation runs afoul of sentences like those in (32).

(32) a. *Heute ist Paulchen abgereist.*
"Today Paulchen has departed."

b. *Gestern war Paulchen abgereist.*
"Yesterday Paulchen had departed."

(32.a,b) may seem unambiguous, like the sentences in (31) and unlike those in (30). If this were indeed the case, then our scope-based account of the possible readings for (30) and (31) would be in trouble. Consider for instance (32.a). Here we cannot exclude the second reading of the sentences in (30) in the way we did for the sentences in (31). For (31) our argument was based on the fact that the denotation of *gestern* does not include the utterance time. But the denotation of the adverb of (32.a), *heute*, does include the utterance time. Similarly, as regards (32.b), nothing prevents inclusion of the (past) tense time in the denotation of *gestern*.

We believe, however, that the sentences in (32) are ambiguous after all, first appearances notwithstanding. For (32.a) the "missing" reading becomes visible in a context such as (33.a). And the same applies to (32.b). Its "missing" reading becomes prominent in the analogous context (33.b).

(33) a. *Vorgestern war er noch da. Aber heute ist Paulchen abgereist.*
'before-yesterday was he still there. But today is Paulchen away-travelled.'

interpretation. Note that whether we take the adverb to have (a) wide or (b) narrow scope wrt. PERF, the interpretation would have to be a prospective one: from the perspective of the tense time either (a) the result state or (b) the event itself would lie in the future. The possibilities for such prospective interpretations of past tenses are very limited. An example is the much discussed *Morgen war Weinachten*, (see [26]) which can be used to express that from the past vantage point of some protagonist the following day would be Christmas. Although we will have something to say about the prospective uses of the present tense in Section 5, we have decided not to consider in this paper the corresponding uses of past tenses. This decision is reflected in the simplified entry for the German past tense which was given in (10) at the end of Section 2. This entry allows for an interpretation where the tense time either includes the event of Paulchens departure or is included in the state resulting from his departure, but not for a 'prospective' state of his going to depart.

b. *Vor drei Tagen war er noch da. Aber gestern war Paulchen abgereist.*
'Ago three days was he still there. But yesterday was Paulchen away-travelled.'

We conclude from these observations that the scope-based analysis is tenable after all. Still, the question why the second reading is so much harder to get for the sentences in (32) than for the sentences in (30) remains. To that question this paper provides no answer.

Related to this last question is the contrast between the sentences in (32) and those in (34).

(34) a. *Heute ist Paulchen verreist.*
"Today Paulchen has departed."

b. *Gestern war Paulchen verreist.*
"Yesterday Paulchen had departed."

Like those in (32) these sentences are ambiguous. But they differ from (32) in that the second reading is easy to get – perhaps even easier than in the case of (30). This contrast between (32) and (34) must be due to distinct properties of the two verbs *abreisen* and *verreisen*, since it is only in their verbs that the sentences differ.

The relevant distinction between *verreisen* and *abreisen*, it has been observed (see [41]), is that *verreisen* has what has been called a *target state* in [51], whereas *abreisen* does not. A target state of a verb V is one which entails that an eventuality of the kind described by V occurred before it, but it is more than that. It is a state which is caused by such an eventuality, but which can be terminated at a subsequent time by some other cause, or simply run its course and disappear. (At times following that time the state no longer holds in spite of the fact that these times are preceded by the eventuality which caused it.) For instance, a target state of *verreisen* is one where the subject is away from home as a consequence of an earlier *verreisen*-event (an event consisting in the subject taking off from his or her home). When the subject returns home, the target state is thereby terminated, and at that point it is misleading to say, *Er/Sie ist verreist.* (However, the target state interpretations of such sentences can be overwritten. *Er ist verreist, aber er ist jetzt wieder nach Hause* *gekommen.* (Engl.: *He has left, but now he has came back home.*) is perfectly acceptable.)

The target state of a verb is described by its past participle. When the participle is used for this purpose, it functions much like an adjective. This endows a sentence like (34.a) with an interpretation which resembles those of present time sentences like *Heute ist Paulchen krank.*, which also assert that an adjectivally described state holds during the n-including denotation of their temporal adverb. There of course remains a difference between such present tense copula sentences and sentences involving past participles like (34.a): the latter describe states which entail the occurrence of some event whose result state they are, while the former do not. But this event is much less prominent than it is in the case of perfects involving non-target state verbs, and this is reflected by the fact that for target-state verbs it is easier to obtain readings in which the temporal adverb is understood as locating the result state and not the eventuality whose result state it is.

Scope ambiguities arise also between PERF and quantificational adverbs. For instance (35)

(35) *Paulchen hat oft getrunken.*
'Paulchen has often drunk.'

is ambiguous between a reading which says that before the utterance time there were many occasions when Paulchen drank – something that might be said, for instance, in summing up Paulchen's sojourn in this vale of tears after he has passed away – and one according to which there are many occasions on which he has drunk and on which he still shows the effects of that (i.e. is still inebriated). According to our analysis, which predicts such scope ambiguities between PERF and quantification adverbs just as it predicts scope ambiguities between PERF and adverbs like *gestern* and *heute*, this is as it should be. But here too our theory is not able to explain why some readings are much harder to get than others.

4.1 Ups and downs in PERF

We now proceed to our formal treatment of the German perfect. German perfects are composed of an auxiliary and a past participle (which we assume is marked in syntactic structure as "PERF = +", or as "+PERF").

The auxiliary carries the information contributed by tense. The morphology of the participle contributes a UDRS component which introduces a discourse referent s^{res} representing the "formal" result state s^{res}. s^{res} is assumed to be the result of an eventuality ev of the kind described by the verb. (The result relation between s^{res} and ev is expressed by the DRS condition "res(s^{res}, ev)"). Like other eventualities s^{res} is temporally located by ups-variables $\uparrow_t$ and $\uparrow_{loc}$. The temporal relation between s^{res} and ev is that of abutment: ev $\supset\!\subset$ s^{res}. (This is a general entailment of the condition that s^{res} is the result state of ev – i.e. "res(s^{res}, ev)" logically entails "ev $\supset\!\subset$ s^{res}".) The downs-variables ${}^{\downarrow}t_t^{ev}$ and ${}^{\downarrow}t_{loc}^{ev}$ serve to secure the eventuality ev through unification. Normally these will unify with the ups-variables of the $l_\perp$-constituent, thereby causing the eventuality of the verbal predication in $l_\perp$ to be the one whose result state is s^{res} (though later on we will also encounter the possibility that ev is not identified with the eventuality of $l_\perp$). The representation of PERF we propose is given in (36).

(36) PERF = + $\rightsquigarrow$ $\boxed{\begin{array}{c} s^{res}\ {}^{\downarrow}t_t^{ev}\ {}^{\downarrow}t_{loc}^{ev} \\ \\ \uparrow_t \subseteq \uparrow_{loc} \subseteq s^{res} \\ \mathrm{res}(s^{res}, \uparrow_{ev}) \\ \uparrow_{ev} \supset\!\subset s^{res} \end{array}}$

The ups-variable $\uparrow_{ev}$ is unlike the ups-variables that have been encountered so far in this paper. $\uparrow_{ev}$ represents the requirement that it be identified with that eventuality variable ev which is temporally located by the ups-variables which unify with the downs-variables from the PERF-constituent. The ups-arrow accompanying 'ev' is to indicate that the eventuality variable ev′ with which ev unifies must be one that is introduced by a component $K_{ev'}$ which in the UDRS (or DRS) resulting from these unifications stands to PERF in the UDRS-ordering relationship $\geq$. Together with the other unifications – of ${}^{\downarrow}t_t^{ev}$ and ${}^{\downarrow}t_{loc}^{ev}$ with the ups-variables from $K_{ev'}$ which entail that $K_{ev'} \leq$ PERF – this condition forces the merge of the two constituents PERF and $K_{ev'}$; which is just what we want.[17]

[17]In the light of what we have just said about $\uparrow_{ev}$, this bit of notation may seem rather like a hack. For one thing, the "unification" which $\uparrow_{ev}$ requires isn't a unification operation in the same sense as those involving the ups- and downs-variables for times.

For an example consider the sentence in (37).

(37) *Paulchen ist gestern verreist.*
"Paulchen has yesterday gone on a trip."

(38) gives a syntactic analysis for this sentence in which the V-node dominates the complex consisting of participle and auxiliary (represented by its trace t_2 after movement to the V2-position). The participle has been decomposed into the lexical verb and the PERF-operator, which is

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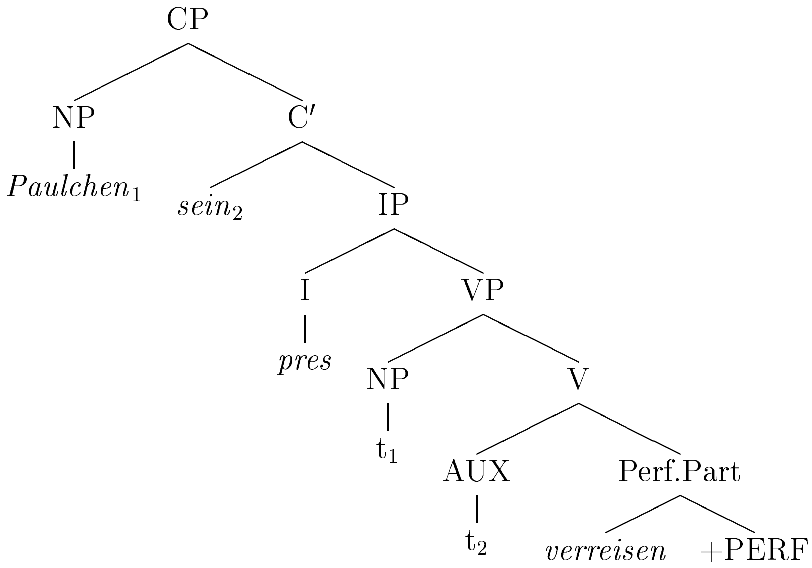
One difference is that the event variables with which $\uparrow_{ev}$ should "unify" are not marked as downs-variables – and should not be, since they are not subject to unification in other UDRSs (including all those which we have considered up to now). The "unification" required for $\uparrow_{ev}$ can be described in more traditional terms as follows: The event variables with which $\uparrow_{ev}$ unifies always belong to UDRS constituents in which they are located by ups-variables $\uparrow_t$ and $\uparrow_{loc}$, something that is recognisable from the presence in this component of a locating condition (either "ev $\subseteq \uparrow_t \subseteq \uparrow_{loc}$," or "$\uparrow_t \subseteq \uparrow_{loc} \subseteq$ ev"); since UDRS components never have more than one pair of ups-variables, the corresponding ev will be uniquely identifiable. Let us refer to this eventuality variable as the *designated eventuality variable* of its UDRS component. The binding instruction that is made visible by the presence of $\uparrow_{ev}$ can then be stated as: (i) replace $\uparrow_{ev}$ everywhere by the designated eventuality variable ev′ of some UDRS component $K_{ev'}$ (ii) merge $K_{ev'}$ with the component containing $\uparrow_{ev}$.

The need for some form of binding of eventuality variables is something which PERF shares with other aspect operators. (For other aspectual operators see Sections 5 and 6.) In more traditional "formal semantics", such operators always require operands which are of the type of a property of eventualities, and so could be cast in the form "λEV.ASP(EV)" where EV is a variable of the type of a property of eventualities (or of an "eventuality type" as we ourselves prefer to call it) and ASP denotes some function from eventuality types to eventuality types. The argument of ASP will then typically take the form "λev′.OPD(ev′)", where ev′ is the designated eventuality variable of what in our set-up is the relevant UDRS-component (in the case under discussion as many others this will be the component $l_\perp$). PERF differs from most other aspect operators in that it is "veridical": applying it to its argument has the effect of instantiating the λ-bound eventuality variable of the argument by a variable that is existentially bound with *de facto* wide scope in the result returned by the operator. As familiar from Montague Grammar, such "extensional" operators can be represented in the form "λEV.($\exists$ev′)(ASP′(ev′) $\wedge$ EV(ev′))", where ev′ corresponds to our $\uparrow_{ev}$.

There may be a way of combining this kind of architecture, in which λ-abstraction and functional application drive semantic composition, with the UDRT-architecture we are using here. But this is a further project. We do not quite know how it might be carried out, or for that matter, whether this would be something worth doing. Compare also the remarks in Section 8.

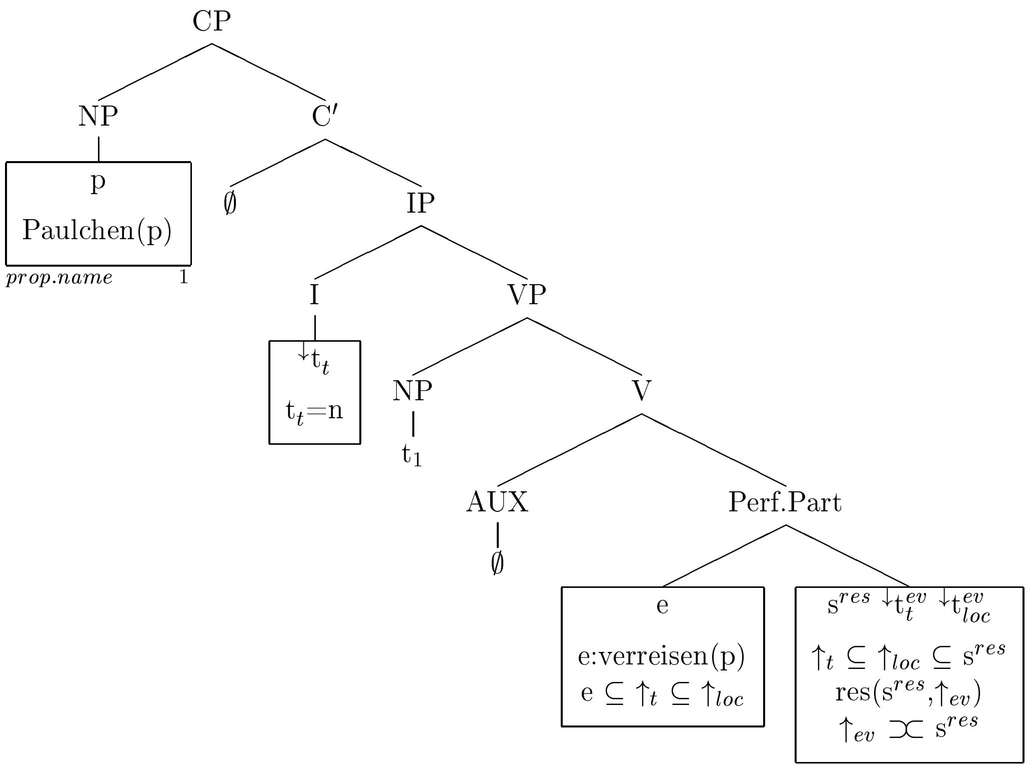
morphologically realised as *-ed* and whose semantics is indicated by the feature value +PERF.

(38)

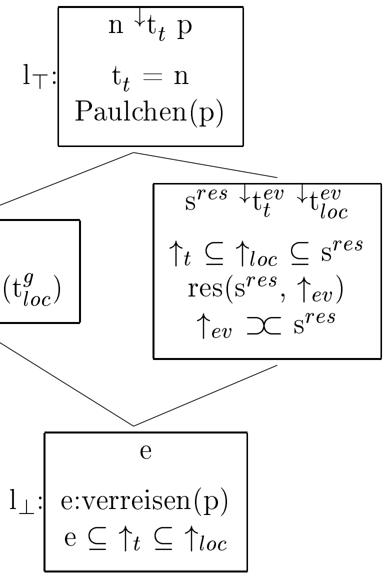


Insertion of the semantic representations of the different lexical items of (38) leads to the decorated tree in (39) which in its turn gives rise to the UDRS in (40).

(39)



(40)



(N.B. Here we have simplified the contribution made by *gestern*. What you see in (40) is short for the merge of the presuppositional and non-presuppositional structure given in (14) on page 22. In (40) justification both for the presupposition of *gestern* and of that connected with *Paulchen* is assumed to have taken place already.)

The algorithm now converts (40) into a DRS. Again proceeding bottom up, it first tries to find a binder for the ups-variables in $l_\perp$. It is easily seen that the only option for $\uparrow_t$ is unification with the variable ${}^{\downarrow}t_t^{ev}$ from the PERF component. (Otherwise the $\uparrow_t$ from PERF would remain without unification mate.) This means that the $\uparrow_{loc}$ of $l_\perp$ also has to unify with the downs-loc variable from PERF, i.e. with ${}^{\downarrow}t_{loc}^{ev}$. But loc-unification need not be one-to-one. There still remains a choice: either the $\uparrow_{loc}$ of $l_\perp$ is also unified with the variable ${}^{\downarrow}t_{loc}^{g}$ from the *gestern* component, or ${}^{\downarrow}t_{loc}^{g}$ is left to unify with the $\uparrow_{loc}$ from PERF. All other unifications are determined by the structure of (40). So we get two possible solutions, viz. the DRSs in (41).

(41)
$$
\boxed{\begin{array}{c}
\mathrm{n}\ \mathrm{t}_t\ \mathrm{p}\ \mathrm{t}_{loc}^{g}\ \mathrm{s}^{res}\ \mathrm{t}_t^{ev}\ \mathrm{t}_{loc}^{ev}\ \mathrm{e} \\
\\
\mathrm{t}_t{=}n \\
\mathrm{Paulchen(p)} \\
\mathrm{yesterday}(\mathrm{t}_{loc}^{g}) \\
\mathrm{t}_t \subseteq \mathrm{t}_{loc}^{g} \subseteq \mathrm{s}^{res} \\
\mathrm{res}(\mathrm{s}^{res},\mathrm{e}) \\
\mathrm{e} \supset\!\subset \mathrm{s}^{res} \\
\mathrm{e{:}verreisen(p)} \\
\mathrm{e} \subseteq \mathrm{t}_t^{ev} \subseteq \mathrm{t}_{loc}^{ev}
\end{array}}
\qquad
\boxed{\begin{array}{c}
\mathrm{n}\ \mathrm{t}_t\ \mathrm{p}\ \mathrm{s}^{res}\ \mathrm{t}_t^{ev}\ \mathrm{t}_{loc}^{ev}\ \mathrm{t}_{loc}^{g}\ \mathrm{e} \\
\\
\mathrm{t}_t{=}n \\
\mathrm{Paulchen(p)} \\
\mathrm{t}_t \subseteq \uparrow_{loc} \subseteq \mathrm{s}^{res} \\
\mathrm{res}(\mathrm{s}^{res},\mathrm{e}) \\
\mathrm{e} \supset\!\subset \mathrm{s}^{res} \\
\mathrm{yesterday}(\mathrm{t}_{loc}^{g}) \\
\mathrm{e{:}verreisen(p)} \\
\mathrm{e} \subseteq \mathrm{t}_t^{ev} \subseteq \mathrm{t}_{loc}^{g} \\
\mathrm{t}_{loc}^{ev} = \mathrm{t}_{loc}^{g}
\end{array}}
$$

Note that only the right hand side in (41) is consistent. This DRS asserts that the departure took place yesterday. The left hand side DRS is inconsistent because the conditions '$t_t \subseteq t_{loc}^{g}$' and '$t_t = n$' force inclusion of the speech time within yesterday, which is obviously impossible.

As we saw in the introduction to this section, the matter is different when we replace *gestern* by *heute*, for then the contradiction of the left hand side representation (41) disappears. So let us consider the next sentence (42.a) and the representations that result from (41) by replacing the contribution of *gestern* by the lexical entry for *heute* as given in (17).

(42) *Paulchen ist heute verreist.*
'Paulchen is today away-travelled.'

According to the scoping on the right of (41) (42) says that the event of departing lies in the past part of the day of the utterance; and the scoping on the left gives an interpretation according to which the utterance day is characterized by a state that results from the fact that there was a departure at some earlier time – that is, at some time *before* that day.

We already noted in the introduction to this section that the ambiguity of (37) is at best marginally present when *verreist* is replaced by *abgereist*. The likely reason for this distinction, we observed, is that *verreisen* gives rise to a "target" state – a result state which consists of more than the mere fact of a preceding *verreisen* event – whereas *abreisen* does not. The target state of *verreist* requires that the agent hasn't yet returned to his place of departure (which in the case of *verreisen* must be the place that counts as home). In (43) the existence of such target states is expressed in the form of a meaning postulate.

(43)
$$\boxed{\begin{array}{c} \mathbf{x}^{subj}\ \mathrm{e} \\ \\ \mathrm{e{:}verreisen}(\mathbf{x}^{subj}) \end{array}} \rightarrow \boxed{\begin{array}{c} \mathrm{s}^{\mathbf{res}}\ \mathrm{h} \\ \\ \mathbf{x}^{subj}\text{'s home(h)} \\ \mathrm{s}^{\mathbf{res}}{:}\neg\mathrm{AT}(\mathrm{h},\mathbf{x}^{subj}) \\ \mathrm{e} \supset\!\subset \mathrm{s}^{\mathbf{res}} \end{array}}$$

This postulate presents the occurrence of a target state (represented as "$\mathrm{s}^{\mathbf{res}}$", with "**res**" in bold face as opposed to general result states which we denote as "s^{res}") as a consequence of an event of type *verreisen* having taken place. In order that this postulate can account for the difference we have noted between (37) and its *heute*-counterpart (42.a) we need a further constraint – one to the effect that temporal locating adverbs are normally understood as locating "genuine" eventualities, and that target states are among these, but result states in general are not. However, as we noted, result states of verbs which don't have target states (in the sense of not having meaning postulates of the type of (43)) can occasionally be located by adverbs too, viz. in contexts where sufficiently strong factors are present to coerce such an interpretation. Coercion, however, is a topic beyond the scope of this paper.[18]

[18]It appears that those German verbs which give rise to target states all select for *sein* (*be*) and not *haben* (*have*) as perfect-auxiliary. (Although as we have seen not all verbs with *sein*-perfects have target states). It also seems that English verbs never give rise to target states with the same grammatical properties that distinguish

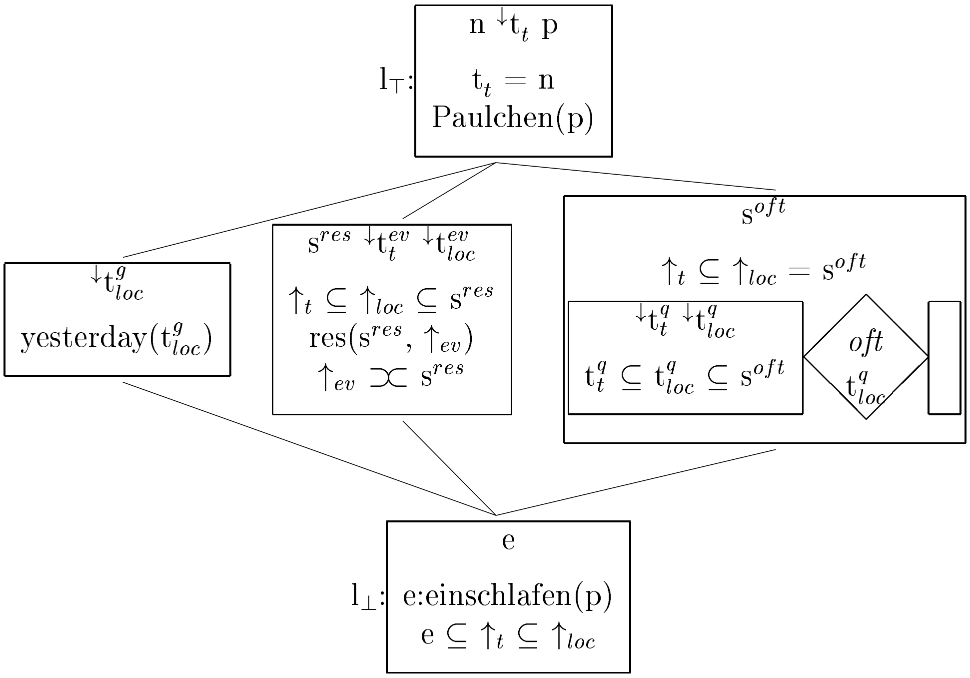
4.2 Complex UDRS-conditions and PERF

So far we have looked at the interaction between the perfect operator, tense and temporal locating adverbs. Matters become more complicated when quantification enters the game as well. Sentences with perfect tense morphology and adverbial quantifiers also lead to initial UDRSs in which PERF and adverb contribute distinct components, of which we assume that they are not yet ordered with respect to each other. For example, consider the sentence in (44) with initial representation in (45).

(44) *Paulchen ist gestern oft eingeschlafen.*
"Paulchen has often fallen asleep yesterday."

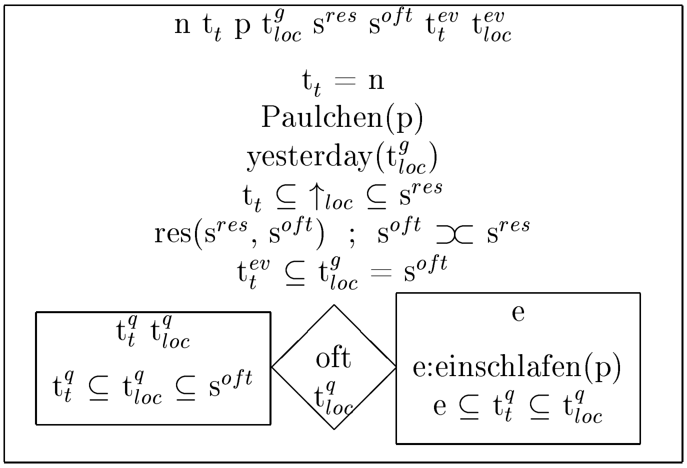
the German target states spoken of here. For instance, as far as we can tell, the sentences *John has departed today.* and *John has gone on a trip today.* only have the reading corresponding to the right hand side of (41), but not that corresponding to the DRS on the left. It is a tempting speculation that this property of the English sentences is related to the fact that English perfects are without exception formed with the auxiliary *have*. In fact, it is our impression that in English the stricture against interpretations in the sense of the right hand side (41) is even stronger and than it is for non-target state verbs in German, including German *haben*-verbs. If it is indeed true that for English the restriction is absolute, an account of the English perfect will probably have to be fundamentally different from the one offered here for German perfects, in which scope relations beween the perfect operator, locating adverbs and other representation components do almost all the work.

(45)



Resolution of the scope relation between PERF and the quantifier component can go either way. If we assume that in (45) PERF takes scope over the quantifier component and that *gestern* is interpreted as the duration of s^{oft} (i.e. as the temporal quantification frame for *oft*) we obtain the representation in (46).

(46)



We devote the final discussion of this section to the other ways in which (44) might be interpreted. We have seen that the initial UDRS

(45) for (44) has three components which are ordered only with respect to $l_\top$ and $l_\bot$, but not vis-a-vis each other. Let us refer to these three components as "PERF", "QUA" (for the quantifier component) and "ADV" (for the component contributed by the locating adverb). The UDRS in (45) is in principle ambiguous between the six different scope orderings of these three elements which are listed schematically in (47).

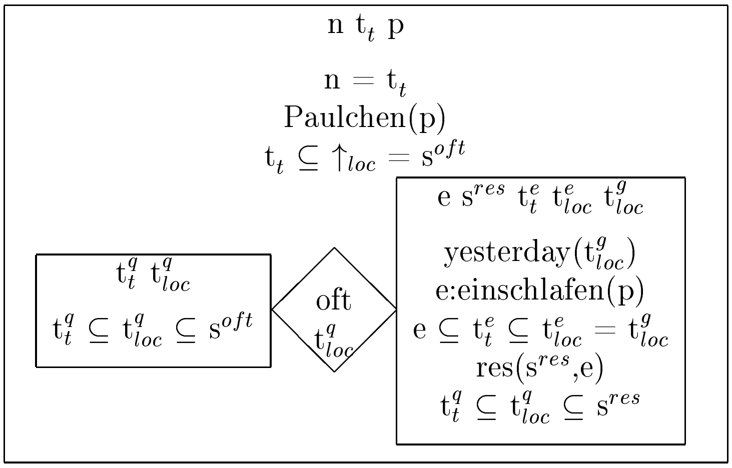
(47) a. PERF ADV QUA
b. PERF QUA ADV
c. ADV PERF QUA
d. ADV QUA PERF
e. QUA PERF ADV
f. QUA ADV PERF

One of the challenges for the approach we are proposing is to explain how and why only those scope orderings are admissible which yield interpretations for (44) that agree with speakers' intuitions.

The interpretation represented in (46) reflects the scope option (47.a). Of the five other options, (47.c) and (47.d) turn out to be impossible for the sentence (44) because the reference of *gestern* is incompatible with the constraints imposed by the present tense. (This, however, is an accidental feature of the particular sentences in question. We return to these two scope options below.)

Three options remain, (47.b), (47.e) and (47.f). Given our unification assumptions (47.b) fails because of a violation of variety: ${}^{\downarrow}t^{g}_{loc}$ and ${}^{\downarrow}t^{q}_{loc}$ both unify with the $\uparrow_{loc}$ of $l_\bot$ and are thus identified. This identification reduces the range of possible values for the quantificationally bound variable ${}^{\downarrow}t^{q}_{loc}$ to a singleton. (47.f) is filtered out for the same reason. This time ${}^{\downarrow}t^{g}_{loc}$ unifies with ${}^{\downarrow}t^{q}_{loc}$ and $\uparrow_{loc}$ of the PERF component. (47.e), on the other hand, does not violate quantificational variety, since ${}^{\downarrow}t^{g}_{loc}$ unifies with the $\uparrow_{loc}$ of the event and ${}^{\downarrow}t^{q}_{loc}$ with the $\uparrow_{loc}$ of its result state. Here there is no violation of variety produced by unification-based identification of ${}^{\downarrow}t^{g}_{loc}$ with the variable bound by the quantification.

(48)



To explain the reason for the oddity of (47.e) let us first consider the pluperfect sentence *Paulchen war um 6 Uhr eingeschlafen.* (Engl.: *Paulchen had fallen asleep at 6 o'clock.*). This sentence is ambiguous between (i) a reading according to which 6 o'clock is taken to be the reference time wrt. which the pluperfect is evaluated, i.e. a reading according to which the event of falling asleep happened before 6 o'clock, and (ii) a reading saying that the event happened at 6 o'clock and is located in the past of some contextually given reference time later than 6 o'clock. A representation of the first reading can be obtained by letting the perfect take narrow scope wrt. the adverbial, which then locates the result state at 6 o'clock. In reading (ii) the adverbial first locates the event at 6 o'clock and then the PERF operator is applied to the event characterisation thus obtained.

Now consider the unacceptable *Um 7 Uhr war Paul um 6 Uhr eingeschlafen.* (Engl.: *At 7 o'clock Paulchen had fallen asleep at 6 o'clock.*). Without further constraints our representation algorithm would allow taking *at 7 o'clock* as reference time for the location of the result state while interpreting the rest of the sentence as in (ii). The impossibility of past perfect sentences like this one is, we believe, an indication that one cannot use within the same clause two locating adverbs denoting disjoint times in such a way that one of them locates the event and the other its result state. In interpreting a clause that involves a perfect one has to make a choice between two options: either one takes the event as the 'principal eventuality described by the clause' in which case a temporal locating adverbial in the clause can only be understood as locating it; alternatively, the main eventuality is taken to be the result state, in which case a locating adverb can only be understood as locating this state. But one can't have it both ways, and so there is no room for two locating adverbials in the same perfect clause, each with its own localisation task. As it stands this principle doesn't tell us anything about sentences like (44), but it does if we make the additional assumption that from the present point of view there is no real difference between quantificational adverbs like *oft* and locating adverbs like *gestern*, *on Monday*, etc. which refer to particular reference times. Just as the location times supplied by locating adverbs only serve to locate the principal eventuality of the clause, this is equally true of the location times introduced by quantifying temporal adverbs. The implication of this assumption is that in the interpretation of (48), where PERF is in the immediate scope of the quantifier *oft*, and the quantificationally bound t^q_{loc} is construed as locating the result state, there is no room for an additional locating adverb that locates the events of which these states are the result states. For by construing the quantification as pertaining to the (location times of the) result states, these result states are made *ipso facto* into the principal eventualities of the clause. The events are thereby excluded from this status and their localisation by means of an additional locating adverb has become impossible.[19]

One consequence of these assumptions about the role of locating and quantifying adverbs is that a quantifying adverb cannot be assumed to have scope over both PERF and locating adverb, which like *gestern* refers to one, fixed time stretch. For either the adverb is then construed as further specifying the location time of the result state, in which case we have a violation of variety, or the adverb is construed as locating the event, in which case there is a conflict with the assumptions just made.

In connection with (44) two of the six possibilities in (47) – (47.c) and (47.d) – could be eliminated because of the conflict between *gestern* and present tense. But as we noted, this rests on an accidental feature of this particular example. In the sentences in (49) this convenient source of conflict has been eliminated.

[19]Note that this 'double location constraint' also prohibits (47.b). This configuration is thus eliminated for two distinct reasons, variety and double location.

(49) a. *Paulchen war gestern oft eingeschlafen.*
'Paulchen had often fallen asleep yesterday.'

b. *Paulchen ist heute oft eingeschlafen.*
'Paulchen has often fallen asleep today.'

First (49.a). (47.b,e,f) are ruled out as before. (47.a) is again a possible option but this time an interpretation in accordance with it a little more involved. It requires a reference time before the speech time at which the state obtains which results from Paulchen often falling asleep on the preceding day. Such an interpretation is natural in a context where one recalls, some time in the afternoon of a certain day d, a thought or conversation which took place that morning. At that earlier time someone did say (or could have said) *Paulchen ist gestern oft eingeschlafen.* Of the two options that require our attention in connection with (49.a), (47.c) and (47.d), we believe that both of these are possible in principle although the interpretations they assign to (49.a) do not seem very natural. (47.c) would seem a plausible interpretation of a sentence like *Damals hatte er oft Erfolg gehabt. (Aber heute würde ich ihm keine zweite Chance mehr geben.* (Engl.: *At that time he had often been successful. (But today I wouldn't give him another chance.*) Here the time referred to is naturally interpreted as one at which the state holds that resulted from there having been many different previous occasions where the subject succeded (with whatever it was he undertook). In the case of (49.a) this interpretation is odd insofar as the result from a many falling asleep events doesn't seem to be a particularly newsworthy item – especially as the period within which there were many falling asleep events remains unspecified.) (47.d) also is a possible option for past perfect sentences like (49.a). In this case the interpretation of (49.a) is more plausible. Yesterday was a day when there were many times at which Paulchen was in the state of having fallen asleep (i.e. in the state of having just dozed off.) Again the plausibility of the interpretation depends on whether we can think of the result states in question as worth mentioning, of limited temporal extend and repeatable.

(49.b) raises some of the same issues as (49.a), among them these which concern (47.c,d), but also some further issues of its own. In particular we here face a more complex interaction between the present tense and the meaning of *heute*. As shown in (17), the denotation of *heute* can be construed in three different ways: either (i) a part of today that lies before the utterance time, (ii) all of today, and (iii) the part of today that follows the utterance time. Each of these three possibilities is relevant for the interpretation of (49.b). (iii) is relevant because of the possibility of interpreting the present tense of (49.b) prospectively (see the next section), although this prospective interpretation seems marginal. (ii) is relevant for an interpretation according to (47.d), in which all of today is taken as the duration of the quantificational state introduced by *oft*; and (i) in connection with an interpretation along the lines of (49.a), where the quantificational state must be situated entirely in the past of the utterance time. We leave it to the reader to puzzle over the details of this case – which of the options in (47) are available at all, which are plausible and why.

(44) and (49) are only three from an open ended set of sentences in which perfect, a locating adverb and a quantificational adverb interact. In the light of the remarks above we should expect to discover further complications and relevant factors when more sentences of this general type are looked at in detail. So this is a direction in which our proposals need a good deal of further exploration.

In the light of the difficulties we have encountered in this section it may seem natural to look for alternative approaches by which they could be avoided. One alternative is to reconsider the role played by perfect tense morphology. For instance, if we could argue that the present perfects of (44) and (49.a,b) are semantically simple pasts, then most of the difficulties we encountered in our discussion of the scope options in (47) would not arise.[20] It must be stressed, however, that this alternative will be an improvement only if it can be assumed that the present perfects of the sentences we have considered *must* be analysed as simple pasts. On the assumption that the morphological present perfect is ambiguous between a simple past and a perfect in the semantic sense (i.e. one involving PERF) we will be just as far from an explanation why the intuitively impossible interpretations of these sentences are ruled out as we are on the PERF-based account presented above. If the 'simple past' analysis of morphologal perfects is to get us any closer to such an explanation,

[20] Though not all of them. The need for the limitations on possible values for s^{oft} in interpretations like that of (47.b) for sentences with right downward monotone quantifiers remains, and has to be dealt with independently.

then we must argue either (a) that the German perfect has turned into a simple past altogether, or (b) that a PERF-based analysis of morphological perfects is excluded in certain sentential contexts, those of (44) and (49) among them.

The first of these two options cannot be right, as there are many contexts in which simple perfect forms and past tense forms cannot be substituted for each other *salva veritate*.[21] And as regards the more modest assumption according to which perfects are obligatorily interpreted as simple pasts in some but not in all syntactic environments – what could be the basis for it? We do not know; and thus we do not see how the hypothesis that morphological perfects can be semantically equivalent to simple pasts could solve any of the problems that we have noted for our own proposal, according to which the semantics of perfect morphology always involves PERF.[22]

[21] The most salient examples showing that simple past morphology and present perfect morphology are not always interchangeable are those involving indirect discourse. *Paulchen sagte, dass er krank war.* (Engl.: *Paulchen said that he was ill.*) has as one of its interpretations – and arguably this is the more salient one – that Paulchen asserted that he was ill at the time when he made his assertion. (In other words the corresponding oratio recta would have been "*Ich bin krank.*" ("*I am ill.*")). The sentence *Paulchen sagte, dass er krank gewesen ist.* (Engl.: *Paulchen said that he has been ill.*) does not have this reading. It is only coherent in a situation where the current utterance time and the earlier time at which Paulchen made the statement that is being attributed to him both belong to the same "extended now"; and in that case the state of illness of which Paulchen is said to have spoken must be understood as lying in the past of this extended-now interval. (See [48] on the so-called "double access" interpretations of "present under past" sentences.) Outside the domain of indirect discourse, straightforward examples showing the non-interchangeability of perfect and simple past are not so easy to find. But even the examples just mentioned demonstrate that perfect and simple past cannot be regarded simply as alternative morphological realisations of the same semantic construct. See [19] and [39].

[22] An explanatory strategy which might come to mind is that past tense interpretations of perfect forms result through some form of coercion. For instance, couldn't it be the case that when the present perfect combines with a temporal adverb denoting a time which wholly precedes n, then its purpose is solely to constrain the location of the described eventuality in harmony with the constraint imposed by the adverb, and that it thus turns into what is de facto a simple past? Alas, it is hard to see how a mechanism of this kind could qualify as an instance of coercion in the sense in which that notion is currently applied and understood. To argue that a present perfect occurring in the company of an adverb whose referent precedes n is coerced to an interpretation as simple past, we would – according to the standard understanding of

We conclude that postulating an ambiguity between perfect forms as true perfects and perfect forms as simple pasts doesn't offer an obvious escape from the unwanted readings to which our own proposal leads. As long as one accepts that PERF-involving interpretations are among those which are possible for German perfects, then there is no simple way around this proliferation problem. In other words, this problem is not just an artefact of the analysis we have proposed. As far as we can see, it arises for any of the theories of tense and aspect which are prominent in the current semantic literature, and not only for German but for many other languages as well (viz. [1]).

5 German Present Tense

In Sections 2 and 3 we only considered one interpretation for the present tense, according to which it locates the described eventuality as overlapping with the utterance time n. But as we showed in Section 1.2, this is a simplification which fails to do justice to the true range of possible meanings of the German Präsens. In particular, we have thus far ignored its prospective interpretation. In German this use of the present tense is very common, especially in sentences whose VPs require or allow for a non-stative interpretation. Our task in the present section is to give a more faithful account of the semantic range of the Präsens, and of the way in which the different possibilities which it covers interact with other components of present tense sentences.

For a proper understanding of these interactions it is important to draw attention to a special constraint which applies – not only in German, but, it seems, in natural language generally – to statements which situate the described eventuality at the utterance time. We have been proceeding on the assumption that the temporal relation between an eventuality ev

coercion – have to show that an interpretation involving PERF leads to incoherence. That incoherence might then be argued to coerce the alternative interpretation, on which the present perfect is a simple past. But there seems no hope of arguing this. For as we have seen, interpreting a perfect in the presence of a past-denoting adverb as a genuine perfect doesn't produce incoherence; it only threatens to lead in some instances to (coherent) interpretations which just aren't there. The problem we are facing is not that of accounting for readings where none would be forthcoming unless an appeal to coercion is made, but to get rid of unwanted readings which are there unless additional mechanisms are brought into play.

and its eventuality time t_t depends on the nature of ev – if ev is an event e, then the relation is inclusion of e in t_t, "$e \subseteq t_t$"; if it is a state s, then the inclusion is reversed: "$t_t \subseteq s$". These conditions hold irrespective of where t_t is situated with respect to n. But they take on a special significance in those cases where t_t coincides with n, as required by the present tense when it is used in the sense of its entry in (10) at the end of Section 3. The reason for this is a further principle, which prohibits the relation "$ev \subseteq n$" except when the present tense is used in one of a number of special ways. In other words, unmarked uses of the present tense in which it is interpreted according to its entry in (10) are possible only when the sentence describes a state, but not when it describes an event.

Prominent among the 'marked' uses of the present tense to which this prohibition does not apply are those known in the literature as the *reportive present* and the *historical present*. (But there are also some other exceptions to the prohibition which arguably do not fall within either of these two categories.) The reportive present is a use of present tense morphology in which each separate (sentential) utterance event is interpreted as providing the deictic anchoring point for the tense of the particular sentence that is just being uttered: the event described in the uttered sentence is taken as simultaneous with the event of uttering that very sentence. The historical use of the present tense is a mode of narration of past episodes in which each sentence is to be seen as involving a fictitious "quasi-utterance time" which coincides with the past eventuality that the sentence speaks of. In both these uses, it has often been noted, the special connection between described event and utterance event that the present tense establishes tends to produce in the interpreter a sense of direct involvement with the subject matter of the discourse, an involvement which would have been absent or less compelling had the speaker/author employed some other mode of discourse.

That the condition "$ev \subseteq n$" is allowed only for such special uses of the present tense is a well-known fact (see [61], [37] or [34]). But why this should be so is another matter. Our conjecture is as follows. In those kinds of discourse where the conditions for the marked uses of the present tense do not apply, the utterance time is on the one hand conceived of as a point. At the same time, however, all points within the duration T_d of the discourse are thought of as equally good candidates for playing the role of the utterance time. This second conception reflects an understanding of the discourse as temporally static: nothing that is of importance to what it talks about changes while it is in progress. It should not matter, therefore, for assessing the truth conditions of any proposition expressed in the course of the discourse, with respect to which of the points within T_d the sentence expressing that proposition is evaluated – i.e. which of these points is taken as its utterance time n. It should be clear that these assumptions are incompatible with the condition "ev $\subseteq$ n". For let t_1 and t_2 be two distinct points within T_d. Then the conditions we get by identifying n with t_1 and t_2, respectively, viz. "ev $\subseteq t_1$" and "ev $\subseteq t_2$", will normally not both be satisfied. (They won't be in any case where there is only one event of the given type occurring within the given discourse time T_d.) So a sentence expressing a proposition whose representation includes "ev $\subseteq$ n" will be inadmissible as part of a discourse of this type.[23]

What has just been said would seem to imply that present tense sentences which describe events are inadmissible unless their tenses are given one of the marked interpretations we have discussed. But this is not so, for there are yet other ways of interpreting present tense morphology, which do not conform to the entry in (10) and do not yield the condition "t_t = n". The first of these, which seems available in a wide variety of languages, is the family of habitual and generic interpretations. According to such interpretations events of the kind described by the sentence happen regularly or typically whenever certain conditions are fulfilled, usually over some period of time which is either implied or given explicitly (e.g. by an adverb in the sentence itself, in much the same way as we saw in Sections 3 and 4, where we explored the interactions between temporal locating adverbs and quantifiers.)

In addition, German has (as opposed to, for example, English) two further options. First, present tense event sentences often allow for a progressive reading. For instance, *Paul schreibt einen Brief.* can be interpreted to mean the same thing as the sentence *Paul is writing a letter* in English. Secondly, German is one of the languages in which the

[23]Note that it is a constraint on discourse of the kind described here that only such eventualities can be described which either (i) lie entirely in the past of T_d, (ii) lie entirely in the future of it, or (iii) include T_d, in which last case they must be conceived as states. These three possibilities are mutually exclusive but they are not jointly exhaustive.

present tense allows for prospective interpretations. Thus in *Paulchen kommt morgen. Und Maria kommt auch.* both occurrences of *kommt* are naturally interpreted as speaking of events on the day after that of the utterance.

For the strictly modular approach towards the computation of sentence meaning which we are pursuing here, the German present tense is a source of considerable complications. Not only is it, as we have seen, ambiguous to a non-trivial degree; a further problem is that there are a number of different factors involved in determining what are the possible interpretations of particular occurrences of the present tense, moreover, among these there are factors of quite different sorts. For example, the question whether a given present tense sentence is an instance of reportive speech, or part of a passage in the historical present, is decided on very different grounds from those that are related to the question whether the sentence has a progressive, habitual/generic or prospective interpretation. A comprehensive treatment of the interpretation of the present tense must (i) identify explicitly what all these factors are; (ii) spell out how each of them is recognised in individual cases; and (iii) account for the ways in which the different factors interact and thereby jointly steer the interpreter towards the intended interpretation. This is a far bigger task than we could have undertaken in this paper and so we will address only a modest set of subtasks. We believe, however, that the issues we will discuss are representative of most of the components that would be needed in a comprehensive account.

We now turn to the formal treatment of some present tense sentences within the framework of this paper. We concentrate on the sentence *Paulchen gewinnt.* in (50.a). The UDRS construction algorithm will at first produce the UDRS on the left of (50.b) with the default entry for the German present tense given in (10), with its conditon '$t_t = n$'. For simplicity we assume as given what kind of utterance is being represented, i.e. if it is an instance of the reportive present, or a historical present, or one of the 'normal' uses, for which any time within the duration of discourse qualifies as a possible utterance time. For now we ignore the 'marked' uses of the present tense, and proceed on the assumption that the given utterance of (50.a) is of the 'normal' kind. (We will return to the marked uses at the end of this section.) On this assumption the UDRS on the left in (50.b) does not yield a coherent interpretation, and reinterpretation of one kind or another is needed. One of the options is to replace the default contribution of the present tense by its prospective interpretation, as shown on the right hand side of (50.b). The resulting DRS is as in (50.c).

(50) a. *Paulchen gewinnt.*
'Paulchen wins.'

b.

$$\begin{array}{|c|}\hline \mathrm{n}\ {}^{\downarrow}\mathrm{t}_t\ \mathrm{p} \\ \mathrm{n} = \mathrm{t}_t \\ \mathrm{Paulchen(p)} \\ \hline \end{array} \qquad \begin{array}{|c|}\hline \mathrm{n}\ \mathrm{t}_t\ \mathrm{p} \\ \mathrm{n} \prec \mathrm{t}_t \\ \mathrm{Paulchen(p)} \\ \hline \end{array}$$

$$\begin{array}{|c|}\hline \mathrm{e} \\ \mathrm{e{:}gewinnen(p)} \\ \mathrm{e} \subseteq {\uparrow}_t \subseteq {\uparrow}_{loc} \\ \hline \end{array} \qquad \begin{array}{|c|}\hline \mathrm{e} \\ \mathrm{e{:}gewinnen(p)} \\ \mathrm{e} \subseteq {\uparrow}_t \subseteq {\uparrow}_{loc} \\ \hline \end{array}$$

c.

$$\begin{array}{|c|}\hline \mathrm{n}\ \mathrm{t}_t\ \mathrm{p}\ \mathrm{e} \\ \mathrm{n} \prec \mathrm{t}_t \\ \mathrm{Paulchen(p)} \\ \mathrm{e{:}gewinnen(p)} \\ \mathrm{e} \subseteq \mathrm{t}_t \subseteq {\uparrow}_{loc} \\ \hline \end{array}$$

As we saw in Section 1, replacement of the default interpretation of the present tense by its prospective interpretation can also be coerced by the presence of an adverb like *morgen* whose referent lies in the future of n. We also saw that such a coercion trigger is necessary for a prospective interpretation when the verbal predication is stative. (In the use of (50.a) the coercion is triggered by the incompatibility of "e $\subseteq$ n" with the assumption that we are dealing with an unmarked discourse mode. But with a state description like *ist krank* we get instead the compatible condition "n $\subseteq$ s", so a prospective interpretation must in this case be triggered by something else.) In (51) this trigger is the adverb *morgen.*

(51) *Morgen ist Paulchen krank.*
'Tomorrow is Paulchen ill.'

The only possible unifications in this case are of the ${\uparrow}_{loc}$ of $\mathrm{l}_\perp$ with the variable ${}^{\downarrow}\mathrm{t}^m_{loc}$ introduced by *morgen* and of the ${\uparrow}_t$ of $\mathrm{l}_\perp$ with ${}^{\downarrow}\mathrm{t}_t$. This clearly leads to a contradiction between "$\mathrm{n} \prec \mathrm{t}^m_{loc}$", "$\mathrm{t}_t$=n" and "$\mathrm{t}_t \subseteq \mathrm{t}^m \subseteq$ s". In this case the prospective interpretation of the present tense is the only way out. (For *Paulchen gewinnt.* this is not so; there a habitual and a progressive interpretation are possible also; we return to this below.)

It is interesting to note that a prospective interpretation is also possible for the present perfect sentence (52),

(52) *Morgen ist Paulchen gesundet.*
'Tomorrow is Paulchen become$_{past.part}$-healthy.'

but only when tomorrow is taken as the time of the result state (the state in which Paulchen is healthy as a result of getting better). This is a further indication that the German perfect tenses can be construed as combinations of an aspectual operator (the perfect) and a simple tense (such as present or preterite). In (52) it is the prospective option for the present tense which is part of the present perfect morphology, that renders a coherent interpretation possible. But this will automatically make tomorrow the time of the result state.

This point is brought out by the interpretation of (52), which in all essential points parallels that of (51). Again the construction of an initial UDRS using the default interpretation of the present tense given by (10) leads to the condition "$\mathrm{t}_t = \mathrm{n}$". This UDRS is given on the left of (53). Ups- and downs-unification in the only way that is possible leads to the conflicting conditions '$\mathrm{n} = \mathrm{t}_t \subseteq \mathrm{t}_{loc} \subseteq \mathrm{t}^m_{loc}$' and 'tomorrow($\mathrm{t}^m_{loc}$)'. This triggers the revision of the interpretation of the present tense in $\mathrm{l}_\top$ that is given on the right hand side of (53), which then yields the reading which (52) actually has.[24]

[24]We use the same abbreviation for the contribution of *morgen* as we used for that of *gestern* in (40) and subsequent representations in Section 4.1. For the full representation compare (14).

(53)

$$
\begin{array}{cc}
\begin{array}{rc}
l_{\top}: & \boxed{\begin{array}{c} n\ {}^{\downarrow}t_t\ p \\ \hline t_t = n \\ \mathrm{Paulchen}(p) \end{array}} \\
 & | \\
 & \boxed{\begin{array}{c} {}^{\downarrow}t^{m}_{loc} \\ \hline \mathrm{tomorrow}(t^{m}_{loc}) \end{array}} \\
 & | \\
 & \boxed{\begin{array}{c} s^{res}\ {}^{\downarrow}t^{ev}_{t}\ {}^{\downarrow}t^{ev}_{loc} \\ \hline \uparrow_t \subseteq \uparrow_{loc} \subseteq s^{res} \\ \uparrow_{ev} \supset\!\subset s^{res} \end{array}} \\
 & | \\
l_{\bot}: & \boxed{\begin{array}{c} e \\ \hline e{:}\mathrm{gesunden}(p) \\ e \subseteq \uparrow_t \subseteq \uparrow_{loc} \end{array}}
\end{array}
&
\begin{array}{rc}
l_{\top}: & \boxed{\begin{array}{c} n\ {}^{\downarrow}t_t\ p \\ \hline t_t \prec n \\ \mathrm{Paulchen}(p) \end{array}} \\
 & | \\
 & \boxed{\begin{array}{c} {}^{\downarrow}t^{m}_{loc} \\ \hline \mathrm{tomorrow}(t^{m}_{loc}) \end{array}} \\
 & | \\
 & \boxed{\begin{array}{c} s^{res}\ {}^{\downarrow}t^{ev}_{t}\ {}^{\downarrow}t^{ev}_{loc} \\ \hline \uparrow_t \subseteq \uparrow_{loc} \subseteq s^{res} \\ \uparrow_{ev} \supset\!\subset s^{res} \end{array}} \\
 & | \\
l_{\bot}: & \boxed{\begin{array}{c} e \\ \hline e{:}\mathrm{gesunden}(p) \\ e \subseteq \uparrow_t \subseteq \uparrow_{loc} \end{array}}
\end{array}
\end{array}
$$

But let us return to example (50.a). The representation on the left of (50.b), we argued, is untenable unless the represented utterance can be understood as a case of reportive present. If that option is foreclosed, then one way out is to go for the prospective interpretation given on the right hand side of (50.b). But it is not the only one. (50.a) also allows for (i) a progressive interpretation, according to which Paulchen is in the process of winning (e.g. the pile of chips in front of him is steadily growing) and (ii) the "habitual" interpretation, according to which he habitually, typically or normally wins; in the case of (50.a) this is the sense conveyed by the reply "Paulchen gewinnt!" that you might get when you have expressed your intention to play against Paulchen for serious money and the speaker wants to warn you: "I wouldn't take on Paulchen if I were you. Paulchen wins!".[25] For non-stative predications progressive and habitual interpretations are always possible in principle, though their acceptability varies somewhat with the choice of verb. This is true not only for the present tense but for other tenses as well, though

[25] We ignore the finer distinctions between events of a certain type happening 'habitually', 'nomally', 'typically', etc. These distinctions would have to be captured in the form of different semantic analyses for the predicate HAB occurring in (54) below.

for other tenses habitual readings tend to be harder to get and to require some further sentence element which forces such an interpretation.

Both these last two reinterpretation options involve representations which relate the eventuality described by the reinterpreted sentence to the type of eventuality described by its verbal predication on its initial interpretation. In both cases this relation is given by a non-veridical aspect operator (see fn. 17 in Section 4). Unlike the veridical operator PERF these operators are not easy to define explicitly, a difficulty that is vividly illustrated by the extensive literature on the semantics of the progressive and on the meaning and logic of habitual and generic quantification. (For an overview see [7].) We leave these semantic problems for what they are and limit ourselves to purely formal entries for the operators, in which all the semantic complexities are hidden within some unanalysed predicate of eventuality types. (We use for these predicates the same names as for the operators themselves.) Moreover, we look here in some detail at the habitual-generic operator HAB. For HAB we propose the following schematic entry.

(54) $$\text{HAB} \rightsquigarrow \boxed{\begin{array}{c} s^{hab} \\ \\ \uparrow_t \subseteq \uparrow_{loc} = s^{hab} \\ s^{hab}\text{:HAB}(\lambda ev.\boxed{\begin{array}{c} {}^{\downarrow}t^{ev}_{t}\ {}^{\downarrow}t^{ev}_{loc} \\ \uparrow_{ev} \subseteq s^{hab} \end{array}}) \end{array}}$$

Like PERF and other aspect operators, HAB is treated as making a state s^{hab} out of a verbal predication. Once again the ups-arrow on ev indicates that the eventuality variable ev must be replaced by the designated eventuality variable from the UDRS component whose ups variables unify with ${}^{\downarrow}t^{ev}_{t}$ and ${}^{\downarrow}t^{ev}_{loc}$, with the effect that the two components are merged (see fn. 17 of Section 4). But in the case of HAB the replacing eventuality variable gets λ-abstracted, so that the UDRS component to which it belongs contributes an eventuality type to the sentence UDRS, rather than the representation of a single eventuality with certain specific properties. As with quantificational states it is assumed that the duration of the resulting s^{hab} within which events of the described type are said to occur 'habitually' is determined by $\uparrow_{loc}$. The motivation is the same: The claim that events of a certain kind happen habitually over a certain period is a claim that occurrences of this event type are distributed over the period in a certain way. Such claims may be true of a certain period without being true either of periods included within it or periods within which it is included. In view of this we insist, just as with quantificational states, that the duration of s^{hab} is identical with its $\uparrow_{loc}$.[26]

Another difference between PERF and HAB is that PERF is associated with a particular element in syntactic structure (viz with the past participle). For HAB this is often not so, and in particular it isn't in the cases under consideration. One way of saving the interpretation of (50.a), we said, takes the form of assigning a habitual interpretation to the verb. The natural implementation of this is to assume an optional rule of "habitual-reinterpretation" which takes the form of inserting the semantic entry (54) for HAB immediately below the component $l_\top$ which carries the tense information. For (50.a) the result is the UDRS given in (55).

(55)
$$
\begin{array}{c}
l_\top: \boxed{\begin{array}{c} n \ {}^{\downarrow}t_t \ p \\ \\ t_t = n \\ \text{Paulchen}(p) \end{array}} \\
| \\
\boxed{\begin{array}{c} s^{hab} \\ \\ \uparrow_t \subseteq \uparrow_{loc} = s^{hab} \\ s^{hab}\text{:HAB}(\lambda ev. \boxed{\begin{array}{c} {}^{\downarrow}t^{ev}_t \ {}^{\downarrow}t^{ev}_{loc} \\ \\ \uparrow_{ev} \subseteq s^{hab} \end{array}}\ ) \end{array}} \\
| \\
l_\bot: \boxed{\begin{array}{c} e \\ \\ e\text{:gewinnen}(p) \\ e \subseteq \uparrow_t \subseteq \uparrow_{loc} \end{array}}
\end{array}
$$

[26](54) ignores one important aspect of habitual readings. Habitual statements are often meant to be understood as saying that the events in question occur habitually (within the given period) on occasions of a certain kind, where it is left to context to tell the interpreter what kind of occasion is intended. This is a complication which also arises in connection with nominal and adverbial quantifiers. In connection with quantification the matter will be taken up in [36]. It is straightforward to modify (54) in the spirit of the proposals which will be made there.

Conversion of (55) yields the DRS (56).

(56)
$$\boxed{\begin{array}{c} \mathrm{n}\ \mathrm{t}_t\ \mathrm{p}\ \mathrm{s}^{hab} \\ \hline \mathrm{t}_t = \mathrm{n} \\ \mathrm{Paulchen(p)}\ \ ;\ \ \mathrm{t}_t \subseteq \uparrow_{loc} = \mathrm{s}^{hab} \\ \mathrm{s}^{hab}\mathrm{:HAB}(\lambda \mathrm{e}.\boxed{\begin{array}{c} \mathrm{e}\ \mathrm{t}_t^{ev}\ \mathrm{t}_{loc}^{ev} \\ \hline \mathrm{e} \subseteq \mathrm{s}^{hab} \\ \mathrm{e:gewinnen(p)} \\ \mathrm{e} \subseteq \mathrm{t}_t^{ev} \subseteq \mathrm{t}_{loc}^{ev} \end{array}}\ ) \end{array}}$$

Coercion of (50.a) towards a progressive interpretation involves the same steps as the construction of (56). It makes use of an optional rule of PROG-insertion. (For a discussion of PROG within DRT see [22].) Note well that this optional PROG-insertion rule does not hold for English.

A final observation on the three reinterpretation options we considered in connection with (50.a): The three interpretations involved – prospective, progressive and habitual – are in general not mutually exclusive. For instance, in (57) the clause *schreibt er mit Sicherheit einen Brief an den Minister* can (and in fact, must) be interpreted as involving both a prospective interpretation of the present tense and a progressive interpretation of the verbal predication.

(57) *Wenn du morgen zu Paulchen ins Büro gehst, schreibt er mit Sicherheit einen Brief an den Minister. Aber ebenso gewiss ist, dass er den Brief nie zu Ende schreiben wird.*
"When you go and see Paulchen tomorrow in his office, then he will no doubt be writing a letter to the minister. But there is no doubt either that he will never finish that letter."

As a matter of fact, the compatibility between prospective tense, PROG and HAB, allows them in principle to combine in semantic representations in various ways. Nevertheless it is not all that common for more than one of them to be involved in any given coercion. This should not be surprising, inasmuch as there appears to be a general tendency for repair strategies to be carried out as "parsimoniously" as possible. (57) is exceptional in that the prospective interpretation of the present and the progressive interpretation of the verb are required explicitly and separately, the first by the initial *wenn*-clause, and the second by the added sentence which makes it clear that what is being spoken of is a letter-writing activity which will not culminate in a completed accomplishment.

We conclude our discussion of the options available for the reinterpretation of present tense sentences with a couple of remarks on the cases which we temporarily set aside earlier – those where the utterance is of one of the "non-normal" kinds, such as reportive speech or the historical present. About the case of reportive speech we can be brief. Here the entailed condition "$e \subseteq n$" is not seen as incoherent, but rather as in agreement with the intuition that it is the utterance time n of the current sentence which locates e. It is arguable whether in such cases the utterance time is to be identified with the duration of e, i.e. whether "$e \subseteq n$" should be strengthened to "$dur(e) = n$", where $dur(e)$ denotes the duration of e. We leave this for others to decide.

The historical present has certain aspects in common with the reportive present, but there are also important differences. One intuition which has often been expressed about the use of the historical present is that it is a narrative device to present past events 'as if they were happening then and there' – as if the interpreter was in some sense transported to the time when these events did happen (even though of course he will be aware that it is the past that is being spoken of and not the real present). We can capture part of this intuition by assuming that the use of the historical present introduces a fictitious utterance time n', which is located in the past of the real utterance time n and cotemporal with the described eventuality. In order that we get a coherent interpretation it must be assumed that in those cases where the eventuality is an event e, n' is large enough to temporally include e. For only then can the entailed condition "$e \subseteq n'$" be satisfied. This implies that n' is not only fictitious in that it is situated in the past of the real utterance time n; it is also very often the case that the time which n' represents must be vastly larger than real utterance times normally are. (58) gives some examples which illustrate this in an increasingly dramatic way.

(58) a. *Am 19. Mai reist Paulchen von London nach Aberdeen.*
"On the 19-th of May Paulchen travels from London to Aberdeen."

b. *1066 erobert William the Conqueror den Großteil Großbrittaniens.*

"In 1066 William the Conquerer takes possession of much of Britain."

c. *Die ersten Wirbeltiere entstehen im Silur.*
"The first vertebrate species establish themselves during the Silurian."

These examples also show another feature of the historical present, viz. that it can combine with locating adverbs which refer to times before the real utterance time n.

An aspect which the historical present shares with its reportive use is that utterance time typically 'moves on' as the discourse proceeds. For the events described in successive sentences of a discourse in the historical present quite often follow each other, rather than being simultaneous. In cases of the historical present this is typically made explicit through the use of adverbs which refer to successive times. For instance, (58.a) could be followed by *Am 21. macht er einen Tagesausflug nach St. Andrews.* (Engl.: *On the 21-th he makes a day trip to St. Andrews.*) The combined effect of successive n′'s, with each of them standing for a substantial stretch of time, can produce in the recipient a sense of moving through time at, sometimes, vertiginous speed. (Admittedly this effect is also produced by similar sentence sequences in which the tenses are pasts rather than presents, but the present tense seems to add a special flavour to this sense of 'time travel'.)

Given our assumption that historical uses of the present tense give rise to fictitious utterance times n′, the contribution which the historical present makes to sentence interpretation can be represented as in (59).

(59) Historical Present $\rightsquigarrow \boxed{\begin{array}{c} \mathrm{n}' \ {}^{\downarrow}\mathrm{t}_t \\ \\ \mathrm{n}' \prec \mathrm{n} \\ \mathrm{n}' = \mathrm{t}_t \end{array}}$

Note that this entry allows for n′, and thus the described event e, to be included within the time denoted by a temporal adverb when this time lies entirely in the past of the real utterance time n. It should also be clear that the representation of a sequence of successive sentences in the historical present will involve a sequence n'_1, ..., n'_k of fictitious utterance times, as a rule related to each other as "$\mathrm{n}'_1 \prec \mathrm{n}'_2 \prec ... \prec \mathrm{n}'_k$". (In this last respect the historical present resembles the reportive present. There too a sequence of present tense sentential utterances gives rise to a sequence of utterance times "$n'_1 \prec n'_2 \prec ... \prec n'_k$"; the only difference is that in this case the successive n'_i represent the times of the corresponding utterance events u_i.)

Incomplete as these observations about the German present tense are, they clearly point to the difficulty of stating in a succinct and transparent way what its semantic contribution can be to the various sentences in which it occurs. To put the question in a slightly different form: What could a 'lexical entry' for the German present be like which specifies this range of possible contributions, and the conditions under which they can be realised? We will briefly turn to this question at the end of the next section.

6 Ambiguity and Underspecification

We saw in the last section that one of the options for interpreting German present tense sentences with non-stative eventuality descriptions is to take them as progressives. We also noted in passing that this option exists not only for the present tense but for all simple tenses (i.e. all those which do not involve perfect tense morphology). That this option exists does not mean, however, that in all sentences where it is available, interpreters must decide whether or not to choose it. Take for instance the past tense sentence (60).

(60) *Paulchen gesundete.*
"Paulchen recovered."

Our line so far has been that this sentence allows for a progressive interpretation, according to which at some contextually salient time Paulchen was in the process of recovering, as well as a non-progressive one, according to which there was a time in the past when Paulchen (fully) recovered. However, a person who hears or reads (60) need not make a concious choice between a progressive and a non-progressive interpretation; and often he won't. On this point German differs from English, where the distinction between progressive and non-progressive interpretations is as a rule morphologically marked.

The case of (60) is an example of a far more general phenomenon: A certain syntactic form is compatible with two or more semantic representations; in some contexts of use the interpreter may be forced to choose between these representations, but in others he can afford to refrain from doing so – and often he will, leaving the interpretation he assigns to the form *underspecified*.

In this regard cases of underspecification differ from cases of what we would want to call *genuine ambiguity* (for an overview see [62],[6]). If an expression is genuinely ambiguous between two or more representations, then no interpretation of an occurrence of it is complete unless it decides between these. Admittedly this distinction between genuine ambiguity and underspecification is a delicate one, and for all we know there may be no sharp dividing line that separates the two. But the distinction is nevertheless important, and there are some cases for which it seems intuitively clear to which of the two categories they belong. Thus the distinction between progressive and non-progressive episodic interpretations of Geman non-stative sentences in the past or future tense appears to be a clear case of underspecification. On the other hand, the distinction between a habitual and a progressive interpretation of (61)

(61) *Paulchen gewinnt!*
'Paulchen wins!'

seems to us a clear case of genuine ambiguity: So long as one hasn't assigned to an utterance of these words either their episodic-progressive reading or their habitual-generic one, one cannot claim to have understood what the speaker said.[27]

To our knowledge no theory currently exists which accounts in systematic terms for which ambiguities must be resolved when. Nor is this the place to try and develop one. But we do want to record our conviction that there exist cases of "cognitively real" underspecification, in which interpretation does not carry an automatic requirement of resolution. The underspecified representations which we have been using up to

[27]Think for instance of a use of (61) on an occasion where Paulchen is sitting behind a stack of chips which, like on most other occasions where he enters a game, is slowly growing. In this situation both readings are plausible. And yet, you cannot escape the sense that the speaker must have meant either one or the other, and that you cannot claim to have understood what he said so long as you don't know which one he intended.

now do not cater for this kind of underspecification. They serve as intermediate stages on the way towards final representations which take the form of DRSs, representations in which all instances of underspecification present at earlier computation stages have been resolved. What we want at this point is a device for representing alternative semantic options that may also remain as part of the final representation of a sentence. To this effect we introduce the symbol $\overset{!}{\vee}$. From the point of view of the syntax of our representations $\overset{!}{\vee}$ acts as a kind of disjunction: It enables us to combine two or more representations of alternative interpretations and to treat such combinations of alternatives as constituents of larger representations. It should be stressed, however, that if conditions involving $\overset{!}{\vee}$ superficially look like disjunctions, this is strictly speaking not what they are from a semantic point of view. For instance, a condition of the form "$K_1 \overset{!}{\vee} K_2$ ", where K_1 and K_2 are DRSs, should not be confused with the disjunctive DRS condition "$K_1 \vee K_2$" of standard DRT. The latter expresses the familiar truth conditions of (inclusive) disjunction: it is true in all worlds or situations in which either K_1 is true or K_2 is true (or both are). In contrast, "$K_1 \overset{!}{\vee} K_2$" serves as an indication that each of K_1 and K_2 remains available as an interpretational option.

The difference between "$K_1 \overset{!}{\vee} K_2$" and "$K_1 \vee K_2$" is particularly clear where the choice between K_1 and K_2 that is expressed by "$K_1 \overset{!}{\vee} K_2$" is an instance of genuine ambiguity. In this case a representation containing "$K_1 \overset{!}{\vee} K_2$" is incomplete, and meaningful only as a step towards a complete interpretation, which will be reached only when "$K_1 \overset{!}{\vee} K_2$", is resolved, i.e. when it is replaced either by K_1 or by K_2. There is a difference between "$K_1 \overset{!}{\vee} K_2$" and "$K_1 \vee K_2$" also in cases where the alternative expressed by "$K_1 \overset{!}{\vee} K_2$" is a case of underspecification, although admittedly in such cases the difference is harder to make out, and more closely connected with further assumptions we make about the architecture of semantic theory. Superficially an interpreter who refrains from committing himself to either K_1 or K_2 will connect with "$K_1 \overset{!}{\vee} K_2$" the same truth conditions that are also represented by the disjunction "$K_1 \vee K_2$": When he takes the utterance whose representation contains "$K_1 \overset{!}{\vee} K_2$" to be true, he thereby commits himself to the assumption that the world described by the utterance is one in which either K_1 or K_2 is true, just as he would when his representation were to contain "$K_1 \vee K_2$". But even in such cases there is a difference. When the discourse makes additional information available, in the light of which one of K_1 and K_2 is untenable, then this will lead to a *revision* of the representation with "$K_1 \overset{!}{\vee} K_2$", in which the "$K_1 \overset{!}{\vee} K_2$" is replaced by the remaining "disjunct". A representation with "$K_1 \vee K_2$" will not require any revision in such a situation, although of course the interpreter may use the new information to infer another representation from it, which contains the tenable disjunct instead of the disjunction.

The only use of $\overset{!}{\vee}$ that we will consider here in some detail concerns underspecification of the distinction between the progressive and the non-progressive interpretation of non-stative German sentences with simple tenses. (62) is a schematic representation of this underspecification as it is contributed by the non-stative eventuality representation.

$$(62)\quad \boxed{\begin{array}{c} \mathrm{s} \\ \uparrow_t \subseteq \uparrow_{loc} \subseteq \mathrm{s} \\ \mathrm{s{:}PROG}\ (\lambda\ \mathrm{e}.\ \boxed{\begin{array}{c} \mathrm{e}\ {}^{\downarrow}\mathrm{t}_t^e\ {}^{\downarrow}\mathrm{t}_{loc}^e \\ \uparrow_e \subseteq t_t^e \subseteq t_{loc}^e \end{array}}\ ) \end{array}} \overset{!}{\vee} \boxed{\begin{array}{c} {}^{\downarrow}\mathrm{t}_t^e\ {}^{\downarrow}\mathrm{t}_{loc}^e \\ \uparrow_e \subseteq \uparrow_t \subseteq \uparrow_{loc} \\ \uparrow_t = \mathrm{t}_t^e\ ;\ \uparrow_{loc} = \mathrm{t}_{loc}^e \end{array}}$$

The left hand side of the $\overset{!}{\vee}$-condition represents the progressive interpretation. This UDRS component functions in essentially the same way as the entry for the operator HAB presented as (54) in Section 5. Ups- and downs-unification has the effect that an event-specifying UDRS component (normally, and possibly always, $l_\perp$) is merged with the argument of PROG and thus serves to define what type of progressive state is represented by s. The right hand side of the $\overset{!}{\vee}$-condition is designed so that it is transparent to unification between up-arrows below it and down-arrows above it. Thus, in simple representations, which have apart from an instance of (62) only the components $l_\top$ and $l_\perp$, the $\uparrow_t$-variable for the event introduced by the verb will unify with the ${}^{\downarrow}t_t$-variable introduced by tense. In (62) this transparency has been captured in the somewhat roundabout way of two unifications – of the downs-variable of its right hand side with the ups-variable of $l_\perp$ and of the ups-variable of the right hand side with the ${}^{\downarrow}t_t$-variable of $l_{\top}$. (Moreover, the ${}^{\downarrow}t_{loc}$-variable of the right hand side will unify with the $\uparrow_{loc}$ of $l_{\top}$.)

We begin by constructing an interpretation for (60), in which the choice between progressive and non-progressive reading is represented as a case of underspecification. The crucial step of this construction is that which combines (62), our representation of the progressive-non-progressive abiguity, with the lexical enry for the verb *gesunden*. This entry, which is essentially like that for *gewinnen* in (9), is given in (63).

(63) $$\textit{gesunden} \rightsquigarrow \boxed{\begin{array}{c} \mathrm{e} \\[4pt] \mathrm{e{:}gesunden}(\mathbf{x}^{subj}) \\ \mathrm{e} \subseteq \uparrow_t \subseteq \uparrow_{loc} \end{array}}$$

Combining (62) with (63) takes the form of unifying and merging of (63) with each of the "disjuncts" of (62). In combination with the construction principles used in earlier sections this leads to the DRS for (60) that is given in (64).

(64) $$\begin{array}{c} \boxed{\begin{array}{c} \mathrm{n}\ {}^{\downarrow}\mathrm{t}_t\ \mathrm{p} \\[4pt] \mathrm{Paulchen(p)} \\ \mathrm{t}_t \prec \mathrm{n} \end{array}} \\ | \\ \boxed{\boxed{\begin{array}{c} \mathrm{s} \\[4pt] \uparrow_t \subseteq \uparrow_{loc} \subseteq \mathrm{s} \\ \mathrm{s{:}PROG}\ (\lambda\ \mathrm{e.} \boxed{\begin{array}{c} \mathrm{e}\ \mathrm{t}_t^e\ \mathrm{t}_{loc}^e \\[4pt] \mathrm{e{:}gesunden(p)} \\ \mathrm{e} \subseteq \mathrm{t}_t^e \subseteq \mathrm{t}_{loc}^e \end{array}}\ ) \end{array}} \ \overset{!}{\vee}\ \boxed{\begin{array}{c} \mathrm{e}\ \mathrm{t}_t^e\ \mathrm{t}_{loc}^e \\[4pt] \mathrm{e} \subseteq \uparrow_t \subseteq \uparrow_{loc} \\ \uparrow_t = \mathrm{t}_t^e\ \ ;\ \ \uparrow_{loc} = \mathrm{t}_{loc}^e \\ \mathrm{e{:}gesunden(p)} \\ \mathrm{e} \subseteq \mathrm{t}_t^e \subseteq \mathrm{t}_{loc}^e \end{array}}} \end{array}$$

Of the remaining unifications the one involving $\uparrow_{loc}$ cannot be carried out sentence-internally, as (60) doesn't have any locating adverbs. But unification of $\uparrow_t$ is possible and yields the representation given in (65).

(65)
$$\boxed{\begin{array}{c} \text{n s } \text{t}_t \text{ p} \\ \text{Paulchen(p)} \\ \text{t}_t \prec \text{n} \\ \boxed{\begin{array}{c} \text{s} \\ \text{t}_t \subseteq \uparrow_{loc} \subseteq \text{s} \\ \text{s:PROG } (\lambda \text{ e. } \boxed{\begin{array}{c} \text{e t}_t^e \text{ t}_{loc}^e \\ \text{e:gesunden(p)} \\ \text{e} \subseteq \text{t}_t^e \subseteq \text{t}_{loc}^e \end{array}}\ ) \end{array}} \overset{!}{\vee} \boxed{\begin{array}{c} \text{e t}_t^e \text{ t}_{loc}^e \\ \text{e} \subseteq \text{t}_t \subseteq \uparrow_{loc} \\ \text{t}_t = \text{t}_t^e \ ; \ \uparrow_{loc} = \text{t}_{loc}^e \\ \text{e:gesunden(p)} \\ \text{e} \subseteq \text{t}_t^e \subseteq \text{t}_{loc}^e \end{array}} \end{array}}$$

For a past tense sentence like (60) (65) – or the result of replacing the conditions $e \subseteq t_t \subseteq \uparrow_{loc}$ and $\uparrow_{loc} = t^e_{loc}$ in the right hand $\overset{!}{\vee}$-disjunct by $e \subseteq t_t \subseteq t^e_{loc}$ – can serve as its final interpretation. But for the corresponding present tense sentence (66) this will in general not be so.

(66) *Paulchen gesundet.*
'Paulchen recovers!'

The reason for this we already encountered in the last section. Unless the present tense of (66) is used in some such special way as that of the reportive or historical present, the right hand side of the $\overset{!}{\vee}$-condition leads to incoherence. More explicitly, the representation for (66) which corresponds to the one which (65) gives for (61) is identical with (65) except that it has "$t_t = n$" in lieu of (65)'s condition "$t_t \prec n$". The conflict with the condition "$e \subseteq n$" which is now entailed by the right hand side argument of $\overset{!}{\vee}$ leads to its elimination, and thus to the replacement of the $\overset{!}{\vee}$-condition by its left hand side argument. The result is given in (67).

(67)
$$\boxed{\begin{array}{c} \mathrm{n\ s\ t}_t\ \mathrm{p} \\ \\ \mathrm{Paulchen(p)} \\ \mathrm{t}_t = \mathrm{n} \\ \mathrm{s{:}PROG}\ (\lambda\ \mathrm{e.}\ \boxed{\begin{array}{c} \mathrm{t}_t^e\ \mathrm{t}_{loc}^e \\ \\ \mathrm{e{:}\ gesunden(p)} \\ \mathrm{e} \subseteq \mathrm{t}_t^e \subseteq \mathrm{t}_{loc}^e \end{array}}\ ) \\ \mathrm{t}_t \subseteq \uparrow_{loc} \subseteq \mathrm{s} \end{array}}$$

These examples were intended as illustrations of what $\overset{!}{\vee}$ means and how it is used in the construction of interpretations. But it should be clear, especially in the light of the discussions of the last section, that as a treatment of the ambiguities connected with non-stative sentences in the present or simple past the analyses we have just given of (61) and (66) are woefully incomplete. They entirely ignore the possibility of a habitual interpretation, and the prospective option is missing too, which is certainly relevant in the case of (66), if less obviously so in the case of (61). Given that these additional options exist, one should have expected, for instance, an initial representation of (66) which mentions four alternative options, rather than the two that are shown in (62).

To obtain such a representation, with a four-membered $\overset{!}{\vee}$-condition to replace the simplified condition (62), we would need for a start a component in which all these four options are represented. (68) – in which $\mathcal{K}$ is the $\overset{!}{\vee}$-condition given in (62) – constitutes a first shot at this. It thus should be seen as an improvement on (62); and we obtain an improved version of the extremely simple entry for the German Präsens fiven in (10), if we substitute (68) for its condition '$\mathrm{t}_t = \mathrm{n}$'.

(68)
$$\boxed{\begin{array}{c} \downarrow_t \\ \mathcal{K}\ \overset{!}{\vee}\ \boxed{\begin{array}{c} \mathrm{s}^{hab} \\ \\ \mathrm{t}_t = \mathrm{n} \\ \uparrow_t \subseteq \uparrow_{loc} = \mathrm{s}^{hab} \\ \mathrm{s}^{hab}\mathrm{:\ HAB}\ (\lambda\ \mathrm{ev.}\ \boxed{\begin{array}{c} \downarrow\mathrm{t}_t^{ev}\ \downarrow\mathrm{t}_{loc}^{ev} \\ \uparrow_{ev} \subseteq \mathrm{s}^{hab} \end{array}}\ ) \end{array}}\ \overset{!}{\vee}\ \boxed{\mathrm{n} \prec \mathrm{t}_t} \end{array}}$$

But this is just one step in the right direction. A number of additional devices are needed to secure a treatment of present tense sentences that is empirically satisfactory and at the same time fully general. Recall for instance our observation that the distinction between generic and episodic interpretations is unlike that between progressive and non-progressive episodic interpretations in that it should be resolved invariably. This is a distinction which the construction algorithm should capture, and thus one that must be marked in some appropriate way in the representations on which the algorithm operates. Also, we noted in Section 5 with regard to the prospective interpretation of the German present tense, such an interpretation seems to require some kind of trigger. So a proper treatment will have to specify what can trigger prospective interpretations and what cannot. This conditional availability of certain readings is another aspect of the interpretation of sentences such as (66) to which the treatment presented in this section has paid no attention.

7 The Algorithm

In the course of this paper we have presented constructions of a good many semantic representations. With some of our examples, especially the earlier ones, we made an effort to show individual steps of the construction procedure, and we hope that in this way we have managed to give a fairly good impression of the principles involved. But an explicit definition of the construction algorithm, for a fragment of German which includes all the sample sentences we have considered, is quite another matter.

Such a definition we won't (and could not) give here. (Just the syntactic and lexical specification of the fragment, which such a definition presupposes, is a non-trivial and lengthy project, most of which would have little direct relevance to this paper's central concerns.) What we will do is state the principles which govern that aspect of the semantic representation constructions exemplified in previous sections that we see as one of the original contributions of this paper and which has been a focus throughout: The unification between ups-variables and downs-variables.

We begin with a brief description of the over-all architecture of representation construction and then state the rules for ups-and-downs unification. The starting point for the construction of semantic representations are syntactic analyses of sentences, given in the tree format familiar from generative grammar. In a first pass the syntactic tree of a given sentence S is transformed into an "initial" UDRS. This UDRS is processed further, with the goal of obtaining a sentence representation in the form of a "preliminary" DRS. This representation – which will in general be a preliminary DRS in that it contains explicit representations of presuppositions triggered by elements of S – is then subjected to a third procedure, in which it is connected with the context in which S has been used. It has been a default assumption in recent work on DRT ([32], [33], [22]) that it is during this third processing stage that the presuppositions of the preliminary representation are justified (and their representations consequently eliminated from the sentence representation), whereupon the resulting DRS is merged with the discourse context.[28]

The third construction stage has played virtually no part in the discussion of earlier sections, and nothing will be said about it in this one. (We refer the reader to [22] for some of the details on the justification of presuppositions.) Of the first construction stage we have given some samples, but an explicit formulation of the procedure will have to wait to some other occasion, since as we said it requires the explicit definition of a sufficiently inclusive fragment of German. In what follows we focus on the second stage, and more particularly on the principles governing the unification of ups-and downs-variables which occurs during this stage.

We base our description of these principles on the assumption that UDRSs are structured as described in the UDRS literature (see ([55], [56]). In any case, the formal definition of the concept of a UDRS will be repeated below.) As regards the principles themselves, they are divided into two kinds:

[28]However, nothing speaks against the practice of dealing with certain presuppositions at an earlier stage. In fact, we have been making use of this possibility in all the constructions we have shown, for instance in assuming that the presupposition connected with the proper name *Paulchen* is dealt with even before the second processing phase gets under way. Many deviations from the default order of the different processing operations are possible, in virtue of the high degree of modularity of our approach and the largely declarative formulations which now exist for UDRS- and DRS-construction (including the formulations which will be given below). It is often useful to make use of this possibility of deviating from the canonical order by first performing those steps which are straightforward in that they do not involve non-trivial decisions about ambiguity resolution. The results of these steps will then be available to support such decisions if and when they arise during the execution of other processing steps. Early justification of presuppositions is just one example of this strategy.

1. Principles concerning the types of unifiable variables and corresponding uniqueness requirements.
2. Principles which constrain unification in terms of the order relations between the representation components to which the unified variables belong.

The principles of the first kind should be fairly clear from their illustrations in the examples we have discussed, and they can be stated succinctly. Recall that ups- and downs-variables come in two types, indicated by the subscripts t and loc on ups-arrows and on down-arrowed variables. In this section we will use 't' and 'loc' also as names for these types.

The principles of the first kind can now be stated as follows:

Principle (1.a) Unification is type-specific
Unification must always be between variables of the same type: downs-variables of type t must unify with ups-variables of type t, and conversely; and the same holds for ups- and downs-variables of type loc.

Principle (1.b) Uniqueness and Exhaustivity
Each downs-variable must unify, and it may unify with only one ups-variable. Similarly, each ups-variable of type t must unify with exactly one ups-variable.
An ups-variable of type loc may unify with more than one downs-variable of its type. Ups-variables of type loc are not required to unify sentence-internally. An ups-variable of type loc which does not unify with a corresponding downs-variable remains as part of the representation until it has received a suitable value in context.[29]

[29] The role played by an ups-variable $\uparrow_{loc}$ which is not unified with a downs-variable of type loc is strongly reminiscent of presuppositions – in either case there is a requirement of the context to provide an adequate justification or resolution. In light of this similarity it may be asked whether ups- and downs-variables should not be considered more generally as embodying presuppositions of some sort, with ups-and-downs unification constituting the case of sentence-internal resolution. To some extent this is a matter of terminology. But whether or not we choose to adopt it, it should be kept firmly in mind that the "justification" rules for the "presuppositions" connected with ups- and downs-variables would be of a very special kind: With the

To state the remaining principles is somewhat more involved than it was for the first group, and it requires some preliminary formal definitions. We recall from the UDRT literature that a UDRS can be defined as a structure $\mathbf{K} = \langle\{l{:}R_l\}_{l\in L}, \langle L, <_{\mathbf{K}}\rangle\rangle$, where the pairs $l{:}R_l$ are the components of $\mathbf{K}$, each one consisting of a label l and a representation R_l; L is the set of all these labels of $\mathbf{K}$. $\mathbf{K}$ is to be thought of as a directed graph whose nodes are the members of L and whose edges constitute a binary relation $<_{\mathbf{K}}$ on L. $<_{\mathbf{K}}$ is the skeleton of a strict partial order in the sense that its transitive closure in L is a strict partial order of L. We refer to the transitive closure of $<_{\mathbf{K}}$ as $<^*_{\mathbf{K}}$. It is assumed that for the sentence UDRSs considered in this paper $<^*_{\mathbf{K}}$ is always a lattice, whose top element is labelled $l_\top$ and bottom element $l_\perp$.[30]

When (in the course of the second processing phase) a UDRS $\mathbf{K}$ is turned into a DRS K', the components of $\mathbf{K}$ are "fitted together" according to rules familiar from UDRT. Fitting together can take in essence two forms. The first way in which two UDRS components $l{:}R_l$ and $l'{:}R_{l'}$ can be fitted together is through DRS merge of the representations R_l and $R_{l'}$. The second form occurs in cases where one of the two components has one or more "slots" for DRSs. In such a case the other component may be inserted into this slot, or into one of these slots. "Insertion" takes the form of DRS-merge of the second component with the empty or schematic DRS which constitutes the relevant slot in the first component. UDRS components which have such slots can be thought of as operators. In the UDRS formalism we have used in this paper the slots which such operator-type components make available are of the following sorts: (i) slots of the compex DRS-conditions involving the logical operators $\Rightarrow$, $\vee$, ; and $\neg$ (the first three are 2-place, i.e. have two slots, while

exception of certain instances of $\uparrow_{loc}$, unifications of ups- and downs-variables are always clause-internal. This is in marked contrast to the form that presupposition justification normally takes: Justifications of the presuppositions which the presupposition literature tends to treat as paradigmatic – among them those connected with definite descriptions, with factive and with aspectual verbs, and with particles like *too* and *again* – are more often than not justifications by the sentence-external context. Sentence-internal justification is the exception rather than the rule, and clause-internal justification tends to be ruled out altogether.

[30] In cases like those discussed in Section 3, where the component representing the verbal predication can be merged with either the restrictor or the nuclear scope of a duplex condition, we can without loss of generality assume that $\mathrm{l}_\perp$ labels the 'dummy', empty UDRS-component.

the last one is 1-place, and thus has one slot); (ii) the slots of duplex conditions, used here to represent both nominal and adverbial quantifiers; (iii) the argument slots of the aspectual operators PERF, HAB and PROG.

We assume that when two components are fitted together in the second way, then each one retains its label. When they are combined in the first way, then the labels l and l' are combined into the set $\{l, l'\}$ as label for the merge. (When components are fitted together successively then those combined at later stages may themselves be labeled by sets. In such cases the result of merging will be labeled by the union of the labels of the merged components. In this way (and identifying single labels with their singleton sets) the resulting DRS and its sub-DRSs will all get labels that are sets of members of L, thus the transition from the UDRS **K** to the DRS K$'$ induces a map from L to $\mathcal{P}(L)$.)

As explained in all the standard introductions to DRT, each DRS K$'$ determines a certain partial order, its so-called accessibility relation $\leq_{\mathrm{K}'}$, on the set of its sub-DRSs, where the DRS itself is counted as one of its own sub-DRSs. (In particular, when the sub-DRS K_1 fills the slot of a condition involving one of the aspect operators PERF, HAB or PROG and this condition belongs to the sub-DRS K_2, then $\mathrm{K}_1 \leq_{\mathrm{K}'} \mathrm{K}_2$.) In the case where K$'$ results as the transformation of a UDRS **K**, its accessibility relation induces a preordering $\leq_{\mathrm{K}',\mathrm{L}}$ on the members of L: for $l_1, l_2 \in L$, $l_1 \leq_{\mathrm{K}',\mathrm{L}} l_2$ iff there are sub-DRSs K_1 and K_2 of K$'$ such that K_2 is accessible from K_1 and l_1 and l_2 belong to the labels of K_1 and K_2 respectively. $\leq_{\mathrm{K}',\mathrm{L}}$ is a preordering and in general not a weak partial ordering in the strict sense or the term, because two different labels l, $l' \in L$ may end up as members of the same DRS label. In this case we have $l \leq_{\mathrm{K}',\mathrm{L}} l'$ and $l' \leq_{\mathrm{K}',\mathrm{L}} l$, while $l \neq l'$. In the remainder of this section we write "$l \equiv_{\mathrm{K}'} l'$" in lieu of "$l \leq_{\mathrm{K}',\mathrm{L}} l'$ and $l' \leq_{\mathrm{K}',\mathrm{L}} l$". The accessibility relation $\leq_{\mathrm{K}'}$ is of course a weak partial ordering on the set of labels of these sub-DRSs, but these labels are, as we saw, subsets of L, not members. Clearly, $l' \leq_{\mathrm{K}',\mathrm{L}} l''$ iff $\exists$ L$'$,L$''$ (L$'$,L$'' \subseteq L \wedge \mathrm{l}' \in L \wedge \mathrm{l}'' \in L \wedge \mathrm{L}' \leq_{\mathrm{K}'} \mathrm{L}''$).

It is a general constraint on the transformation of URDSs **K** into DRSs K$'$ that $\leq_{\mathrm{K}',\mathrm{L}}$ must be an extension of the order skeleton $\leq_L$. Ups-and-downs unification imposes further constraints on the relation between K and K$'$, which also have to do with $\leq_{\mathrm{K}',\mathrm{L}}$. The first of these, called $\leq$-Preservation, is of a positive nature:

Principle (2) (Downs above ups)

When an ups-variable $\uparrow_\tau$ (where $\tau \in \{t, loc\}$) belongs to a UDRS component with label l_u and ${}^{\downarrow}\mathrm{t}_\tau$ to a UDRS-component with label l_d, then $\uparrow_\tau$ and ${}^{\downarrow}\mathrm{t}_\tau$ may unify only when not $\mathrm{l}_u \leq^*_{\mathrm{K}} \mathrm{l}_d$ – that is, if neither $\mathrm{l}_u <^*_{\mathrm{K}} \mathrm{l}_d$ nor $\mathrm{l}_u{=}\mathrm{l}_d$ (in which case $\uparrow_\tau$ and ${}^{\downarrow}\mathrm{t}_\tau$ would belong to the same component of K).[31]

When a UDRS **K** is transformed into a DRS K′, the resulting relation $\leq_{\mathrm{K}',\mathrm{L}}$ will be an extension of the order skeleton $<$L. $\leq_{\mathrm{K}',\mathrm{L}}$ is also an extension of another relation between labels, which is established by the ups-downs unifications that are made on the way from K to K′. We refer to this relation as $\leq_{\mathrm{Un},\mathrm{K}'}$. To be precise, $\leq_{\mathrm{Un},\mathrm{K}'}$ contains all those pairs $\langle l_u, l_d\rangle$, where l_u and l_d are labels of components of **K** whose ups- and downs-variables are unified in the process of obtaining K′ from **K**. It follows from Principle (2) that $\leq_{\mathrm{Un},\mathrm{K}'}$ too is the skeleton of a strict partial ordering; moreover, this is also true for the union of $\leq_{\mathrm{Un},\mathrm{K}'}$ and $\leq_L$. It is this order, the transitive closure of this union which we will use to state our last constraint on ups-downs unification. We refer to it as $\leq_{\mathbf{K},\mathrm{K}'}$. Thus $\leq_{\mathbf{K},\mathrm{K}'} = \mathrm{TC}(\leq_L \cup \leq_{\mathrm{Un},\mathrm{K}'})$.[32]

[31] As we have seen in many of the examples discussed in this paper, unification often goes hand in hand with a merge of the components labelled by l_u and l_d. This was the case, for instance, in our simplest examples in Section 2, in which the $l_\perp$ component is merged with the $l_\top$ component, and it also arose when a component was merged with the slot of a component representing an aspect operator. But we have also encountered cases where this is not so, e.g., when the ups-variables of $l_\perp$ are unified with the downs-variables in the restrictor of a duplex condition representing an adverbial quantifier, while $l_\perp$ itself is merged with the nuclear scope. (N.B. there are special problems connected with the familiar logical operators $\Rightarrow$, ;, $\vee$, $\neg$ and nominal quantification. In all these cases the temporal dimension makes for complications which have this far been ignored in existing DRT-treatments (as well as, to our knowledge, in other treatments of those operators in formal semantics). The matter will be adressed in [36].)

[32] When the transition from **K** to K′ only involves ups-downs unifications, then $\leq_{\mathrm{K}',\mathrm{L}}$ will be definable from this union:

(*) $l_1 \leq_{\mathrm{K}',\mathrm{L}} l_2$ iff there are labels $l_1', l_2' \in L$ such that l_1 and l_1' belong to the same (set) label in K′, l_2 and l_2' belong to the same label in K′, and $<l_1', l_2'>$ belongs to $\mathrm{RTC}(\leq_L \cup \leq_{\mathrm{Un},\mathrm{K}'})$, the reflexive transitive closure of $\leq_L \cup \leq_{\mathrm{Un},\mathrm{K}'}$.

In general, however, we may expect that other factors besides ups-downs unification play a role in the transition from **K** to K′ as well. In that case the relation defined

We are now ready to state our final constraint on ups-downs unification, the minimal distance constraint. Intuitively speaking, this is the constraint that unification of a given variable must always be with a matching variable from a component that is as close to that of the first variable as possible; or, put differently, unifications may not "cross". To formulate the principle correctly is not completely straightforward, however, because order gets created as unifications take place, and satisfaction of the minimal distance constraint must preserved while this happens. It is to capture this feature of the constraint that we have introduced the relation $\leq_{\mathbf{K},\mathrm{K}'}$.

Principle (3) (Minimal Distance Constraint)

> Suppose that $\uparrow_{t_1}$ and $\uparrow_{t_2}$ are ups- and ${}^{\downarrow}\mathrm{t}_1$ and ${}^{\downarrow}\mathrm{t}_2$ downs- variables in K and that l_{u_1}, l_{u_2}, l_{d_1} and l_{d_2} are, respectively, the labels of the UDRS components to which these variables belong. Suppose further that $\uparrow_{t_1}$ has been unified with ${}^{\downarrow}\mathrm{t}_1$ and $\uparrow_{t_2}$ with ${}^{\downarrow}\mathrm{t}_2$ and finally that the four labels form a chain in $\leq_{\mathbf{K},\mathrm{K}'}$. Then the minimal distance constraint requires that this chain must be of one of the forms listed below:
>
> (i) $l_{u_1} \leq_{\mathbf{K},\mathrm{K}'} l_{d_1} \leq_{\mathbf{K},\mathrm{K}'} l_{u_2} \leq_{\mathbf{K},\mathrm{K}'} l_{d_2}$
>
> (ii) $l_{u_2} \leq_{\mathbf{K},\mathrm{K}'} l_{d_2} \leq_{\mathbf{K},\mathrm{K}'} l_{u_1} \leq_{\mathbf{K},\mathrm{K}'} l_{d_1}$

So much for the unification of variables of type t. As regards variables of type loc, it is necessary to distinguish between two cases of downs-variables: (a) those which come in pairs with downs-variables of type t (as in the contributions from quantifiers and aspect operators), and (b) downs- variables which come on their own. (These are contributed by temporal adverbs.) The unification constraints for downs-variables of category (a) are the same as those for downs- variables of type t. The easiest way to formalise this constraint is to insist that when a downs-variable of type t unifies with a given $\uparrow_t$ and this downs variable is accompanied by a downs variable of type loc, then the latter variable must always unify with the $\uparrow_{loc}$ which accompanies the given $\uparrow_t$.

---

by the definiens of (*) will still be a subrelation of $\leq_{\mathrm{K}',\mathrm{L}}$, but the two relations need not be identical.

Downs variables of category (b) may unify with an $\uparrow_t$ provided all the constraints are satisfied that we have stated for variables of type t. Recall in this connection that a $\uparrow_{loc}$ need not unify sentence-internally, but that all downs variables of type loc must unify.

So far the considerations of this section have ignored the ambiguity operator $\overset{!}{\vee}$ which we introduced in Section 6. As we saw in Section 6, conditions involving this operator may survive into the DRS-like representation which results from the second processing phase and serves as input to discourse integration. Of such cases it is particularly clear – but the principle holds generally for transformation of UDRSs containing $\overset{!}{\vee}$-conditions – that each $\overset{!}{\vee}$-disjunct is to be treated as if it were a UDRS component in its own right, which interacts with the other UDRS components in the ways described above (so to speak, as if the other disjuncts from the $\overset{!}{\vee}$-condition to which it belongs weren't there). This independence principle applies in particular for ups-and-downs unification. Suppose for instance that a given $\overset{!}{\vee}$-disjunct D contains ups-variables $\uparrow_t$ and $\uparrow_{loc}$ and that these are unified with downs-variables ${}^{\downarrow}t_t$ and ${}^{\downarrow}t_{loc}$ from some other UDRS component with label l. Then this unification has no meaning with regard to any of the other disjuncts from the $\overset{!}{\vee}$-condition of D. So if we take another such disjunct D$'$, then other unifiers will have to be found for those variables.

Although these remarks are sketchy, they should make it clear enough how the rules for ups-and-downs unification can be extended to cover representations containing $\overset{!}{\vee}$.

8 Conclusions and Comparisons

The central concern of this paper has been to introduce a hitherto unexplored mechanism for the binding of temporal variables, based on the unification of "ups-arrows" and "downs-arrows". We explored the viability of this mechanism by looking at a variety of different sentence types, each one of them presenting a new twist to the phenomenon of interacting sentence elements that contribute to temporal reference and/or aspect. Section 7 offered a formal description of the unification mechanism illustrated by our treatment of the sample sentences.

One important reason for our interest in ups-and-downs unification is the apparently natural way in which it fits within the general architecture of UDRT, in which unifications are only partly constrained by the form of the representations within which they take place and in which they may themselves impose additional constraints on the resolution of scope relations.

Directly connected with our commitment to underspecification, which is plainly manifest in our use of UDRT, is our conviction of the importance of modularity: a proper account of meaning and interpretation should assign to each word and semantically significant bit of morphology a lexical entry which enables it to make the same semantic contribution to every sentence in which it occurs as a constituent. As we have seen in a number of instances, insisting on lexical modularity of this kind imposes additional constraints on the mechanisms which drive interpretation, since these must now be capable of eliminating lexical meanings where they are not wanted, but where lexical entries of the sort our approach requires will inevitably introduce them, whether they are wanted or not.

On the face of it ups-and-downs unification looks quite different from the variable binding mechanisms that are prominent in the current formal semantics literature – mechanisms whose principal variable binding devices are the λ-operator and/or special operators such as quantifiers and the term-forming ι operator. There is no perfect uniformity within natural language semantics as regards the use of these devices. As a matter of fact the exact choice is largely a matter of style. Obviously every variable binding operator Q can be reduced to a combination of the λ-operator and some predicate (or other type of functor) that takes λ-terms as arguments. In the light of this we can, for the purpose of comparing these alternative mechanisms with the ups-and-downs unification of this paper, focus without loss of generality on a version in which λ is the only variable binder.

There are two questions which naturally arise in the context of such a comparison:

(i) What if any is the difference between (a) handling variable binding in natural language by way of the method of λ-binding and (b) relying on the kind of unification we have proposed?

(ii) Could the ups-and-downs mechanism of this paper be extended to non-temporal variables?

To answer these questions even in the sketchy and preliminary manner that is all we can attempt here it is necessary to briefly review the salient aspects of variable binding that any account of the semantics of natural languages such as English or German has to account for. Predicate words, among them nouns and verbs, have two kinds of arguments, a "referential argument" and zero or more "non-referential" ones. Consider for instance a relational noun like *Freund* (Engl.: *friend*). In *Freund von Maria* one of the two arguments is realised by the phrase *Maria*. The other one, for the person who is described as Maria's friend, is given implicitly with the noun *Freund* itself, and it is there whenever the noun is used. Non-relational nouns like *table*, or *fish*, only have a referential argument. With verbs the referential argument is the event or state described by the verb, whereas all other arguments are non-referential. (Usually, when people speak about the "arguments" of a verb or about its "argument frame", it is only its non-referential arguments they have in mind.) It is natural to assume that the variables which represent non-referential arguments of a predicate are introduced by the argument phrases which accompany it. As regards its referential argument, there are two possibilities: (i) the argument is introduced by the given occurrence of the predicate itself, (ii) it is introduced by some functional element (or "functional projection") associated with the predicate. As long as an occurrence of a predicate in a sentence involves such a functional element or projection it is not easy to choose between these two possibilities. Quite possibly the choice is not important.

From the perspective of variable introduction and binding our proposal for the handling of temporal information may appear to be of an unseemly complexity. It is hybrid in that the referential arguments of verbs – the variables representing the events and states the verbs describe – are introduced by the verbs themselves, whereas the temporal variables which serve to locate these eventualities along the time axis are introduced elsewhere in the syntactic structure. In the simplest cases location time is introduced by the functional projection of the verb which harbours the information contributed by tense. In these cases the eventuality variable belongs to the $l_\perp$-component and the variable for the location time to the top component labelled $l_\top$; and temporal ups-variables serve to make sure that the temporal variables in $l_\perp$ with which they unify impose their temporal constraints on ev.

There are two reasons for handling the referential arguments and their temporal location in such an apparently hybrid way. The first is the old intuition that we need besides the eventuality variable ev itself also one or more temporal variables that mediate the temporal constraints which the sentence imposes on ev, that one of these variables reflects the information contributed by tense and that this variable should be therefore regarded as originating at that node of the syntactic structure where tense information is assumed to be located. As far as this is concerned we have simply followed, at the level of interpretation, what we take to be a conviction of a large and influential part of the syntactic community. The second reason – which can be seen as a further confirmation of these convictions – has to do with the way in which temporal information is processed in more complicated cases, in which aspectual and adverbial operators intervene between $l_\perp$ and $l_\top$. As we have described temporal processing in cases of this more complicated kind, such intervening operators have the effect of breaking up a single temporal location process – of the referential argument of the verb by the tense information present in $l_\top$ – into a chain of two or more 'nested' locating processes, in which the tense information plays its usual part in the highest of these processes, while the referential argument of the verb is directly located by the lowest of them.

In many cases, however, – and this is so whether our particular assumptions about the origins and interactions of temporal variables and eventuality variables are optimal or not – there is no reason to assume that a λ-based system could not capture the predictions that are made by the theory we have represented. (This includes in particular suitable characterizations within such a formalism of the intervening operators, with their quite complex structure of ups- and downs-variables, which enables them to decompose a single locating process into two.)

Nevertheless there is one crucial difference between what is possible within such a formalism and the account we have presented here. It is not clear – and here we come back once more to the central concern of the present paper – how a classical λ–based formalism of the kind indicated above could be given the flexibility which is required by underspecification of the kind we have proposed – that flexibility which makes it possible to construct initial representations in which the choice of unification partners for ups- or downs-variables can be left open, with the option of making these choices later, when relevant information has become available which only a semantic representation (whether fully specified or underspecified) is able to reveal. Again, we do not think that it is impossible in principle to endow a standard formalism with such flexibility but we suspect that when the adaptation has been made, little difference will remain between what has resulted and the theory we have presented. The point of the ups- and downs-variable regime is that it captures a certain kind of "locality of variable symbols" which is alien to all the familiar formalisms of classical logic (including Montague's Higher Order Intensional Logic and the variants of it that are common in current Formal Semantics). This "locality" is neither as radical nor as straightforward as the locality of $\uparrow$ and $\downarrow$ in LFG: In our theory it is only the ups-arrows that can be considered "local", while the variables marked with downward arrows are fully specified, "global" variables, which need no further instantiation. And it is the unification of an ups-variable with a downs-variable which confers upon the former the full variable status which the second already possesses.[33] But this

[33]The difference between the system presented here and one without local ups-variables is comparable to that between DRT and the systems of Dynamic Semantics proposed in the late eighties and early nineties by Groenendijk and Stokhof ([25], [24]). In DRT the discourse referent introduced by an anaphoric expression such as a pronoun becomes a discourse referent in the full sense of the word only through its identification with the discourse referent that represents the pronoun's anaphoric antecedent. (See e.g. [34] for an often quoted presentation of "clasical" DRT. The special status of such discourse referents is more clearly visible, however, in more recent formulations, e.g. that of [22], according to which such a discourse referent is present at first as a constituent of an anaphoric presupposition, and turns into a "normal" discourse referent only when this presupposition is resolved through linking of the constituent with some other normal discourse referent.) In the mentioned systems of Dynamic Semantics the possibility of "resolving" discourse referents after they have been introduced is not available. All the variables of these systems are variables in the full, traditional sense of classical formal logic. This entails that as soon as a variable is introduced for an anaphoric pronoun this automatically determines the pronoun's antecedent (viz. as that NP for which that very same variable has also been chosen as representative). Consequently the only way in which semantically guided anaphora resolution can be described in such a system is as follows: "randomly generate" anaphoric connections through the choice of variables (or "coindexations"), then check for semantic coherence, and thus eliminate all connections except those

comparatively mild form of locality is nonetheless alien to the concepts of variable and variable binding that are at the core of standard predicate logic and the λ-calculus.

To repeat and conclude, it is ambiguity and disambiguation – in the lexical domain of individual tense forms, aspect morphology, individual verbs and temporal adverbs, and in the structural domain of scope – which have been our central concern in this paper. It is this concern which leads naturally to the architecture proposed here, in which the ideas, architecture and formalism of UDRT are quintessential. And it was within this setting that ups- and downs-variables and the unification principles by which they are governed imposed themselves upon us – not only as an effective way of accounting for a complex set of data, but also because they permit a perspicuous and computationally viable account of how correct interpretations can be computed from input rife with ambiguities.

8.1 Comparison with other Theories of Tense and Aspect

Because of its emphasis on ambiguity, disambiguation and underspecification, the present paper is quite different from virtually all other treatments of aspect and temporal reference that we are aware of. So comparisons with other approaches are not easy. Nevertheless it may be useful to try to say something about how we see the relations between the proposals of this paper and some of the work that addresses some of the same empirical phenomena.

There is far less we will say here than would do justice to the variety and depth of the tense and aspect literature as it currently exists. The

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that have stood the test of semantic viability.

Much the same difference exists between the system we have proposed here and one in which scope ambiguities between aspectual and quantificational operators are resolved instantly, and where the semantically untenable resolutions are then sifted out again by subsequent checking. It should be stressed, however, that underspecification as it is represented by the theory we have presented here goes much farther than the comparatively modest form of it that is found in standard DRT. This is what distinguishes UDRT from DRT in general; and it is true in particular of the present form of UDRT, with its local ups-variables and the role unification plays in scope disambiguiation.

little we do say is organised along two orthogonal dimensions, that of general methodological assumptions and that of covering and explaining empirical facts.

First methodology. The nearest in spirit to the present proposal is the quite extensive work on tense and aspect within DRT. (We remind the reader that concerns about tense and temporal reference were the original impetus towards DRT.) Salient among the DRT-based studies on tense and aspect are [5], [14], [11], [15], [45] and [17], and [18]. ([18], which uses UDRT rather than DRT, contains some proposals dealing with the temporal aspects of interpretation, but temporal reference is not its sole, or even central concern.) An interesting use of DRT is made in [61], where DRSs are taken as designating mental representations that result from sentence interpretation by human speakers. Not all information specified in such DRSs is relevant to their truth conditions. Additional information may pertain in particular to aspect (more particularly so-called *viewpoint aspect*) thus revealing the perspective from which the represented content is perceived. Such a cognitively motivated interpretation of DRT can of course be extended to UDRT too. It plays no indispensible part in the theory presented here. There is no reason why it could not be combined with the concerns of this paper and incorporated into a theory with the general architecture we have proposed. As a rule DRT-based proposals can be incorporated into a UDRS framework without much difficulty, for one thing because DRSs and DRS construction are included within UDRT, and for another because of the general tendency there has been within both DRT and UDRT not to tie proposals to one specific theory of syntax. Eventually of course the 'abstract interfaces' to syntax which existing DRT- and UDRT-based semantic analyses have defined or presupposed should be replaced by theories which deal in a fully explicit, theoretically and conceptually motivated way with both syntax and semantics and in which the interface between them is an integral and central part of the theory as such.

The bulk of current work on tense and aspect makes use of what has served as the standard formalism of formal semantics since [46]. (In essence this is Higher Order Intensional Logic (HOIL), sometimes its extensional fragment, and often enriched with additional types for time-related entities like instants, temporal intervals, events and/or states.) So long as only the semantics of single sentences is concerned, there isn't all that much to choose between using some suitable variant of HOIL or DRT as semantic representation language.[34]

Today, more than 20 years after its appearance, Dowty's [16] still stands out as a model for analysing tense and aspect with the methods of Montague Grammar. But much has happened since then to refine and replace the particular analyses this book proposes. Salient contributions to the theory of temporal and aspectual phenomena in which the methodology and formalism of Montague Grammar are used are [64], [2], [49], [54]. An important part in this development has been played by Von Stechow. Singly as well in many collaborations he has extended his version of Montague Grammar (viz. Stechow's Transparent Logical Form, or TLF) to cover a remarkably wide range of phenomena within the domain of tense and aspect. Once again, however, comparison with the proposals of this paper is difficult because of quite different basic assumptions. Von Stechow follows Montague in assuming that all structural ambiguity is resolved at the level of syntax. The task of the semantic component of the theory is then merely to assign semantic values to those disambiguated syntactic analyses; typically, this is achieved by mechanically transducing the syntactic analyses into canonical descriptions of those semantic values, e.g terms of HOIL. Theories of this sort differ from our approach in two ways. First, they do not have – or at least this appears to be true of the contributions to this research program with which we are familiar – a component which deals explicitly and systematically with disambiguation. In this respect TLF is like many other current approaches which also do not put as much of an emphasis on ambiguity and disambiguation as we do, including most of the extant accounts of tense and aspect within DRT ([34],[59] [22]). However, as far as disambiguation is concerned, the gap between our proposal and TLF appears to be even wider. Theories developed within TLF provide no obvious room for the semantically and pragmatically driven disambiguation mechanisms some of which have been mentioned here and which our approach is designed to accommodate in general. As we perceive it, this is a problem with two sides to it. First, we are not pesuaded that all

[34]Note in this connection that higher order versions of DRT are available where the original first order DRT formalism proves insufficient (see [42], [22]). The difference becomes important when one moves from DRT to UDRT, as here, or when the syntax-semantics interface is spelled out explicitly, as in the work of von Stechow – see below.

cases of ambiguity – not even structural ambiguities such scope ambiguity – can be explained as ambiguities at the level of syntax. But even for those ambiguities which arguably are syntactic, it is not clear how semantic and pragmatic disambiguation mechanisms could be plausibly integrated into a TLF framework. It would be possible to generate and interpret all possible syntactic analyses for a given sentence S, and then apply the 'disambiguation' mechanisms to each of the semantic representations that result in this way. Those representations for which the application of these mechanisms yields incoherence or inconsistency are then eliminated and only the representations which pass the appication filter remain as admissible (syntactic and semantic) analyses of S. This is a sentence disambiguation method that is possible in principle. But it lacks the computational and conceptual advantages of disambiguation on UDRSs which were the central motives behind UDRT to begin with.

As regards the determination of sentence interpretation by sysntactic structure, we might be accused of having erred on the other side. For in the proposals we have made in this paper syntactic constraints have received only scant attention. This is obviously an omission, for, as noted in earlier UDRT work ([55]), the syntactic structure of a sentence S often does impose constraints on the subordination relations between the components of the UDRS derived from S. In the examples considered in this paper, however, few such constraints appear to be strict: constituent order may favour one interpretation over another, but without excluding the other one altogether. We see this for instance in sentences containing both a frequency adverb and a locating adverb: When the locating adverb precedes the frequency adverb, it is usually understood as having scope over the quantifier. With the opposite word order there is a stronger tendency to take the scope relation between these two elements to be reversed. This means that the effect of surface order cannot be captured in the form of hard constraints on UDRS resolution. But the weaker effects just mentioned nevertheless exist and they should be accounted for eventually.

The importance of surface order for interpretation has been emphasised also in recent work that builds heavily on DRT, or on some alternative but closely related form of Dynamic Semantics. (viz. [8] (and other papers listed in http://www.rci.rutgers.edu/m̃bittner/ou.html), [60]). These proposals stress the 'online'-aspects of interpretation: Interpreters interpret the words of a sentence as they reach them, and therefore the interpretation of a particular word may depend crucially on the particular position it occupies in the sentence that is being interpreted; had the word occurred in a different position, then the contribution it would have made to the intepretation of the sentence would necessarily have been different. To incorporate the results of these theories into our proposal it is necessary to enrich the partial order of UDRS-components with an additional linear order which is triggered by the surface ordering of the phrases which these components represent. An explicit integration of the results of strict on-line processing in general is, however, subject to further research.

Within AI various other formalisms have been proposed for the analysis of temporal and aspectual relations. In particular there are proposals which make use of the event calculus (viz. [65]), and more specifically of implementations of the event calculus within constraint logic programming.

[67] mentions DRT as an enterprise of kindred spirit, but lacking the much-needed link to non-monotonic inference engine which comes as part of the logic programming environment. We see the two approaches rather as complementary and would like to seem them combined. One of the strengths of DRT-based approaches (including the one presented here) is the attention they have paid to the interface between the formal representations used (DRSs, UDRSs, SDRSs, etc.) and the surface structures of natural language. By providing an interface between these representations and the logic programs of [67] it may be possible to arrive at a theory which combines linguistic coverage with the efficient theorem proving that is needed both for ambiguity resolution and for the subsequent exploitation of the resolved semantic representations.

8.1.1 Data-oriented Comparisons

As we have pointed out more than once already, empirical coverage is not one of this paper's principal aims. Of course, it has been important for us (as it would be for any linguist) to be as accurate as possible with regard to the possible interpretations of the sentences that we have been looking at. And we have tried to come up with tenable explanations of why these sentences permit those and only those interpretations which according to our assessment they can have. Nevertheless, our sentence sample has been quite small, and its small size reflects the paper's methodological goals. In view of this comparisons with other work from a data-oriented perspective is neither easy nor will it necessarily be very illuminating.

There are, however, two areas within the realm of temporal and aspectual phenomena where the paper makes quite specific and detailed proposals which have clear empirical import and which at the same time some will consider far from uncontroversial. The first of these is the perfect, the second adverbial quantification. On each of these topics there now exists a substantial literature, with theories that differ to a greater or lesser extent from the proposals we have made. This is true in particular for the perfect, which has drawn a surprising amount of attention in recent years,[35] but also for adverbial quantification. Against the background of an existing range of proposals for dealing with a certain construction or type of expressions, anyone who comes up with an alternative to these may be expected to provide a careful comparison between her or his own proposal and those from which it differs. Our reason for not offering such comparisons here is that had we done so, the paper, which is already quite long as it is, would have grown to even greater lengths. Hence our decision to leave such a comparison for another occasion.

As we implied in Section 4, one of the proposals of this paper of which we ourselves suspect that it may prove to be in need of adjustment, when more data are taken into account than we have considered here is our treatment of the perfect. A good many current theories of the perfect differ from our proposal in that they asume that perfects must always be evaluated with respect to a certain extended temporal interval, currently often referred to as 'Perfective Time Span' (or 'PTS', see [63], and also other contributions to the collection [30]) to which this paper belongs). Perhaps the strongest evidence that PTS is needed also in the analysis of the German perfect derives from the way in which it interacts with prepositional phrases beginning with *seit*. (The preposition *seit* corresponds to English *since*, but only in the latter's purely temporal sense.) *seit*-phrases have not been considered in this paper, and the question how well our proposal fares in their presence has not been put

[35]Largely this interest seems to have been fostered by the curious restrictions that affect the present perfect in English. Puzzles about English continue to be a major factor in setting the research agenda of both syntacticians and semanticists.

to the test. If and when this is done a close comparison with existing alternatives will be *de rigueur*.

As regards adverbial quantification, we already mentioned [13]. Another important publication by De Swart is [13]. DRT-based treatments of adverbial quantification can be found in [53], [68] and [50]. Here too, there are, as nmote above, differences between our own proposals and those found in the literature. To some extent these differences are theory-internal. For instance, some of the details of our treatment are dictated by the general architectural assumjptions we have made: the contribution that is made by a quantificational adverb must be able to establish unification-based links both to what is within its scope and to what is without. But on the other hand our treatment of adverbial quantifiers also has certain empirical consequences, and a data-oriented comparison with other theories in this area is thus needed as well.

But this too is a task we must defer.

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