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THE SEMANTICS OF NOCH AND SCHON IN A REICHENBACHIAN TEMPORAL LOGIC

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Reichenbach is to be credited for introducing the idea that the meaning of some tenses and temporal expressions depends not only on the time-of-speech and the time at which an event takes place but also on a third time, the reference time. In this paper I argue that the semantics of the German adverbial particles noch and schon, in their temporal uses, depends on the employment of reference time as a theoretical tool. In the treatment proposed, reference time functions as one of three dimensions in a tense logic; but it is otherwise the same concept introduced by Reichenbach.

What is reference time?

The concept of reference time has puzzled some researchers. Reichenbach distinguished speech time t_s , event time t_e and reference time t_r . Let us examine these as applied to a concrete example:

- (1) After he had eaten everything, he said good-bye.

The first two concepts are familiar. The speech time is simply the time at which the above sentence is uttered. The event time of the subordinate clause is the time at which he ate. In addition, this event time is seen from the reference time of his saying "good-bye."¹⁾

Reference time is often provided only by the context, as Reichenbach noted. He commented that in the sentence Peter had gone:

"...it is not clear which time point is used as the point of reference. This determination is rather given by the context of speech. In a story, for instance, the series of events recounted determines the point of reference which in this case is in the past, seen from the point of speech; some individual events lying outside this point are then referred, not directly to the point of speech, but to this point of reference determined by the story." (Reichenbach, 1947, 288)

Two aspects of Reichenbach's proposal will be exploited below. First, reference time is subject to pragmatic influence. Second, a reference time may be given by the event time of previous discourse.

The Logic

The logic to be employed will semantically treat all temporal expressions as propositional operators. For this reason, a sentence logic is sufficient to demonstrate the treatment. We will assume that an interpretation function I assigns truth values to atomic propositions with respect to intervals of time (which are designated here by superior bar, e.g. \bar{t}) This is encoded in (3).

- (3) for \bar{t} an interval, p an atomic proposition, $I(p, \bar{t}) \in \{0, 1\}$

¹⁾ Reichenbach, 1947, 289 is responsible for the formulation that reference time is the time "from which an event is seen."

For atomic propositions, only one interval of time - not three, as the full system allows - is relevant to the determination of truth conditions.

$$(4) \text{ for atomic } p, \mathcal{O}_{t_s} \left| \frac{t_e}{t_r} \right. p \text{ iff } I(p, t_e) = 1.$$

(I have referred to all the times in (4) as intervals because this simplifies some definitions, but this is not an essential part of the analysis.)

It is important that the intuitively persuasive notion of temporal dependence familiar from simpler tense logics is preserved here, i.e. that basic expressions are still assigned semantic values with respect to a single time. Intuitively clear foundations are required if we are to interpret the formal system. It is not immediately clear how one would interpret a basic expression with respect to pairs or triples of times.

No simple sentences in German are interpreted by atomic formulae, however. All include some temporal modification, viz. tense. We now turn to its analysis.

German Tense

The Preterite in German simply asserts that event time precedes speech time while the Present is best viewed as the complement to the Preterite. These analyses are encoded in (5) and (6):

$$(5) \mathcal{O}_{t_s} \left| \frac{t_e}{t_r} \right. \text{PREM}(p) \text{ iff } t_e < t_s \text{ and } \mathcal{O}_{t_s} \left| \frac{t_e}{t_r} \right. p, \text{ where}$$

where for all intervals i_1, i_2 $i_1 < i_2$ iff i_1 completely precedes i_2 , i.e. formally iff $\forall t_1 \in i_1, \forall t_2 \in i_2$ $t_1 < t_2$.

$$(6) \mathcal{O}_{t_s} \left| \frac{t_e}{t_r} \right. \text{PRES}(p) \text{ iff } t_e < t_s \text{ and } \mathcal{O}_{t_s} \left| \frac{t_e}{t_r} \right. p$$

Partee, 1973 argued for the need for tense operators with definite interpretations in place of (or in addition to) the indefinite interpretations which the Priorian operators provide. Both (5) and (6) provide for these interpretations of the tense operators.

This analysis of the Preterite is uncontroversial. The proposal about the Present requires some comment, however. First, this definition cannot be applied to cases of the so-called "historical present" or "narrative present", which is available in German as in many other languages. The analysis is thus committed to regarding these uses of the Present tense form as distinct. They constitute a marked use limited to narration.

Second, although the proposed definition allows that any present tense sentence may be understood to be true of a future event time, pragmatic factors may make this understanding quite implausible. For example, sentence (7), in the absence of preceding discourse, would only be understood about present time.

(7) Der Jo ist krank
'Joe is sick'

It is improbable that a speaker would know about future illness; the hearer may therefore infer that a present illness is being reported.²⁾

It should be noted that (5) and (6) are formulated so that reference time is irrelevant. The formulation claims in effect that the use of the

²⁾ This tendency to exclude future readings seems limited to stative predicates. If this limitation turns out to be genuine, it will require a modification of (6).

Preterite and the Present is insensitive to previous discourse. According to the qualifier above about the historical present, this seems to be true.

(For those familiar with Bäuerle and Stechow's work on German tempora, (5) and (6) also signal that reference time is not used as their Beobachtungszeit. Cf. Bäuerle, 1979, 468 and Bäuerle and Stechow, 1989, 307ff.)

Frame Adverbials

As Bennett and Partee, 1972 propose, adverbs such as gestern 'yesterday' or heute 'today' function to place event time within a specified frame. This is formalized in (8):

$$(8) \text{ (preliminary version) for } f \text{ a frame adverbial}$$

$$Q_{t_s} \left| \frac{t_e}{t_r} \right| f(p) \text{ iff } t_e \in [f] Q_{t_s, t_r, t_e} \text{ and } Q_{t_s} \left| \frac{t_e}{t_r} \right| p.$$

Note that all mention of reference time has been suppressed on the right side of (8). This is remedied in the final version of the rule (35).

'[f] Q_{t_s, t_r, t_e}' stands for the semantic value of f with respect to the model and times indicated. In the case of gestern, this value obviously depends on speech time.

Let us consider an example to see how (8) functions:

- (9) Es regnete gestern
- 'It rained yesterday'

This should be assigned the analysis (10):

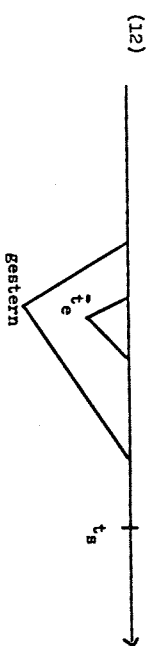
$$(10) \text{ GEST(PRET(es regnen))}$$

$$(11) Q_{t_s} \left| \frac{t_e}{t_r} \right| (10) \text{ iff } t_e \in \text{[PRET]} Q_{t_s, t_r, t_e} \text{ and}$$

$$t_e < t_s \text{ and}$$

$$Q_{t_s} \left| \frac{t_e}{t_r} \right| \text{ es regnen}$$

That is, (9) is true in the situation sketched in (12):



The "derivation" in (11) obviously lacks some steps, e.g. how gestern is assigned the denotation of the day preceding speech time. But it illustrates how frame adverbials and tense interact. Note that relative scope is unimportant. Instead of (10), we might have assigned (9) the analysis in (10'):

$$(10') \text{ PRET(GEST(es regnen))}$$

Duratives

The class of durative adverbials includes tage/lang 'for days', lange 'for a long time' and drei Jahre 'for three years'. As evidenced in (13), these combine freely with atelic verbs, but not with telic verbs:

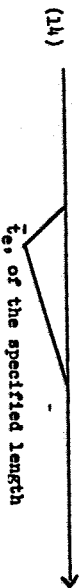
(13) atelic Er wohnte tagelang bei uns.
 lange
 drei Jahre

He lived with us for days
 for a long time
 for three years

telic * Er erledigte die Sache tagelang
 lange
 drei Jahre

He took care of the matter for days
 for a long time
 for three years

These adverbials apparently specify the length of \bar{t}_e . Cf. (14):



Before attempting a semantic analysis, let us note an interesting interaction of durative adverbials with frame adverbials in sentence (15):

(15) Morgen noch er drei Jahre bei uns
 tomorrow lives he [for] 3 yr with us
 'As of tomorrow, he'll have lived with us for three years'

Rule (8) specifies that \bar{t}_e in (15) fall within the time denoted by MORGEN, i.e. tomorrow. If we analyze duratives as merely specifying the length of \bar{t}_e , then sentence (15) will be true only in situations in which a three year period falls within tomorrow. This is of course incorrect.

We might at this point revise the rule which analyzes frame adverbials. Rather than require that \bar{t}_e fall within the time specified by a frame adverbial, we might require only that \bar{t}_e end within this time. This would provide a correct set of truth conditions for (15). This sort of analysis would have some quite counterintuitive consequences as well, however. It would allow that sentence (16) be true in a situation in which Thomas finishes writing his dissertation tomorrow, although he may have been writing it for some time.

(16) Thomas schreibt morgen seine Dissertation
 writes tomorrow his diss.
 'T. will write his dissertation tomorrow'

(16) is quite clearly false in this situation, however.

For this reason, the rule introducing durative adverbials will be formulated somewhat differently:

(17) for d a durative adverbial,

$$Q_{t_s} \left| \frac{\bar{t}_e}{t_x} \right| d(p) \text{ iff there is a } \bar{t}_e' \text{ such that}$$

1. \bar{t}_e' is a final subinterval of \bar{t}_e'
2. \bar{t}_e' is of [d] $Q_{t_s} \bar{t}_e'$ -length
3. $\forall t \in \bar{t}_e', Q_{t_s} \left| \frac{\bar{t}_e'}{t_x} \right| p$

The formulation (17) is deceptive in that it is based on a categorization of duratives as sentence adverbials when they are probably best analyzed as verb phrase adverbials. It furthermore ignores the composition of the durative phrases themselves. (17) does allow a correct analysis of (15), however. This is sketched in (18):

(18) HORG(FRIG(3J(er bei uns wohnen (= p))))

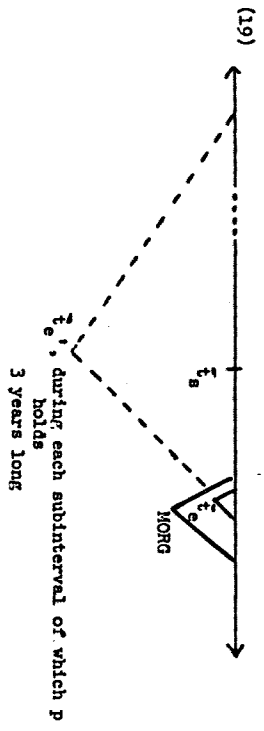
$Q_{t_s}^t \equiv \frac{t}{t_r}$ (18) iff (a) $\bar{t}_e \in [HORG] Q_{t_s}^t \bar{t}_e$ and

(b) $\bar{t}_e \not\in \bar{t}_s$ and

(c) there is a \bar{t}_e' such that

1. \bar{t}_e is a final subinterval of \bar{t}_e'
 2. \bar{t}_e' is of [3J] $Q_{t_s}^t \bar{t}_e'$ -length
 - and 3. $\forall \bar{t}_e' \in \bar{t}_e'$
- $Q_{t_s}^t \equiv \frac{t}{t_s}$ p.

(19) would thus be true in a situation such as (19):



Note that each of the truth conditions derived in (18) is correct. Together they provide a sufficient guarantee of the truth of (15).

Clause (3) of the definition (17), which requires that the sentence to which a durative applies hold of every subinterval, will fail for all telic verbs. This guarantees that duratives only occur (sensibly) with atelic verbs. This aspect of (17) is taken from Dowty, 1979, 333.

(temporal) schon

We can now turn our attention to the adverbial particle schon. It has already attracted a great deal of scholarly attention. Although some have maintained that it makes no contribution to truth conditions, but only to the presuppositions (or conventional implicatures) of sentences, this is clearly wrong:

(20) Thomas schreibt eine Seminararbeit
writes paper

(21) Thomas schreibt schon eine Seminararbeit

(20) is true if Thomas is now writing or will later write his paper, while (21) requires that he be writing it now.

I will analyze the contribution of schon to truth conditional semantics and ignore that component of the meaning of schon which is responsible for conventional implicatures. In (21) schon ties event time to speech time. The tie is not direct, but rather by way of reference time. This may be seen in examples where reference time is distinct from speech time, for example where it is specified by the preceding context. Consider (22):

- (22) Ich bin um vier gekommen. Er war schon da.
 I AUX at 4 come(part) he was already there
 'I came at 4. He was already there.'

There is no indication in the second sentence that his presence was contemporaneous with speech time, but only that it overlapped with reference time, fixed in this case by the event time of the first sentence.

Rule (23) provides a semantic treatment of schon: 3)

$$(23) \mathcal{O}_{t_s} \left| \begin{array}{c} t_e \\ \hline t_r \end{array} \right. \text{SCHON}(p) \text{ iff } \mathcal{O}_{t_s} \left| \begin{array}{c} t_e \\ \hline t_r \end{array} \right. p \text{ and } t_e \leq t_r,$$

where $t_1 \leq t_2$ iff t_1 does not extend beyond t_2 , formally
 iff $\forall t_1 \in I_1 \exists t_2 \in I_2$ such that $t_1 \leq t_2$.

As we saw above, reference time is to be construed as the time from whose vantage point the event is viewed. This may be specified by the context of speech as in (22), or it might conceivably be fixed by the shared knowledge of interlocutors, as in the case where (24) is uttered about a time known to speaker and hearer:

- (24) Er war schon da
 he was already there

In the absence of such contextual specification, the speech time functions as the time from whose vantage point the event is viewed. The speech time functions as the reference time. With this in mind, the analysis of (21)

3) erst makes the same contribution to truth conditions and has the same semantics, though not the same conventional implicatures.

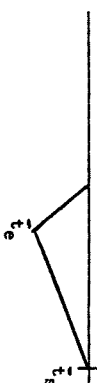
is straightforward:

$$(25) \mathcal{O}_{t_s} \left| \begin{array}{c} t_e \\ \hline t_r \end{array} \right. \text{PRES}(\text{SCHON}(\text{er eine Seminararbeit schreiben})) \text{ iff}$$

- (a) $t_e \not\leq t_s$ (PRES)
 (b) $t_e \leq t_s$ (SCHON)

(c) $\mathcal{O}_{t_s} \left| \begin{array}{c} t_e \\ \hline t_r \end{array} \right. \text{er eine Seminararbeit schreiben}$

(26)



(a) and (b) in combination require that t_e not completely precede t_g and that t_e not extend beyond t_g . Thus conditions are jointly met only in situations such as (26). The definitions correctly require that the atomic proposition hold of a time immediately prior to and including speech time.

The addition of duratives to sentences such as (25) is likewise unproblematic. Consider (27):

- (27) Sie arbeitet schon drei Jahre hier
 she works already 3 years here

'She has worked here for three years'

$$\mathcal{O}_{t_s} \left| \begin{array}{c} t_e \\ \hline t_g \end{array} \right. (28) \text{ iff } (a) t_e \not\leq t_g \text{ (PRES)}$$

(b) $t_e \leq t_g$ (SCHON)

(c) there is a t_e' such that
 1. t_e' is a final subinterval of t_e'

It might appear that (34) will be analyzed as contradictory according to the present scheme. The present tense and schon will apparently combine to require that event time end at speech time while MORGEN will require that event time be contained within tomorrow.

The solution to this apparent difficulty follows from Felchenhach's conception of reference time as the time from which an event is seen. The frame adverbial provides such a time. The final formulation of the rule introducing frame adverbials is (35) below:

(35) for f a frame adverbial

$$Q_{t_s} \left| \begin{array}{c} \bar{t}_e \\ \hline \bar{t}_r \end{array} \right. f(p) \text{ iff } \bar{t}_e \subseteq [f] Q_{t_s, \bar{t}_r, \bar{t}_e} \text{ and } Q_{t_s} \left| \begin{array}{c} \bar{t}_e \\ \hline [f] Q_{t_s, \bar{t}_r, \bar{t}_e} \end{array} \right. p.$$

This allows us to analyze (34) as (36):

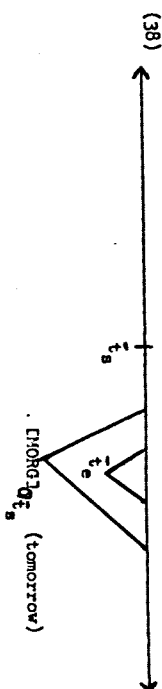
(36) MORG(PRES(SCHON(er eine Seminararbeit schreiben)))

(37) $\bar{t}_s \left| \begin{array}{c} \bar{t}_e \\ \hline \bar{t}_g \end{array} \right. \text{ iff (a) } \bar{t}_e \subseteq [MORG] Q_{t_s, \bar{t}_s, \bar{t}_e}$

(b) $\bar{t}_e \not\subseteq \bar{t}_s$ (PRES)

(c) $\bar{t}_e \subseteq [MORG] Q_{t_s}$

and (d) $Q_{t_s} \left| \begin{array}{c} \bar{t}_e \\ \hline [MORG] Q_{t_s} \end{array} \right. \text{ er eine Seminararbeit s.}$



Condition (c) in (37) follows from (a) for that schon is superfluous (truth-conditionally) in (34) as well. It is superfluous in all sentences with frame adverbials.

It is crucial in (34) that MORGEN be analyzed as having wider scope than schon. But we might expect of a frame adverbial that it have wide scope.

There are two sorts of apparent counterexample to the analysis of schon proposed here. First, there are examples of the sort cited by Hoepelman and Rohrer, 1991 such as (39) (their (22), p.108):

(39) Die Oper fing an und schon schlief Hans
the opera began and slept

'No sooner had the opera begun when Hans slept (fell asleep)'

This constitutes a counterexample to the analysis of schon proposed here because the event time of Hans' sleeping begins after the reference time established in the first clause, i.e. $t_e \not\subseteq t_r$. But this is clearly a special use of schon. This is best indicated by the fact that schon has this meaning only in sentence-initial position. (39) contrasts with (40):

(40) Die Oper fing an. Hans schlief schon.
the opera began slept

'The opera began. Hans was already asleep.'

The meaning of schon in (40) accords with the treatment proposed here. The special status of the schon in (39) may also be indicated by the fact that it is marked as belonging to a narrative style.

Second, there are uses of schon such as (41) in which event time clearly follows reference time (in this case speech time):

- (41) Geh weg! - Ich gehe schon.
Go away - I go
'Go away!' - OK, 'I'll go'

These uses of schon are generally concessive or confirmatory in meaning. They may be distinguished from the temporal schon in several ways. First, they may co-occur with noch, which is never possible with temporal schon:

- (42) Ich gehe schon noch einkaufen
I go yet shopping
'I'll certainly still go shopping'

Second, they may often bear a markedly falling intonation:

- (43) Er arbeitet schon
he works
'Granted, he does work'

Third, they may never be preposed, unlike the temporal schon:

- (44) Schon drei Stunden arbeite ich
3 hours work I
'I've been working for three hours'

(Not all speakers of German accept accept sentences with preposed temporal schon, particularly if it is alone. It is in any case very marked.)

- (45) Schon arbeite ich drei Stunden
only: 'I have been working for three hours'
never: 'Certainly I work for three hours'

I conclude then that the use of the Reichenbachian reference time allows a correct and quite simple formulation of this adverbial particle's semantics.

(Temporal) noch

The semantics of noch are not as simple as those of schon, but their correct formulation also requires mention of reference time. The semantic rules for noch are provided here without much comment.

Like Koepelman and Rohrer, 1981 the system here must distinguish the uses of noch in combination with telics such as (46):

- (46) Er kommt noch
he comes yet
'He'll come yet'

As Koepelman and Rohrer note, this use of noch is always replaceable with doch noch. Here $t_x < t_e$. This is formulated in (47):

$$(47) \text{ } O_{t_s} \overline{t_e} \text{ NOCH}(p) \text{ iff } \exists t'_e \text{ such that } \overline{t'_x} < t'_e$$

$$\text{and } O_{t_s} \overline{t'_e} \text{ } p.$$

Note that (47) predicts that there is no definite interpretation of tense in cases where noch is used this way, except of course that reference time

places a lower bound on event time. This prediction seems to be correct.

Noch is also used with duratives with which it forms constituents. (49) provides interpretations for the constituent noch - durative without specifying how these are derived.

(49) $Q_{ts} \left| \begin{array}{c} t_e \\ t_r \end{array} \right|$ NOCH-d(p) iff there is a t_e such that
1. t_e is an initial subinterval of t_e ;
2. t_e is of [d] $Q_{ts} t_r t_e$ -length

3. $\forall t \in t_e \left| \begin{array}{c} t_e \\ t_r \end{array} \right|$ p.

(49) Noch lange haben sie geschuftet
yet long AUX they toil(part)
'They toiled for a long time'

Finally, (immer) noch may be used in any sentence to indicate that event time and reference overlap.

(50) $Q_{ts} \left| \begin{array}{c} t_e \\ t_r \end{array} \right|$ (immer)NOCH(p) iff t_r is an initial subinterval of t_e
and $Q_{ts} \left| \begin{array}{c} t_e \\ t_r \end{array} \right|$ p.

(51) Sie waren immer noch da
they were still there

Note however that the rules above provide no account of the anomaly in (52):

(52) Er war gestern noch drei Wochen da
he was yesterday yet 3 weeks there

(The anomaly in (52) is explicable if tense has narrower scope than duratives, but this does not generalize.)

Conclusions

The analyses above indicate that the employment of Reichenbach's reference time facilitates the semantic description of some temporal expressions. Indeed, it is difficult to see how the semantics of noch and schon might be formulated without the concept of reference time. Moreover, the very same concept may profitably be employed in analyzing the German Plusperfect, the future use of the German Perfect, adverbials of the sort seit einer Stunde 'for the last hour', and those of the form bis Freitag.⁵⁾

The use of reference time in temporal analysis does not obviate the need to refer to speech time and event time, however. The temporal reference of expressions such as yesterday, today and tomorrow obviously depends crucially on speech time. Event time is indispensable first because it provides the time at which (non-temporal) atomic expressions are semantically evaluated. Further, it is important in the analysis of duratives above, and in providing for the definite interpretation of tense (cf. p.4 above.) It is also manipulated in the semantics of mal 'once', which signals indefinite tense interpretation.⁵⁾

No argument presented here proves that e.g. event time and reference time must be viewed as distinct primitive concepts, but the indications are quite strong that they should be viewed this way. Reichenbach seems to

⁵⁾ These are analyzed in Nerbonne, in progress.

have been correct in distinguishing three temporal indices.

But Reichenbach was correct not only in seeing the need to interpret temporal expressions with respect to three times, he was also correct in his conception of the three. This is obvious in the case of speech time and event time. It is less obvious, but just as correct, in the case of reference time. Reference time is clearly influenced by the context of speech, just as Reichenbach maintained, and reference time is correctly conceptualized as "the time from which an event is viewed," again as Reichenbach suggested.

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