WORDS FOR TIME

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Abstract

Taxonomies of the temporal subordinating conjunctions and prepositions in English, Dutch and German are presented. These high frequency words are highly ambiguous. So a good taxonomy is of practical importance for computerized Natural Language understanding or translation system.

It is also of psychological importance. By examining the taxonomies that we have developed for different languages, we see that certain features are common across languages, for example before and after, and their equivalents in other languages can qualify any type of temporal point or interval. Other features are idiosyncratic. For instance, in English *night* is treated differently from the other parts of the day: *in the morning/at night*. The extent of the idiosyncratic features is a sure indication of associative learning that must take place during language acquisition. However all is not ruleless. This agrees with a theory of the mind as a hybrid system capable of learning and using not only regularities but also a large number of individual associations.

1 Introduction

Linguists have long been interested in lexical semantics. However, it is only recently that an interest in the non-content words - the function words - has grown (Zelinsky, in press). The spatial prepositions have attracted considerable interest. We have already looked at the use of prepositions of inference and cause (Brée, Smit & Schotel, 1984). In this paper I would like to look at the temporal use of prepositions and subordination conjunctions, which I will call 'temporals' for short. As with the spatial use of prepositions, temporals show similarities, but also idiosyncratic differences across languages. One of our tasks is to distinguish between these by comparing the meanings of temporals in several different languages. We have already analysed (Brée & Smit, 1987) and compared (Brée, Smit & van Werkhoven, 1990) English and Dutch temporals. We have also analysed the German temporals (Durrell & Brée, in press). Here we use this last work to revise the previous analysis of English and Dutch. The result is a uniform analysis of the temporals in all three languages.

Our general approach is to build a 'selection tree.' This is similar to a decision tree, being a graph, with a root node and leaf nodes. The leaf nodes indicate the temporal word to be used in a particular context. The other nodes indicate questions about the context. The possible answers to these questions are indicated on the links emanating from nodes and directing the selection process to a further question or to a particular temporal at a leaf node. These selection trees can also be used in natural language understanding. The path back from a particular temporal leads along various links which indicate the context which the temporal requires. This context can be considered to be the 'meaning' of the temporal.

The questions that are posed in our selection trees centre on the temporal relationship between the time of the event or state (which we call a 'stevent') in the matrix and sub-clauses. This time is usually a time located on the ordinal time axis, being either a point in time or a period of time. But it may also be a pure time duration, for example 5 minutes, not located on the time axis. With pure durations, there is a similar distinction, that between the duration of the main stevent and the duration from the Time of Discourse to the beginning or ending of the main stevent. It has turned out that the separation of durative from non- durative uses considerably simplifies the selection trees. In language generation this separation is clearly no problem; in comprehension there could be a problem, but as it is always clear whether the temporal phrase is a pure duration of time or an actual location on the time axis, the appropriate selection tree can be consulted.

A distinction is also made between a stevent filling the whole of a period or just occurring at some point or sub-period within that period.

A major distinction is that between the sub-stevent directly setting the time at which the matrix stevent occurs versus setting one end of a period in which it occurs. In the latter case the other end is often the Time of Discourse

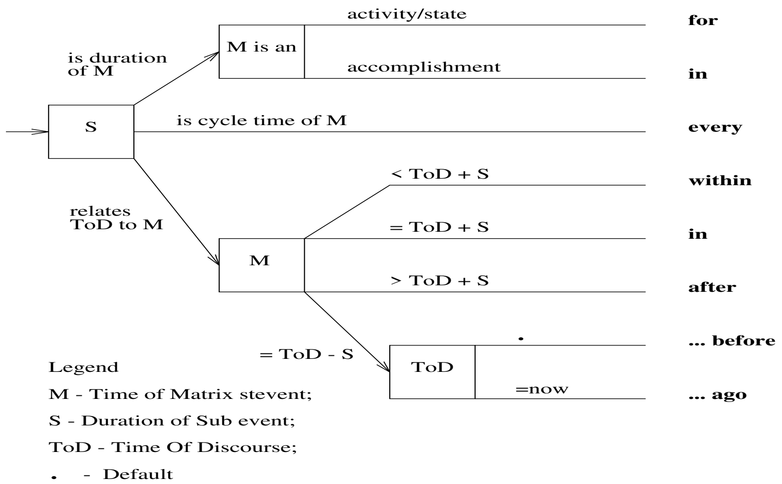


Figure 1: Selection tree for English durative use of temporals

(ToD). The ToD may be either the here and now, or a past or a future time. Another concept that is required is that of a semi-range. A semi range is either the time from the Big Bang up to a particular time point or the time from a point up to Eternity.

Finally a distinction is made between the sub being a clause or a phrase. It is interesting that for the choice of a temporal this frequently makes no difference; either a temporal can be used both as a preposition and as a conjunction, for example *after*, or the preposition can be turned into a conjunction by adding some standard suffix equivalent to *that* in English, for example *na +dat* in Dutch. These are enough distinctions to go on with.

2 Pure Duratives

The first way to specify a temporal attribute of a stevent is to indicate its duration without directly specifying the whereabouts on the time axis the duration occurs. Examples of pure time durations are: a moment, five minutes, a year. Each of the three languages under consideration has a half dozen or so prepositions for doing this. We will look in detail first at the English prepositions. Then we will note the differences that both Dutch and German have from English.

2.1 ENGLISH DURATIVE PREPOSITIONS

The prepositions taking a pure durative phrase fall into three major categories. The basic use is to give the duration of the main stevent. This duration itself may be linked to the Time of Discourse (ToD). A second use is not to give the duration of the matrix stevent but rather the duration of the time interval between such events. Lastly the sub-phrase can be used to place the time of the matrix stevent on the time axis through linking its time of occurrence with the ToD. The sub-phrase then gives the time duration from the ToD to a second time point; the preposition relates the time of the matrix stevent to this second time point. We now examine the three main categories of the use of temporal prepositions with a pure durative in English - see Figure 1.

When the sub-phrase is used to indicate the duration of the main stevent, the preposition depends on the nature of the main stevent. If it is an accomplishment, the English preposition to be used is *in*. If it is an activity or a state, then *for* is used. For example

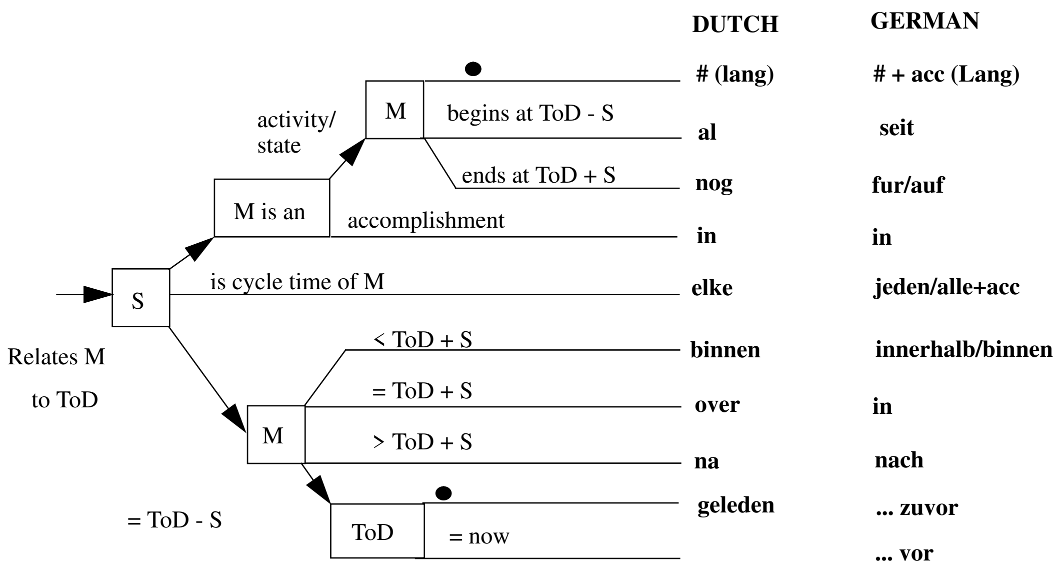
The coach can reach St Malo in three hours.
We sat in the coach for three hours.

The second use is to fix the cycle time of the matrix 'stevent'. In English no preposition is required, but rather the adjective *every*, for example

A train leaves Paris for Rennes every hour.

Finally there are four uses of the sub-phrase to relate the time of occurrence (as opposed to the duration) of the matrix stevent to the ToD. Two uses fix the time at a specific time point either before or after the ToD, for example

The train had left an hour before. `(this is to say at ToD - 1 hour)`
The train leaves in an hour. `(this is to say at ToD + 1 hour)`



Legend: M -Time of Matrix Stevent; S - Duration of Sub stevent; ToD - Time of Discourse; ● - Default

Figure 2: Selection tree for Dutch and German durative use of temporals

The other two uses indicate the semi-range of time in which the matrix stevent is to occur. The secondary time point is always fixed later than the ToD and the matrix stevent is to fall either earlier or later than this point, for example

The train will leave within an hour. `(this is to say at a time < ToD + 1 hour)`
You can come back after an hour. `(this is to say at a time > ToD + 1 hour)`

There is one complication in English. When the time of the matrix stevent is being placed at a point earlier than the ToD by the duration of the sub-phrase, then the choice of preposition depends on whether the ToD is also the time of speech, this is to say the here and now. If it is then ... *ago* is used rather than ... *before*, compare:

John rushed into the station, but the train had already left 5 minutes before.
"You just missed it. The train left 5 minutes ago."

Note that there is an ambiguity in the English temporal prepositions used with a pure duration: in is used to indicate the duration of an accomplishment but also to indicate the time span after the ToD at which the matrix stevent will occur, for example

John will present his paper in 20 minutes.

can mean either that John will take 20 minutes to present his paper or that he will start his presentation 20 minutes from now. It is necessary to decide in which way English *in* plus a durative is being used. How this should be done is still an open question.

This completes our description of the English temporals used with a purely durative phrase. We turn now to the differences that Dutch and German durative temporals have from their English counterparts.

2.2 THE DUTCH DURATIVES

The durative use of temporal prepositions in Dutch is similar to that in English - see Figure 2. There are two differences, one minor the other major. The minor differences is that in Dutch there is no distinction that parallels that between ... *before* and ... *ago*. When the time of the matrix stevent is being set to a time earlier than the ToD by the duration in the sub-phrase, then the Dutch use ... *geleden*, irrespective of whether or not the ToD is the here and now.

The major difference is that where English uses *for* Dutch has three alternatives: # (no preposition), *al, nog*. Normally when the duration of a matrix stevent which is an activity or a state is being set, then no preposition is used in Dutch, for example

We will stay in St Malo five days. `(no preposition)`

When the matrix activity or state is to be attached to the time axis at the ToD, then a preposition is used, the choice depending on whether the matrix activity or state is to begin or end at the ToD, for example

We have been in St Malo for four days. (al 4 dagen)
We will remain in St Malo for another day. (nog een dag))

As far as machine translation is concerned, the only problem arises in translating English *for* into Dutch *al, nog* or no preposition.

2.3 THE GERMAN DURATIVES

The German use of temporal prepositions with a duration in the sub-phrase parallels that of the Dutch use. The actual prepositions are of course different - see Figure 2. There are two minor points to be made.

While in German the use of the sub-phrase to indicate the cycle time of the matrix stevent is again indicated by an adjective with the accusative case as in Dutch, a different adjective is used for singular (*jeden*) versus plural (*alle*) nouns. The other minor difference is that there are two prepositions in German to indicate that the matrix stevent occurs at a time later than the ToD plus the duration of the sub-phrase, corresponding to *within* in English: *innerhalb* and *binnen*. Usually *innerhalb* is used, but in more formal registers *binnen* may be used.

2.4 IN SUMMARY

There is little difference between the three languages in the use of temporal prepositions together with a time duration to indicate either the duration of the matrix stevent or its cycle time or when it occurred in relation to the ToD. All three systems are rather neat with only one or two idiosyncrasies. When we turn to the non-durative use of temporal prepositions, this simplicity will no longer be found.

3 Non-duratives

In the non-durative use of temporals the sub-phrase specifies a time point or period on the time axis, compare ... *in a month* (durative) ... *in October* (non-durative). In this section we will look first at the non- durative use of English temporals (see Figure 3), and then at their Dutch and German counterparts.

The major distinction in the non-durative use is between the sub-stevent being used to indicate the time of the matrix stevent versus indicating one (or more) end(s) of a time period in which the matrix stevent falls. This corresponds to the distinction in the durative use between indicating the time of the matrix stevent in relation to a time point some distance from the ToD versus the duration of the matrix stevent itself. There is no equivalent in the non-durative use of temporals that corresponds with the use to indicate the cycle time of the matrix stevent.

3.1 INDICATING THE TIME OF OCCURRENCE OF THE MATRIX STEVENT

When the sub-stevent is being used to indicate the time of occurrence of the matrix stevent, there are two major cases: the sub-stevent is used to indicate a point in time or a period in time. Typical points in time are clock times and non-durative actions such as exploding, dying etc. Typical durations are months, years and states such as ”being at a workshop”. This distinction is not always to be found in the nature of the sub-stevent itself. An explosion is usually considered to be a point in time, but if one is interested in the sequence of events during an explosion then an explosion is regarded as a period (and hence during is used in English). On the other hand a millenia, while usually a period of time, can be regarded from a geological point of view as a point in time. Even longer periods can be regarded as points in time, in for example

When the dinosaurs ruled the earth, there was a balanced ecology.

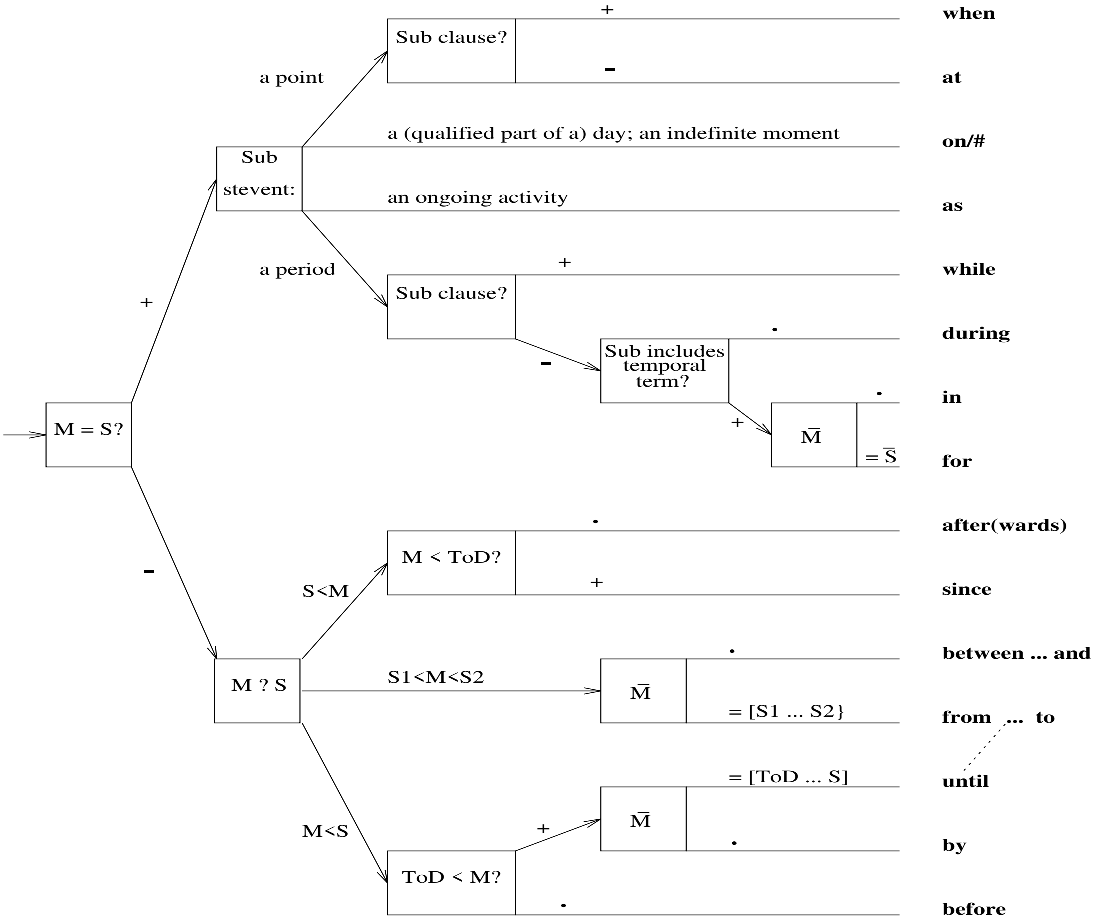
an interest is being expressed in the conditions pertaining at a certain time in contrast to another time. Compare this with an interest in the goings on in the same time period:

While the dinosaurs ruled the earth, mammals didn’t stand a chance.

In English the two temporal conjunctions that are used for time point and time periods are when and while respectively. The contrast between them can be seen for example in

*When (*while) John reached the footlights, he looked up.*
*While (*when) the minutes ticked by, we held our breaths.*

The situation is not so simple when it comes to the temporal prepositions as opposed to the conjunctions. The English preposition used to indicate a time point is simply *at*, for example at *5 o’clock, at high tide, at the beginning of the day*. However, to indicate a time period in which the matrix stevent is to occur there is a choice between *during* and *in*. There most probably are no criteria for choosing between these two prepositions common across different speakers in English. However, there is one necessary condition for permitting the use of *in* rather



M, S Time of Matrix/Sub stevent
$\overline{M}$, $\overline{S}$ Duration of Matrix/Sub stevent
ToD Time Of Discourse

\+ Condition fulfilled
\- Condition NOT fulfilled
. Default

Figure 3: Selection tree for English non-durative use of temporals

than *during*: the sub-stevent must not be able to be given a non-temporal interpretation. If the sub-stevent can be given a non-temporal interpretation, then *in* may not be used. For example

The King fell asleep in the opera.

would mean that the King was a character in the opera. If he was part of the audience, then one would have to say:

The King fell asleep during the opera.

In addition a distinction can be made concerning whether or not the matrix stevent lasts for only a part of or for the whole of the period of the sub-stevent. If it is definitely to last for the whole of the period (which means that it cannot be an accomplishment) then English use *for*.

This completes the description of the use of English temporals to indicate the time point or period of the matrix stevent in general. However, there are two special cases for indicating the time of the matrix stevent. The first is common to many languages. When the sub-stevent is a day then a special preposition is used. In English this is *on*, for example

We arrived (on) Monday.

It should be noted that the *on* is not required with days; no preposition may be used. No preposition is also used for indefinite moments in the past, for example

One day we found him hiding under the bed.

On is also used for a qualified part of a day; although not for an unqualified part of a day:

You can see the isle of Jersey on a fine morning.
*You can see the isle of Jersey *on a morning.*

The other special case for English is that when the sub-stevent is an ongoing activity then the conjunction *as* may be used instead of *when* or *while*, for example

As we walked down the drive, we could see over the park to the hills beyond.

The criteria for choosing as rather than *when* or *while* are not clear. Following David Palliser in the "Quincunx", I favour 'ongoing activity' as the criterion. This completes the overview of the use of a temporal sub-stevent to fix the time of the matrix stevent directly. We turn now to its use to fix the ends of its time duration.

3.2 INDICATING AN END OF THE TIME PERIOD IN WHICH THE MATRIX STEVENT OCCURS

When the sub-stevent is being used to fix one end of the time period in which the matrix stevent is to fall, the question arises: what is going to fix the other end? There are two alternatives, the first is that the other end is open or fixed by default to the ToD. The other is that the sub-stevent is in fact a double stevent, fixing both ends of the matrix stevent.

When the other end is open or fixed by the ToD there are two situations: either the sub-stevent is used to mark the beginning of the time period in which the matrix stevent occurs, or to mark its end. In both cases the other end can be open, so that a semi-range is indicated (or set to the ToD by default). When it is left open as a semi-range, then English uses *after* or *before*, for example

After we left Paris, we were quiet for a while.
Before we arrived at St Malo, everybody had introduced themselves.

If the ToD marks the other end of the time duration, then *since* and *until/by* are used, for example Since we left Paris, not a word has been said.

Please remain seated until the plane comes to a complete halt.
By the time we reach St Malo, everyone will have introduced themselves!

The distinction between *after* and *since* is that with after the actual period during which the matrix stevent occurs or may occur is open, as long as it is later than the sub-stevent, whereas with *since* it must occur earlier than the ToD. Similarly the distinction between *before* and *until/by* is that with *before* the matrix stevent can occur in any time earlier than the sub-stevent, whereas with *until/by* it must occur later than the ToD.

There is an asymmetry between *since* and *until* (Brée, 1985). With *since* the matrix stevent may occur at any time during the period from the sub-stevent to the ToD or it may occupy the whole of this period. In contrast, *until* may be used only if the matrix stevent is to occupy the whole of the period from the ToD to the sub-stevent. If it is to occur only at some point in this period, then *by* must be used, compare:

John has been in great spirits since we got here.
John will be in great spirits until we leave / by tonight.
John has phoned home once since we got here.
*John will phone home once *until we leave / by tonight.*

With *until* the matrix stevent must last for the whole of the period, so it cannot be an accomplishment; with *by* it can. If *by* is used with an activity or state then this does not already hold at the ToD, whereas with *until* it does.

We turn now to the situation in which there is a double sub-stevent, fixing both ends of the matrix stevent. Here again there are two alternatives, corresponding to the difference between *until* and *by*. If the matrix stevent is to occur for the whole of the period between the two sub-stevents, then *from ... to* is used, for example

Lights will be out from 10 in the evening to 7 in the morning.

Note that *until* may be used instead of *to*. In such cases the default of the ToD normally assumed for *until* is overridden. If the matrix stevent is to occur at some point in the time period or only for some of the time period, then *between ... and* is used, for example

You may go out once between 10 in the evening and 7 in the morning.

This completes the description of the use of the sub-stevent to fix the ends of the time period of the matrix stevent. There are no ambiguities. The only 'surprise' is that *since* and *until* are not symmetric with respect to temporal order.

3.3 THE DUTCH NON-DURATIVES

Having completely described the use of non-duratives in English, we will describe their use in Dutch by pointing out the contrasts with English. We begin with the 'top half' of Figure 4, showing the selection of Dutch temporals for non-durative use. When a conjunction is needed, this is to say when the sub-stevent is expressed by a clause, then there are several differences between Dutch and English. In the first place, there is no equivalent to the English *as*. Temporal *as* is almost always translated into Dutch by *toen* or *terwijl*. To choose between these two, the simplest rule is to replace *as* by *when* or by *while* in the original English. This can always be done, and usually only one of the two is appropriate in the context, for example

*As (while/*when) we were eating, we discussed the issue.*
*As (when/*while) I left, I felt a weight had been taken from my shoulders.*

For the rest, the 'top half' of the figure is more complex for Dutch than for English.

In the first place, when the sub-stevent indicates a time point and a clause is needed, then Dutch must choose between *toen*, *als* or *wanneer* whereas English makes do with *when*. The choice is based on the timing of the matrix stevent. If this is a one-off event in the past, then *toen* is used. In all other cases, this is to say for events in the present and the future and for repeat events and regularities, then *als* or *wanneer* are used. The van Dale Dutch dictionary also permits *als* to be used for one-off events in the past. However this use is not frequent in modern Dutch, if it is used at all nowadays.

To fix the time of the matrix stevent at a point three prepositions, *om, met* and *aan*, are available in Dutch instead of the single *at* in English. *Om* is used only with clock times. For religious feasts the Dutch use *met* (literal translation in English being *with*!). *Aan* is used in a few expressions, for example *at the beginning/end*. *Aan* in its spatial sense is used to indicate something hanging on a surface, for example a painting on the wall, as opposed to on top of a surface, for example a book on a table; here *aan* is used for a time at either end of a time period rather than in the middle. *In* would be used for the middle of the day.

There are a couple of other occasions in which *at* is used in English which are given different translations in Dutch. *At night* is translated by *'s nachts*. The Dutch treat the night as any other part of the day, such as the morning, whereas the English do not. For them night is treated as a point in time, *at night*, whereas other parts of the day are treated as periods of time, *in the morning* etc. The other occasion in which *at* is not translated by *om, met* or *aan* is for natural events such as: *at high tide, at sunrise*. For these events the Dutch use *bij*, a preposition which is used for sub-stevents that are causally linked to the main stevent.

Turning now to the placing of the matrix stevent in a time period rather than at a point in time, the choice of preposition is again more complex in Dutch. This is particularly the case when the sub-stevent is not a temporal term, this is to say where *during* is required. In Dutch *tijdens* is normally used. However if the sub-stevent is a simple action then either *bij* or *onder* may be used. *Bij* (also used for natural events, see above) is used when there is some causal connection between the sub and matrix stevents. If there is no causal connection, then *onder* is used, for example

During my morning exercises, I would ... `(bij)`
During the meal, he would tell us stories of the war. `(onder)`

There is also a complication when the stevent is a temporal term and *in* would be used in English. Dutch also uses *in*, but if the sub-stevent is a part of a day, for example morning, evening, night, or the two main seasons, winter and summer, then it usually uses *'s* (*'s* is short for *des*, the old genitive of the definite article in Dutch). For the minor seasons, spring and autumn, this option is not available. We have here moved from the level of general to language-specific rules.

Turning to the lower half of Figure 4, we will note the few differences from the English when the sub- stevent sets one end of the time period in which the matrix stevent is to occur. The first is that whereas the English prepositions *after, before, since* and *until* can also be used as conjunctions, their Dutch counterparts (with the exception of *sinds*) have to have *dat* (that) added as a suffix to make them into conjunctions. If *-dien* is added to these prepositions as a suffix, then they are deicitic, in the same way as *afterwards*.

The second difference is that the Dutch equivalent to *by, tegen*, literally means *against* which is reflected in its use. *Tegen* is appropriate with clock times but not in expressions such as *by the time* in which case *toen* (when) is used, for example

> *We'll be there by 5 o'clock. (tegen)*
> *John had left by the time we got there. (toen)*

The other difference is that when the sub-stevent is to mark the end point of matrix stevent that is negative, either explicitly or implicitly, for example

> *It was a long time before I saw what he was getting at.*

eer may be used instead of *voor* when the matrix contains a negative.

To summarize, the main differences between Dutch and English in the non-durative use of temporals are that:

- there is no equivalent for the English *as* to indicate that the matrix stevent is taking place at the same time as an ongoing activity; a choice has to be made to use either *toen* (when) or *terwijl* (while);
- the point of time at which the matrix stevent occurs may be introduced by *toen* or *als/wanneer* depending on whether the ToD is in the past or not;
- there are three prepositions for a time point, corresponding to *at*: *om* for clock times, *met* for religious feasts and *aan* for beginnings and ends;
- there are three prepositions *tijdens, bij, onder* to indicate that the matrix stevent occurred in a time period, distinguished by whether or not the sub-stevent is an action and, if so, whether or not it is causally related to the matrix stevent;
- a special construction, *'s*, is used for parts of days and the major seasons.

3.4 THE GERMAN NON-DURATIVES

Once again the German selection tree is similar to the Dutch (see Figure 5). There are a few differences to be noted. First, when a clause is being used to indicate the point of occurrence of the matrix stevent, then *wie, als* or *wenn* is used in German. But note that German *als* is used when the matrix stevent is one-off in the past, whereas Dutch *als* is used when it is not! The equivalent to Dutch *als/wanneer* is *wenn* in German. The equivalent to Dutch *toen* is either *als* or *wie* in German. *Wie* is used with the historic present.

Second, whereas both Dutch *aan* and German *an* are used with "the beginning/end" *an* is also used with a day or a part of a day. In Dutch a day either takes no preposition or *op*; a part of a day is treated like a period and takes *'s* or *in*. In German the distinction between *in* and *'s* does not exist. However, there is a means for indicating that the matrix stevent lasts for the whole of the period of the sub-stevent, namely by using no preposition and the accusative case.

Thirdly the preposition *zu* in German is not only used with religious feasts (compare *met* in Dutch) but also with phrases containing the words for time: *Zeit, Stunde*. These 'time' phrases may also be used with *in*, indicating that they may be considered either as points (with *zu*) or periods (with *in*).

Fourthly, there is no German equivalent of the Dutch *onder* to indicate that there is no causal relation between the sub-action and the matrix stevent.

In the 'lower' half, of Figure 5 we see a close correspondence with the Dutch. Note that whereas the Dutch make a conjunction from a preposition by adding *-dat*, the German generally adds *-dem*, with the exception of *be+vor*. The only other difference is that in German there is no correspondence to the *until/by* or *tot/tegen* distinction. In both the durative and the non-durative pointers to the time period following the ToD, German uses *bis*.

3.5 IN SUMMARY

The non-durative temporals can be divided in two main groups, those that fix the time of the matrix stevent to be that of the sub-stevent and those that fix one or both ends of a time period in which the matrix stevent falls. In the former case, the time of the matrix stevent is fixed at either a point or a period. In addition days of the

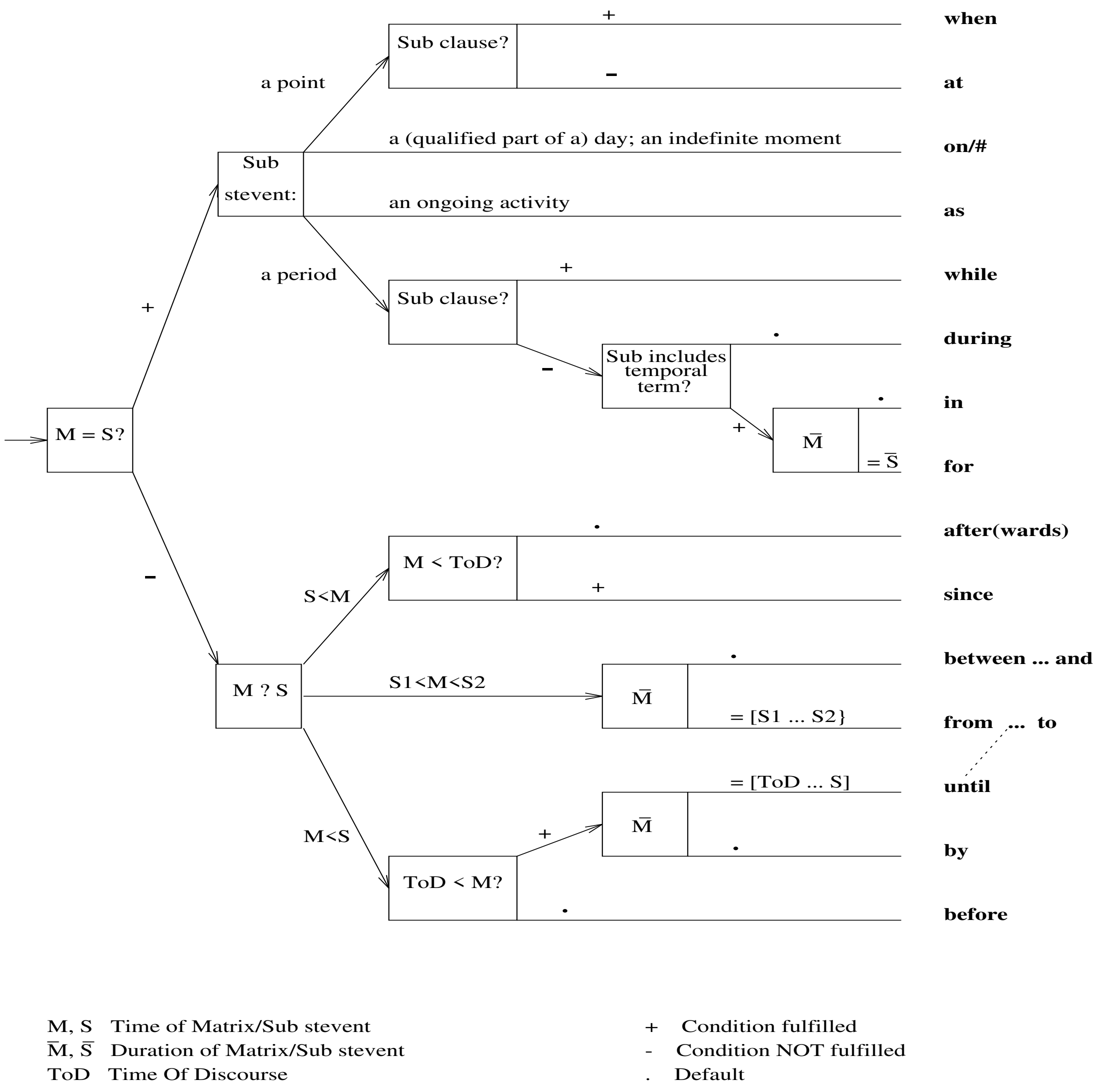


Figure 4: Selection tree for Dutch non-durative use of temporals

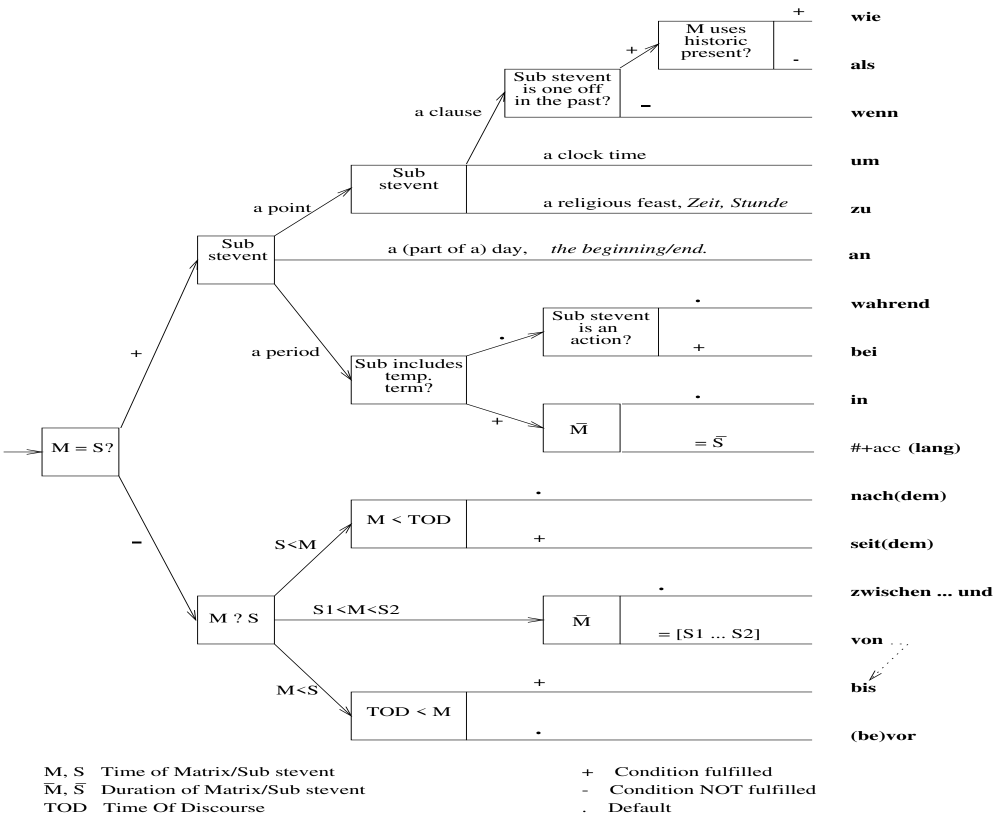


Figure 5: Selection tree for German non-durative use of temporals

week are given a special treatment. In these cases prepositions and conjunctions are different words. Both Dutch and German have more such temporals than English. They typically have different conjunctions for time points, depending on whether the situation is a one-off event in the past or not. Also they have special prepositions for time points, depending on the kind of point that is being picked out by the preposition: clock time, religious feast, beginning/end etc. In addition both Dutch and German have a finer distinction for prepositions indicating a time duration than does English.

As for the prepositions, and the conjunctions made from them, that indicate the ends of the time period in which the main stevent takes place, there is a primary distinction between those prepositions that take a single and those that take a double phrase, the later enabling both ends of the matrix stevent to be explicitly fixed. When only one end is fixed, the other end may be left either open or fixed at the ToD.

4 Conclusion

After considerable adjustment to the selection trees as they were originally proposed, it seems that this method of representing the use of temporal prepositions and conjunctions has settled down. It can now be used to quickly pinpoint the temporals that are idiosyncratic to any other European language. Examination of the criteria by which the temporals are selected reveals that there are very basic concepts, such as:

- pure duration versus on the time axis;
- fixing the time of occurrence or the length of time of the matrix stevent;
- pointing to a time point or period;
- locating the matrix time as earlier than or later than the sub-stevent time;
- in those cases where one end of the time period is fixed, indicating whether the other end is open or fixed by default at the Time of Discourse;
- in those cases where a time period is involved, indicating whether or not the matrix stevent occurs somewhere in that period or for the whole of the period;
- sometimes an indication of a regular co-occurrence or a one-off situation;
- a special treatment for days and sometimes for parts of days, religious feasts etc.

In addition to these regular features that occurred in all three of the languages, there are points peculiar to an individual language. For instance, the use of *'s* with *winter* and *summer* but for *spring* and *autumn* in Dutch. There are a few of these in all three languages and there is no reason to doubt that they will occur in other languages that are examined.

So what we find is a basic system that is likely to be reflected in the use of temporals in all languages, or at least all European languages, together with a few language-specific points. Preliminary work with French supports this. Extension to other European languages is planned.

5 References

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