

‘ON-LINE’-INFERENCES IN THE SEMANTICS OF DANN AND THEN *

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Abstract

The paper presents a theory of the semantics and the discourse effects of German temporal *dann* and English *then* in their sentence-initial, –internal and –final positions. The theory provides an algorithmic reconstruction of these differences on the basis of a single specification of the semantics of *dann/then*, which interacts with other semantic elements at sentence and discourse level in ways that vary with its position. The requirement which *dann/then* imposes is that the time it denotes is separated from the time which the narration had reached by a change in some contextually salient property of a topical discourse referent. What is available as contextually salient property depends on where *dann/then* occurs in the sentence. Integration of this insight into a general account of semantic processing entails a shift of perspective in current semantic theory. Semantic processing must now be treated as incremental following the left to right order not only sentence by sentence but also word by word.

1 A short characteristics: semantics and position of German *dann* and English *then*

It is a well-known phenomenon that sentence-initial and sentence-final *then* are different; the former is known as updating, the latter as co-temporal *then*.¹ That German *dann* also differs as a function of position is a less well known fact. Sentence-initial *dann* is like sentence-initial *then*; there is, however, also a sentence-internal position in German in which *dann* occurs and in which it behaves differently from sentence-initial *dann/then* on the one hand and from the sentence-final *then* on the other. Our attention was drawn to this distinction when investigating a corpus of oral narratives.² We frequently find instances like (1a), where the alternative version in (1b) would be unacceptable.

- (1) a. man sieht nochmal sein gesicht und dann sieht man einen schwarzen
you see again his face and then see you a black
bildschirm
screen

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¹Shiffrin (1992), Glasbey (1993), Spejewski and Carlson (1993) and others.

²These are corpora for psycho-linguistic studies at the *Institute for German as a Foreign Language* at the University of Heidelberg.

- b. man sieht nochmal sein gesicht/ und # man sieht dann einen schwarzen
 you see again his face and # you see then a back
 bildschirm
 screen

Context (1a) is true if you see a face and no black screen at t and at t' you see no face but a black screen. (1b) would mean a black face but no black screen is seen at t and at t' the face as well as the black screen is seen. Since you cannot see the face and a black screen at the same time (1b) would be the wrong thing to say. (The data show that this is a mistake that people do not make.)

The difference between sentence-initial and sentence-final *then* is not quite the same as that between sentence-initial and sentence-internal *dann*. (2a) is like (1a).

- (2) a. you see his face again/ and then you see a black screen
 b. you see his face again/ # and you see a black screen then

Context (2b) would like (1b) describe an impossible situation. But in this case the impossibility would arise because the second sentence suggests that a black screen is seen throughout the time denoted by the first sentence (and not just that the two states would overlap).

These findings already show a tendency: With sentence-initial *dann* we have non-persistence of the antecedent state to the right and non-persistence of the consequent to the left. I.e. (1a) and (2a) speak of two times and two states, which do not overlap. With sentence-internal *dann* we have persistence to the right of the antecedent state and non-persistence to the left of the consequent state. The context speaks of two times, $t \prec t'$, but the antecedent state also obtains at t' . With sentence-final *then* we have persistence of the antecedent state to the right and persistence of the consequent state to the left. The context speaks of a single time at which both states are presented to obtain.

Is there a unique semantics of *dann/then* on the basis of which the differences can be calculated compositionally? We claim that there is. *Dann* (or *then*) signals a change of some property of the subject from the antecedent state to a new state where the subject no longer has that property: In (1a) and (2a) the property 'see the face' changes to 'not see the face'. In (1b) the change is from 'not see the black screen' to 'see the black screen' while the property 'see the face' continues to hold. This difference between (1b) and (1a) is due to the fact that the discourse referent of *man* in the second sentence of (1b) is interpreted as keeping its property 'see the face' before *dann* signals that some change occurs. In the case of sentence-final *then* in (2b) that signal comes too late to prevent another inference that would be drawn if *then* had been absent altogether, viz. that the second property already held at the time described by the first sentence. *Then* in its sentence-final position must be understood as signalling a change from the state of both seeing the face and seeing the black screen to a state where neither seeing the black screen nor seeing the face is longer guaranteed to obtain.

Changing the examples so that the antecedent sentence contains an event rather than a state shows effects which do not arise with stative predications and which have to do with the causal relation between the events in the first and in the second sentence.

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- (3) a. das männchen steht auf/ und man sieht dann dass es aus lehm ist
the little man stands up and you see then that it from clay is

Context (3a) means that the event of the little man getting up makes you see that he is made out of clay, something you wouldn't have seen if he hadn't got up; we infer a causal connection. If we swap positions of *dann* and *er*, so that *dann* is sentence-initial and *er* is internal, see (4a), the causal relationship is suspended. This also holds for the English version (4b) with sentence-initial *then*.

- (4) a. das männchen steht auf/ und dann sieht man dass es aus lehm ist
the little man stands up/ and then see you that it from clay is
b. the little man stands up and then you see that it is made out of clay

The potential of sentence-initial *dann/then* to suspend a causal relationship is wellknown from the literature, see e.g. Glasbey (1993), Spejewski and Carlson (1993). The fact that *dann* in its clause-internal position can trigger a causal connection is not known and is surprising. It has been noted in the literature that sentence-final *then* does not prevent the interpretation of a causal relation as such (see (5)). However pure background readings are more common. That is also the default interpretation of (5), when *having achieved a lifelong ambition* is omitted.

- (5) Daniel climbed Ben Nevis. He was happy then (having achieved a lifelong ambition).
Glasbey (1993)
- (6) Daniel bestieg den Ben Nevis. Er war dann glücklich.
'Daniel climbed Ben Nevis. As a result he became happy'

A pure background reading is not available with (3a), nor with (6), where *dann* is also internal.

We will argue for the fact that the power of sentence-initial *dann/then* to suspend a causal relationship is due to a discontinuity it introduces into the descriptions, whereas sentence-internal *dann* and sentence-final *then* describe the eventuality sequence as continuous. We will define these notions in terms of properties ascribed to the topical discourse referent at the times *t* and *t'* described by the two sentences. Our distinction between continuous and discontinuous descriptions reconstructs that of Shiffrin (1992) between 'continuation of reference time' (applying to sentence-final *then*) and 'shift of reference time', (applying to sentence-initial *then*). Other authors have made similar dichotomies: Spejewski and Carlson (1993), speak of 'temporal subordination' vs. 'temporal distinction' at the discourse level. Glasbey (1993) speaks of "part-whole-relation" vs. "no part-whole-relation" between eventualities. Our account differs from those in that we explain the discourse effects as a result of inferences at the level of verbal predication.

2 *dann/then*: a challenge for dynamic semantics

2.1 state of the art in dynamic semantics and difference in meaning

The difference between (1a) and (1b) is one that current dynamic semantics fails to represent. Following the proposals of semantics construction in current DRT and UDRT, ³interpretation is a two step process. Representation starts from a syntactic tree representation. As always, the leaves of this tree are decorated with the lexical items of which the sentence is composed. These items are replaced by the semantic representations with which they are paired in the DRT-lexicon. These representations are “preliminary representations” in the technical sense: they consist of (i) a (set of) presupposition(s) and (ii) a non-presuppositional part. (See (8)). In current DRT these lexical representations are then combined, following the structure of the tree, to form a preliminary DRS for the sentence. (See (9)). Resolution of its presuppositions then converts this preliminary DRS into the final sentence representation.

In UDRT the lexical representations are first arranged in the form of a semantically motivated lattice (UDRS). The conversion of this UDRS into the final sentence representation makes it possible to take other factors besides syntactic structure into account and to permit presupposition resolution to guide the resolution of scope and other ambiguities. In the account of representation construction we propose here the lexical components are also kept separate initially, but their integration is allowed to proceed on-line: As the lexical items and their semantic representations become available in a left-to-right processing of the sentence, those representations which correspond to an initial segment of the sentence string can be integrated into a partial sentence representation, which will then be extended as the following lexical items become available. Moreover, certain lexical items require interpretation in relation to the part representation provided by just those lexical items which precede them in the sentence. This is so in particular for *dann* and *then*, and it is that which is responsible for the different effects these words produce when they occur in different sentence positions. Instead of UDRSs we use ‘modular representations’ which keep track of the order in which the lexical representations are introduced by the lexical items of the sentence string. (8).a and (8).b. give the modular representations for the second sentences of (1a) and (1b). The lexical entry for *dann* is (7). ⁴

$$(7) \quad \textit{dann} \rightsquigarrow \left\langle \left\{ \begin{array}{l} t_0 \text{ } s_0 \\ t_0 \subseteq s_0 \end{array} \right\}, \begin{array}{l} t_{dn} \\ t_0 \prec t_{dn} \\ t' \subseteq t_{dn} \end{array} \right\rangle \text{ or } \left\langle \left\{ \begin{array}{l} t_0 \text{ } e_0 \\ e_0 \subseteq t_0 \end{array} \right\}, \begin{array}{l} t_{dn} \\ t_0 \prec t_{dn} \\ t' \subseteq t_{dn} \end{array} \right\rangle$$

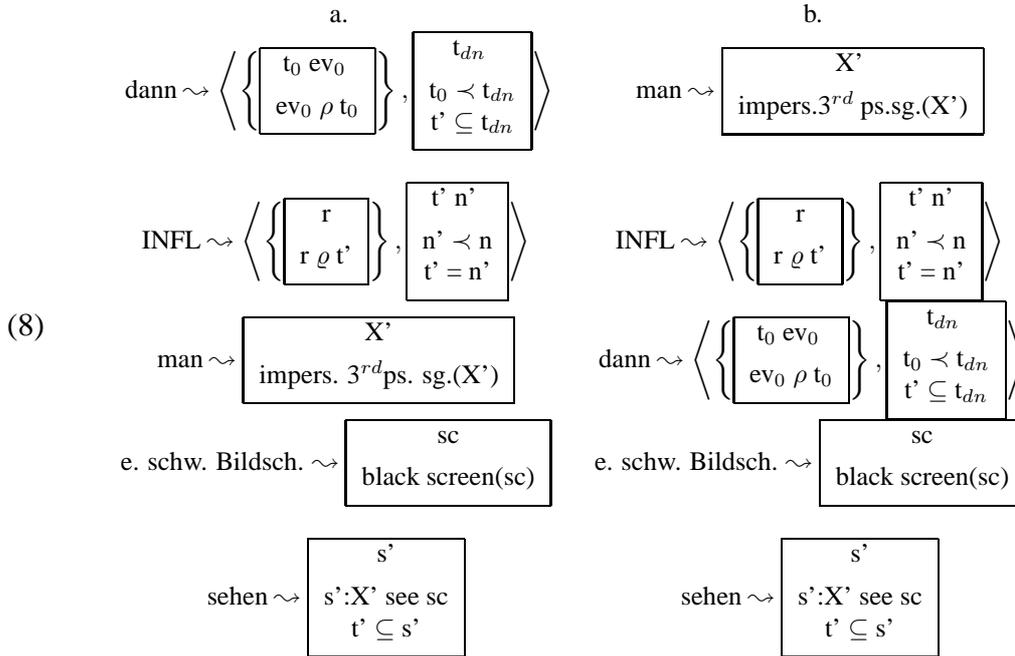
The entry (7) reflects how *dann* has been dealt with in DRT: *Dann* and *then* are anaphoric. This is made explicit in the lexical entry (7) in terms of a presuppositional binding condition which requires finding an event or state ev_0 in the context. The period discourse referent t_{dn} which *dann* or *then* introduces follows the location time t_0 of the antecedent eventuality ev_0 ; see condition ‘ $t_0 \prec t_{dn}$ ’ in the assertion part of the entry. The entry (7)

³see Genabith, Kamp and Reyle (2004), Kamp (2001a), Reyle and Rossdeutscher (2001), Reyle, Rossdeutscher and Kamp (n.d.)

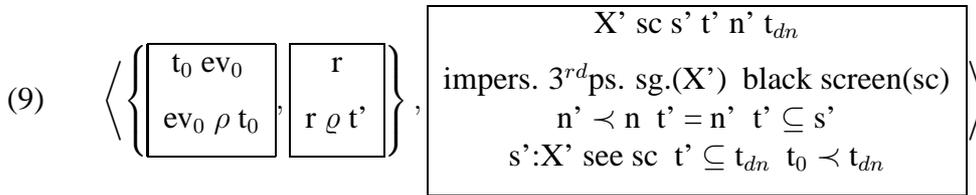
⁴In the representation of *dann* in (8) ev_0 (eventuality) generalises over e_0 (event) and s_0 (state) as in the lexical entry (7).

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will be refined and revised, see (14), below.



According to DRT the preliminary sentence representation which results from both modular representations (8).a for (1a) and (8).b for (1b) is presented in (9).



Here the crucial difference between (1a) and (1b) has been lost because all presuppositional contributions are collected into a single set (which is left adjoined to the representation of the assertion) and all assertional contributions are gathered in the assertion part. This applies in particular to the contribution made by *dann*. That *dann* makes its contribution at different stages of a left-to-right interpretation of the two sentences process is entirely ignored.

But before going into discussion of the consequences, let's finish the text representation of (1a) and (1b) to see what we really get. Presupposition justification in the context of *man sieht (nochmal) sein gesicht* t_0 in the presupposition triggered by *dann* binds the location time t of the state s , $t \subseteq s$, of the condition $s: X \text{ see } fc$.

The relation between r (eference time) and location time t' of s' (see condition $r \varrho t'$, where r is t) turns out $t \prec t'$. This relation is due to *dann*. Thus we obtain an update reading saying that at time t you see the face of the protagonist m and at a later time t' you see a black screen.

This result is unsatisfactory because it cannot explain why speakers would produce (1a) and not (1b). Moreover, the same truth conditions that are computed for (1a) and (1b) would be computed for (2b) as well and this would be entirely wrong. For we are made to

infer from (2b) contrary to our intuitions that seeing the face and seeing the black screen happen simultaneously. We could avoid this problem by saying that sentence-final *then* is a different *then*. But saying so would go against the principle that we should not postulate ambiguities where they aren't needed.

What we need is a more finegrained account of incremental semantic processing which enables us to articulate how the representations on which sentence-initial *dann* of (1a) and sentence-internal *dann* of (1b) operate and why the results of these two operations differ in the way our intuitions tell us. The modular representations as in (8) are not a bad starting point for such a theory. But the theory needs refinement in several respects. One of them is a bookkeeping device on discourse referents which keep track of the temporary properties the text attributes to the represented individuals during various stages of the discourse.

We will now present basic principles to make the necessary refinement of the semantic construction operative.

3 Basic principles

3.1 the linguistic Principle of Monotonicity (MON)

We cite this principle without further motivation. For motivating examples see e.g. the original discussion in Caenepeel and Sandström (1993), for applications see Reyle and Rossdeutscher (2001), and Roßdeutscher and von Stutterheim (n.d.).

(MON) Linguistic Principle of Monotonicity

Once a text has attributed to an individual x a state s of having property P , that state persists (in the direction of the future or 'to the right') until the text provides explicit evidence to the contrary, i.e. there is some state s' , $s \prec s'$ where x bears the property $\neg P$. (Persistence to the left, analogously.)

3.2 introduction of temporary properties of individual discourse referents

Information about temporary properties of individuals enters the discourse by means of verbal predicates. Homogeneous verbs like *love*, *be ill*, *run about*, *watch tv* predicate of their subjects the property of loving somebody, of being ill, running about or watching (tv), etc. Change of state predicates like *become ill*, *switch on the tv*, *go to the bus stop* provide more complex information of two successive states with the first changing into the second. For instance *become ill* ascribes a succession of two states (a) a presupposed state of the subject not being ill and (b) an asserted state of the subject being ill. (The subject has the properties for the duration of the corresponding states.)

3.3 a bookkeeping device for temporary properties of individuals

The bookkeeping of properties that are attributed to an individual discourse referent at various stages of the discourse is captured with the help of an indexing procedure for topical discourse referents. As will be argued in the next section the second sentence of (1b) will at one point in the processing of that sentence have the representation of the

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following form (where X represents impersonal third person (= *man/you*) and sc is the black screen).

$$(10) \quad s': X_s \text{ see sc} \quad t' \subseteq s' \cap s$$

Here the topical discourse referent X is indexed with s, see X_s , where s represents the state introduced in the first sentence, i.e. seeing the face. s is the state that counts as 'current' at the point where (10) is established. Indexing X with s in the representation of the form $s': \varphi(X_s)$ where t' is location time of s' indicates that during t' the variable X bears the properties attributed in s and the property attributed in s'. s' is the state introduced by the sentence whose representation is under construction. A complex condition of the form 's': $\varphi(X_s), t \subseteq s'$ thus always entails that $t \subseteq s' \cap s$. A special situation arises with the first sentence of a discourse, where the 'current' state s is the state which the sentence speaks about, see (11), where fc represents the face.

$$(11) \quad s: X_s \text{ see fc} \quad t \subseteq s$$

pronouns as anaphora with state properties Individual discourse referents keep their temporary properties beyond sentence boundaries. Anaphoric expressions 'inherit' their temporary properties from their antecedents. Thus the referent of the pronoun *she*, e.g. continues to have those properties its antecedent has been ascribed in context. This insight gives rise to a slight change in lexical entries for pronouns such as *she* compared with the lexical entry as given in Genabith et al. (2004).

$$(12) \quad she \rightsquigarrow \left\langle \left\{ \begin{array}{c} \text{a. current DRT} \\ u \\ \text{female}(u) \end{array} \right\} \right\rangle \left\langle \left\{ \begin{array}{c} \text{b. the present proposal} \\ u_{s^0} \\ \text{female}(u_{s^0}) \end{array} \right\} \right\rangle$$

As in Genabith et al. (2004) *she* introduces a binding constraint for a discourse referent u presenting a female individual, but here the binding constraint is a double one. This double binding constraint applies in particular for discourse referents for topic NPs: They receive a state index. For instance the contribution of the anaphoric use of *man* in (1b) and (1a) must now be of the form (13).b rather than of the simpler form (13).a.⁵

$$(13) \quad man \rightsquigarrow \left\langle \left\{ \begin{array}{c} \text{a. current DRT} \\ X' \\ \text{impers. 3}^{rd}\text{ps.sg.}(X') \end{array} \right\} \right\rangle \left\langle \left\{ \begin{array}{c} \text{b. present proposal} \\ X'_{s^0} \\ \text{impers. 3}^{rd}\text{ps.sg.}(X'_{s^0}) \\ \text{'current state'}(s^0, X') \end{array} \right\} \right\rangle$$

Presupposition justification of the occurrence of *man* in (1b) — but not in (1a) as will be argued for in the next section — comes to the complex identification $X'_{s^0} = X_s$, where $X' = X$, (X is introduced by *man* in the first sentence of (1b)) and $s^0 = s$ (where s is the state described in the first sentence which consists in X having the property P).

⁵What the conditions 'current state'(s⁰, X') amounts to will become clear as we proceed.

3.4 Lexical properties of *dann/then*

Using *dann* the speaker signals a relevant change in the episode of which the given sentence containing *dann* is used to describe some part. At the point where *dann/then* occurs *dann* makes explicit that a change has occurred and what follows must be interpreted on the basis of that change. We can say thus that *dann/then* triggers the presupposition of a change. And it is because of that change that t_{dn} follows the time t the narration has reached. To be more precise there is a state s^p with appropriate property P of the topical discourse referent x in context, such that the condition $s^p:P(x)$ holds at s^p and a state s^{*p} , where the negative condition $s^{*p}:\neg P(x)$ obtains, $s^p \prec s^{*p}$ (see the two columns in the presuppositional part of (14)). The period t_{dn} is located within s^{*p} , see condition ‘ $t_{dn} \subseteq s^{*p}$ ’ in the rightmost presupposition column in (14). This latter condition can be strengthened to $\text{dur}(t_{dn}) = \text{dur}(s^{*p})$. For *dann/then* are no frame adverbials like *tomorrow*, *after the funeral* but signal a change in states of affairs. We have positive evidence only of a left boundary, which is co-temporal with the new state conditions to obtain.

(14) (preliminary)

$$dann/then \rightsquigarrow \left\langle \left\{ \begin{array}{|c|} \hline \text{ev}_0 \ t_0 \\ \hline t_0 \ \rho \ \text{ev}_0 \\ \hline \end{array} \right\}, \left\{ \begin{array}{|c|c|} \hline s^p \ x & s^{*p} \\ \hline s^p:P(x) & s^{*p}:\neg P(x) \\ \hline & t_{dn} \subseteq s^{*p}. \\ \hline \end{array} \right\} \right\rangle \left\langle \begin{array}{|c|} \hline t_{dn} \\ \hline t_0 \prec t_{dn} \\ \hline \end{array} \right\rangle$$

The reader might notice that the new entry does not make any commitments concerning a relation between t' , i.e. location time of the verbal predication, and the period t_{dn} which is introduced by the adverbial. This lack of commitment is intended. Refraining from giving constraints in this respect seems to involve an offence against the well founded insight that adverbials also restrict location time of the sentence, see e.g. Kamp and Reyle (1993) and others. But different from frame adverbials the semantics of *dann/then* is based on inference processes involving temporary properties of individuals that involve temporal inferences also. Whether $t' \subseteq t_{dn}$ obtains or not varies both with position and context. (We will see later that ‘ $t' \subseteq t_{dn}$ ’ is valid only for sentence-initial and -internal *dann/then*.) (Note that the entry (14) is preliminary only and will be further refined later. Still refinements will not affect the general structure of presupposing change.)

4 ‘On-line’-inferencing in *s*;*s'*-descriptions

4.1 state;state-descriptions with sentence-internal *dann*

We will now follow the modular representation (8).b of the second sentence of (1b) with two accommodations: The old entry for *dann* (7) is replaced by (14). The repeated occurrence of *man* is represented as in (13).b.

man The first discourse referent that gets introduced into the processing of this sentence is the one expressed by the impersonal pronoun *man*. This occurrence of *man* is interpreted as co-referential with the *man* of the first sentence. This means that the discourse referent X'_{s_0} is set equal to the discourse referent X_s introduced by the first occurrence of *man*. The effect of this is that the state attributed to X a in the first sentence is ‘inher-

ited' by X': the predication represented by s and the new predication X' expressed by the second sentence overlap at the new predication time t'. In the case of (1b) this means that the discourse referent of *man* is seeing the face and a black screen at the same time. For the first inference we gain (10) = (15).

$$(15) \quad s': X_s \text{ see sc} \quad \text{black screen}(sc) \quad t' \subseteq s' \cap s$$

dann According to (14) the interpreter must find states s^p and s^{*p} which attribute to the topical discourse referent contradictory properties P and $\neg P$. In the case at hand the topical discourse referent must be X_s . So the requirement imposed by *dann* in (1b) takes the form of (16).

$$(16) \quad s^p: P(X_s) \quad s^{*p}: \neg P(X_s), t_{dn} \subseteq s^{*p}$$

VP Which is the property P *dann* could signal the change of? At the stage when in the course of interpreting the second sentence of (1b) *dann* has to be accounted for there are only two candidates: the one attributed to X in the first sentence —that of seeing the face — and the one which is contributed in the second sentence. But it cannot be the first for this would mean that the discourse referent of *man* would bear the properties 'seeing the face', 'seeing the screen' and 'not seeing the face' at the same time. For we have inferred in virtue of (MON) that X_s continues to have the first property, see (15). But given the signalled change concerns the latter property, we need not give up the inference already taken on board. The property changes from 'not see a black screen' at t to 'see a black screen' at t', $t' \subseteq t_{dn}$ and we end up with (17).

$$(17) \quad \begin{array}{l} s: X_s \text{ see fc} \\ s^p: \neg X_s \text{ see sc} \quad s': X_s \text{ see sc} \\ t \subseteq s \cap s^p \quad t' \subseteq s' \cap s \\ t \prec t'; t' \subseteq t_{dn} \subseteq s' \end{array}$$

This is why we get the interpretation that at t you see the face, but do not see the black screen and at t' you see both the face and a black screen. So (1b) ends up with an inconsistent reading. Sentence pairs of the same form as (1b) can be perfectly coherent provided the predications of the first and the second sentence are compatible. An example is (18).

$$(18) \quad \begin{array}{l} (\text{Als } \text{ ich Maria besuchte), \text{ war sie krank. Sie war dann im Krankenhaus.} \\ (\text{When I } \text{ Maria visited), \text{ was she ill. She was then in hospital} \\ (\text{'When I paid a visit to Maria) she was ill. As a result of her illness she came to} \\ \text{hospital.}' \end{array}$$

We infer from (18) that Maria was ill but not in hospital yet, at t (i.e. when visited) and she was ill and in hospital at $t' \subseteq t_{dn}$, $t \prec t_{dn}$. These are the truth conditions incremental inferencing predicts and which the sentence actually has. ⁶ We also infer from (18) that

⁶ The reader may verify easily: Interpreting the pronoun *sie* in context yields the condition $u_{s_0} = m_s$, where m_s represents Maria which bears the property of being ill at s; 's: be ill (m_s) Maria (m_s)'. As *sie* is the subject of *im Krankenhaus sein* this leads to the inference 's': be in hospital (m_s), $t' \subseteq s' \cap s$.'

Maria went to hospital because of her illness.

4.2 state;state–descriptions with sentence-initial *dann*

dann Following now the modular representation (8).a for (1a) the first word to be processed in the second sentence of (1a) is *dann*. Again presupposition justification in (14) must be resolved wrt. (11). This yields $ev_0 = s$, $t_0 = t$, $t \subseteq s$. This time only one property is available for fulfilling the requirements of *dann*, viz. that attributed to the topical discourse referent X in the first sentence. The result of using this property as s^p in the justification of *dann* is that the discourse referent stops seeing the face before t_{dn} . In other words: The speaker utters *dann* at the beginning of the new predication in order to signal that the previously established properties of X no longer obtain, the state s is terminated: You see the face no longer. Thus we obtain (19) for the first inference.

$$(19) \quad \begin{array}{ll} s: X_s \text{ see fc} & s^{*p}: \neg X_{s^{*p}} \text{ see fc} \\ t \subseteq s & t \prec t_{dn}, t_{dn} \subseteq s^{*p} \end{array}$$

man,VP Again the variable X'_{s^0} must be resolved in the current context. The individual antecedent of X'_{s^0} is X, but X is no longer conceptualised as bearer of the property of seeing the man's face in s, but instead as bearer of the property of not seeing the face any longer. So resolution now has the form $X'_{s^0} = X_{s^{*p}}$, where s^{*p} is as in (19). The result is (20), because $X'_{s^0} = X_{s^{*p}}$ is the subject of the second sentence.

$$(20) \quad \begin{array}{ll} s: X_s \text{ see fc} & s^{*p}: \neg X_{s^{*p}} \text{ see fc} \\ t \subseteq s & t \prec t_{dn} \\ & s': X_{s^{*p}} \text{ see sc} \\ & t' \subseteq s^{*p} \cap s'; t' \subseteq t_{dn} \end{array}$$

Table (20) presents the partial inference that at t you see the man's face and at t' you do not see the man's face but a black screen. This time the interpretation rules we have been assuming do not trigger any inference about whether the topical X has the second property – that of seeing a black screen – at the earlier predication time t. But of course the interpreter will nevertheless infer that X did not see a black screen at t, since that is incompatible with seeing a face. That it is indeed the incompatibility between the two properties which is responsible for the inference that X did not see a black screen at t, is shown by (21), where there is no incompatibility between Maria's being ill and her being in hospital. Indeed, (21) does not strictly exclude that Maria was in hospital already at the earlier time t.

$$(21) \quad \begin{array}{l} (\text{Als ich mit Maria letztens telefonierte}), \text{ war sie krank. Dann war sie im} \\ (\text{When I with Maria recently phoned}), \text{ was she ill. Then was she in} \\ \text{Krankenhaus.} \\ \text{hospital} \\ \text{'(When I called Maria recently) she was ill. Then she was in hospital'}. \end{array}$$

Justification of *dann* concerns location properties. s^p : –be in hospital(m_s) ; s' : be in hospital(m_s)

Still the hearer of (21) will assume, that the speaker has evidence to the effect that Maria isn't yet at hospital at t , i.e. he will not only infer non-persistence to the right of the antecedent state but also non-persistence to the left of the consequent state. (21) suspends a causal relationship between Maria being ill and being in hospital which we inevitably infer from (18). (See section 7).

4.3 state;state-descriptions with sentence-final *then*

The interpretation of (2b) starts like that in (1b) but since *then* is not sentence-internal as *dann* in (1b), but final, the *then*-signal doesn't fire before all inferences concerning the temporary properties attributed by the verb of the second sentence that would also have been drawn had *then* been absent are already fully registered.

you The first inference is just like in (1b), we yield (15) = (22)

$$(22) \quad s': X_s \text{ see sc} \quad \text{black screen(sc)} \quad t' \subseteq s' \cap s$$

VP The contribution of the VP becomes processed in absence of any signal that a change had occurred in the course of the described episode. So the interpreter infers that the state of seeing the face and that of seeing the screen were simultaneous. Not only do they overlap at the new location time t' but the reference time t is stable, which is represented as $t \subseteq t'$ in (23).

$$(23) \quad \begin{array}{l} s: X_s \text{ see fc} \\ s': X_s \text{ see sc} \\ t \subseteq t' \subseteq s' \cap s \end{array}$$

Just as (1b) (2b) forces the interpreter to assume an overlap of incompatible states. Once again we get a coherent discourse when the two sentences attribute to the topic properties that are not incompatible. (24) supports the inference that Mary was in hospital at the time she was paid a visit.

$$(24) \quad (\text{When I paid a visit to Mary}) \text{ she was ill. She was in hospital then.}$$

then According to our lexical assumptions *then* signals a change from $s^p:P(x)$ to $s^{*p}:\neg P(x)$, where $t_{dn} \subseteq s^{*p}$. The properties the topical discourse referent bears in context are both seeing the face and seeing the black screen. For s^{*p} the continuation of both properties is cancelled. The period t_{dn} is part of that state s^{*p} . That there is a period t_{dn} to the right of t_0 present makes itself felt in the fact that the presence of sentence-final *then* can drive the sentence into ungrammaticality. Here is an example: (25), e.g. spoken during a telephone call while staying with Maria is ungrammatical:

$$(25) \quad (\text{I am just paying a visit to Maria}). \text{ She is ill. * She is in hospital then.}$$

How come that (25) is ungrammatical? To arrive this fact from the analysis of *dann/then* offered here we need one further assumption. It has been implicit in what has been said

so far, but should now be made explicit. The result state s^{*p} of the change required by *then/dann* stands in a temporal relation to the speech time n that is indicated by the tense information of the sentence containing the word. In the examples so far considered this means that the change invoked by sentence-final *then* is itself located at some time t_c in the past of n , and thus is between n and the described episode, thereby producing the impression of ‘remoteness’— the episode was entirely before t_c which itself is situated in the past of n .⁷ This explains why with a present tense passage like (25) we get in trouble. Here the present tense of the sentences locate both predications at n : $t = t' = n$. An attempt to justify the sentence-final *then* by assuming a change which puts an end to the complex predication that has been established as holding at $t = t' = n$ now fails. At the one hand the result state of the change demanded by *then* should be located at n , on the other hand it should follow the predication at $t = t'$.

Justification of clause-final *then* We must be more explicit about our idea of “cancellation of the continuation of properties” signalled by sentence-final *then*. Justification cannot invoke a change from ‘not in hospital’ at s^p to ‘in hospital’ at s^{*p} in (24), as in (18). The signal comes too late for that. But neither does the sentence-final signal indicate a change from ‘in hospital’, or ‘ill’ and ‘in hospital’ into a state s^{*p} where the negations of one or both properties obtain. Indeed, being in hospital may very well be claimed to continue. For we can continue (24) as in (26) without being contradictory.

(26) (When I paid a visit to Maria) she was ill. She was in hospital then. In fact she has been in hospital ever since.

The puzzle is solved if we assume that the change which sentence-final *then* signals may be of an epistemic nature: For the *then*-period $t_{dn} \subseteq s^{*p}$ the speaker refrains from committing himself to any specific properties the topical discourse referent may or may not have. This is still a genuine change between a period of time with respect to which the speaker commits himself to certain predications of the topic to a period regarding which he makes no such commitments. Such changes too may be signalled in discourse. However, the signal can be overwritten by a subsequent sentence as we find in (26). We present lack of commitment to specific properties by means of the trivial property, s. (27). The trivial property is a property that does not contradict with any of the properties Mary (or the topical x in general) might bear. We write the trivial property as \top . (Compare 5.)

As far as the temporal properties are concerned, sentence-final *then* follows the lexical constraint, see (27). (Note that location time t' is not located within the period denoted by *dann/then*.)

⁷Many of the occurrences of sentence-final *then* we find in the narrative work of Charles Dickens express remoteness. Note the present tense in the immediate left of the sentence with *then*.

- (i) He walked me up to my room slowly and gravely – I am certain he had a delight in that formal parade of executing justice — and when we got there, suddenly twisted my head under his arm . It sets my teeth on edge to think of it. He beat me then, as if he would have beaten me to death.

$$(27) \quad \begin{array}{l} s: \text{be ill}(m_s) \\ s': \text{be in hospital}(m_s) \quad s^{*p}: \top(m_{s^{*p}}) \\ t \subseteq t' \subseteq s \cap s' \quad t_{dn} \subseteq s^{*p}, t \prec t_{dn} \end{array}$$

5 Refinements

Sentence-final *then* shows that the signal of change, which *then/dann* contributes, may involve an epistemic dimension. Sentence-final *then* signals a change from positive evidence to non-commitment or absence of evidence. Sentence-internal *dann* in state descriptions signals change from negative to positive evidence.⁸ But epistemic modularity may apply for sentence-initial *dann/then* as well. It may signal change from positive evidence of a property P at s^p to negative evidence of P at s^{*p} or to non-commitment to P at s^{*p} . The latter possibility doesn't come to mind in (1a) and (2a), because it is possible to understand the change as one from seeing the face to not seeing it, and that interpretation is chosen. But both a non-epistemic and an epistemic interpretation seems possible in (21), where the speaker might either signal that Maria is no longer ill when she comes to hospital or else his non-commitment to the question whether Maria is ill or healthy at that time.

We must incorporate our insight that the change which *dann/then* signals is change modulo an epistemic operator **K** (=Know or commit to) into the lexical entry. Instead of (14) we yield (28).

$$(28) \quad \text{dann/then} \rightsquigarrow \left\langle \left\{ \begin{array}{|c|c|c|} \hline \text{ev}_0 \ t_0 & s^p \ x & s^{*p} \\ \hline t_0 \ \rho \ \text{ev}_0 & s^p: \mathbf{K} \ P(x) & s^{*p}: \neg \mathbf{K} \ P(x) \\ \hline & t_{dn} \subseteq s^{*p}. & \\ \hline \end{array} \right\} \left\{ \begin{array}{|c|} \hline t_{dn} \\ \hline t_0 \prec t_{dn} \\ \hline \end{array} \right\} \right\rangle$$

Compared to (14) entry (28) is less restrictive because the condition ' $\neg \mathbf{K} P(x)$ ' (i.e. non-commitment to $P(x)$) in $s^{*p}: \neg \mathbf{K} P(x)$ is weaker than ' $\mathbf{K} \neg P(x)$ ' (i.e. commitment to $\neg P(x)$) The latter is equivalent to the condition in (14), where we wrongly assumed full commitment to P and $\neg P$ as if **K** would have been applied according to its strong mode. Between the two epistemic modes the following axiom obtains.

$$\models \mathbf{K} \neg P(x) \rightarrow \neg \mathbf{K} P(x)$$

We refrain from giving a precise semantic of the operator **K**. For $\mathbf{K} \neg P(x)$ will translate $\neg P(x)$ for representation purposes and $\neg \mathbf{K} P(x)$ will translate $\top(x)$.

⁸However, there are also examples of sentence-internal *dann* which must be interpreted as involving an epistemic change. But this occurs only as an interpretation of last resort, i.e. if the predicate blocks interpreting the signal as indicating change from $\neg P$ to P. For instance the second sentence of (i) is interpreted as a re-description of the same state of illness which the first sentence speaks of from a later perspective: Unforeseen at the time the speaker paid a visit to Maria — but known now — her illness had lasted three months. (i) bears the same element of remoteness familiar from sentence-final *then*.

- (i) (Als ich Maria besuchte), war sie krank. Sie war dann drei Monate lang krank.
(When I Mary visited), was she ill. She was then three months long ill.

6 ‘On-line’-inferencing with descriptions involving events

We compare ‘on-line’ inferencing in the felicitous (29) and the weird (30). Leaving out *dann* or *then*, both contexts would express a causal relation in virtue of lexical inferencing.

- (29) Einmal wurde Maria schwer krank. Sie war dann drei Monate lang krank.
 Once became Maria seriously ill. She was then three months long ill
 ‘Once Maria fell seriously ill and stayed ill for three months.’

The antecedent sentence in both (29) and (30) introduces a change from the pre-state $s^{pr}: \neg \text{ill}(m_{s^{pr}})$ to the result state $s^{res}: \text{ill}(m_{s^{res}})$. s^{res} functions as the state of current properties in both contexts (29) and (30). In (29) *sie* occurs before *dann*. The binding condition of the pronoun *sie*, see (12).b is resolved as $u_{s^0} = m_{s^{res}}$. As $m_{s^{res}}$ is the subject of the second sentence inferencing yields the conditions ‘ $s': \text{ill}(m_{s^{res}})$ for three months $\wedge t' \subseteq s' \cap s^{res}$ ’. Internal *dann* must be justified as signalling a change from a presupposed state of negative conditions, i.e. ‘not being ill (for three months)’ to the positive condition which is attributed in the second sentence. The interpreter identifies the presupposed state of negative conditions as s^{pr} , contributed by the first sentence. So all presuppositions match the context and (29) is fine.

- (30) Einmal wurde Maria schwer krank. # Dann war sie drei Monate lang krank.
 ‘Once Maria fell seriously ill. # Then she was ill for three months.’

In (30) *dann* or *then* fires first and introduces a state s^{p*} to the right of the current state of temporary properties s^p of Maria’s in context. The signal enters discourse with a presupposition of change in properties between s^p and s^{p*} . The current state property of Maria’s is her being ill, thus s^p resolves $s^{res}, s^{res}: \text{ill}(m_{s^{res}})$. The binding condition of the pronoun *sie* is resolved $u_{s^0} = m_{s^{p*}}$. We yield the conditions ‘ $s': \text{ill}(m_{s^{p*}})$ for three months $\wedge t' \subseteq s' \cap s^{p*}$ ’. As for the properties of $m_{s^{p*}}$ that obtain at s^{p*} (where $s^{res} \prec s^{p*}$) there are two possibilities for a justification available, according to (14). (i) $s^{p*}: \mathbf{K}\neg \text{ill}(m_{s^{p*}})$, implying that the speaker commits himself to the fact that Maria isn’t ill any longer; or (ii) $s^{p*}: \neg \mathbf{K} \text{ill}(m_{s^{p*}})$ implying that the speaker doesn’t commit himself to whether Maria is ill or healthy. In both cases the context turns out contradictory: For the speaker does claim positive evidence about the state of illness in the second sentence. This is why (30) is weird.

7 Continuous vs. discontinuous descriptions and the accommodation of the discourse relation ‘cause’

(29) intuitively is a continuous description of a continuous situation, (30) is a discontinuous description of the same continuous situation.

Definitions: Let t, t' be the location times of $ev; ev'$. Let $s^1 = s$ in case $ev = s$ and $s^1 = s^{res}$ in case ev is a change of state.

(i) If $s^1 \cap t' \neq \emptyset$, then the description is continuous

(ii) If the description of ev' introduces the conditions $s^{p*} \neq s^1 \wedge t' \subseteq s^{p*}$, then the description is discontinuous.

The property of Maria being ill functions as a conceptual bridge between t and t' in (29) and in (31).

- (31) Einmal wurde Maria schwer krank. Sie kam dann ins Krankenhaus.
'Once Maria fell seriously ill and, as a result, went to hospital'.
- (32) Einmal wurde Maria schwer krank. Dann kam sie ins Krankenhaus.

Using a discontinuous description as (32) the speaker conveys that he conceptualises the eventuality sequence as not being causally connected. For he would have chosen a neutral or a continuous description in that case. For detailed discussion see Roßdeutscher and von Stutterheim (n.d.) and Roßdeutscher and von Stutterheim (n.d.).

References

- Caenepeel, M. and Sandström, G.: 1993, A discourse-level approach to the past perfect, in M. Aurnague, A. Borillo and M. Bras (eds), *Semantics of Time, Space and Movement*. c
- Genabith, J. v., Kamp, H. and Reyle, U.: 2004, *Discourse Representation Theory. An updated Survey*, Kluwer Academic Press.
- Glasbey, S. R.: 1993, Distinguishing between events and times: some evidence from the semantics of "then", *Natural Language Semantics* **1**, 285 – 312.
- Kamp, H.: 2001a, The importance of presupposition, in C. Rohrer, A. Rossdeutscher and H. Kamp (eds), *Linguistic Form and its Computation*, CSLI-Publications, Standord.
- Kamp, H. and Reyle, U.: 1993, *From Discourse to Logic*, Kluwer Academic Publishers.
- Reyle, U. and Rossdeutscher, A.: 2001, Temporal underspecification in discourse, in C. Rohrer, A. Rossdeutscher and H. Kamp (eds), *Linguistic Form and its Computation*, CSLI.
- Reyle, U., Rossdeutscher, A. and Kamp, H.: n.d., Ups and downs in the theory of temporal reference, University of Stuttgart.
- Roßdeutscher, A.: 2005, 'on-line'-inferencing in the semantics of temporal *dann*, *then* and temporal *da*, Universität Heidelberg.
- Roßdeutscher, A. and von Stutterheim, C.: n.d., Semantische und pragmatische Prinzipien der Positionierung von d a n n, submitted to LB.
- Shiffrin, D.: 1992, Anaphoric then: aspectual, textual and epistemic meaning, *Linguistics* **30**(4), 753–792.
- Spejewski, B. and Carlson, G. N.: 1993, Modification of event relations, *Proceedings of the 23th Annual Meeting of the N E L S, Universtiy of Amherst*.