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The Semantics of Aspect in English and German

Hisashi KOMATSU
(Kyushu Institute of Technology)

Abstract

This thesis deals with the aspects in English and German in connection with Aktionsarten and tenses.

In Chap. 1, definitions of Aktionsarten, aspects and tenses are given in a schema.

In Chap. 2, it's argued that the time point semantics is insufficient to describe the temporal phenomena precisely. The two proponents of the extended version of the time point semantics - interval semantics and event calculus - are compared, and the former is adopted as a basic semantic instrument of this thesis. And its augmented version, called the Aspectual Logic (AL), is used in the following chapters.

In Chap. 3, the temporal phenomena of English are analyzed. The Aktionsarten are described by means of meaning postulates. In order to grasp the semantic nature of aspects and tenses, the Reichenbachian three time points - E (time of event), R (time of reference), and S (time of speech) - are introduced. And the aspect is defined as a category which determines E from R, and the tense as the category which determines R from S. Then the English aspects - progressive, perfect, and predetermined future - are analyzed in terms of the two basic aspects, perfective and imperfective. Further, it's argued that there are three categories of termporal adverbs in English, tense adverbs, aspect adverbs, and perfect adverbs. Then, the mutual functions and some logical conclusions of the temporal expressions are considered.

In Chap. 4, the semantic characteristics of German temporal expressions are analyzed in contrast with English. And it's argued that, in German, there are three categories of tenses - past, present, and future, but only two aspects - perfect, and predetermined future -, and only one category of temporal adverbs - aspect adverbs. From this, it's concluded that English is - as to the temporal expressions - more analytical than German. Conversely, the latter supplements the lack with pragmatic elements.

In Chap. 5, the formal definitions of AL are resumed.

Contents

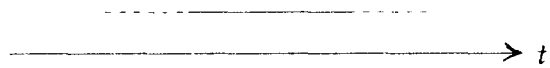
1. An Informal Definition of Aktionsart, Aspect, and Tense

The temporal expressions which are discussed in this thesis consist of the following four categories: 1) Aktionsart, 2) aspect, 3) tense, 4) temporal adverbs. 1) and 4) are lexical categories, and 2), 3) are grammatical categories. 1), 2), 3) are basic categories which every sentence obligatorily contains. 4) optionally appear in sentences. 4) are treated in Chap. 3, 4 and 5. In this Chapter, I give an informal definition of 1), 2), 3).

The term " Aktionsart " (pl. " Aktionsarten ") stems from German, and means a way of action, i.e. how a state of affairs develops along the time axis. As to the classification of the Aktionsarten, various proposals have been presented untill now. But here, I adopt the Vendler-Classification, which Vendler(1967:Chap.4) conceived, and Dowty(1979) made precise. It classifies the Aktionsarten of verbs into the four patterns: stative, activity, accomplishment, and achievement.

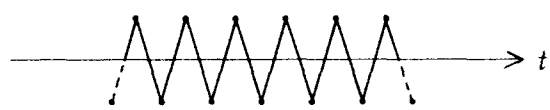
Dowty(1979) formalizes them in meaning postulates as MP.2-5 in 5.6. But their intuitive meaning is as follows:

(1) a) Stative:



(2) John is a student.

b) Activity:

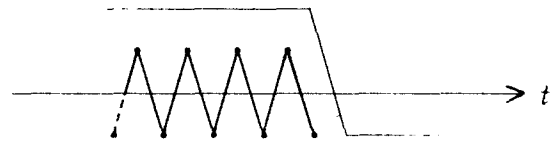


(3) John is running in the park.

c) Achievement:

(4) John died.

d) Accomplishment:



(5) John painted a picture.

The stative means a duration of a state, e.g., (2) means a duration of John's being a student. The activity also means a duration of a state, but it's not a static state, but a kinetic one. Precisely, it means an amorphous change of static states. (3) means an alternative change of the state that John's right leg is forward, and the state that John's left leg is forward. The achievement means a change of a state into another state. (4) means a change of the state that John is alive into the state that John is dead. The accomplishment is a composition of the activity and the achievement, i.e. it means that an activity causes an achievement. (5) means that John's motion of a paintbrush brings about the existence of a picture.

Vendler says that the Aktionsart is expressed by a verb. But in reality, it's expressed by the whole sentence. E.g.,

(6) John ran in the park

is an activity sentence. But

(6') John ran to the gate

is an accomplishment sentence. Therefore, in a precise discussion, we must consider not the Aktionsart of a verb, but the whole sentence.

The aspect is a way of viewing the Aktionsart. The two basic aspects are the perfective and the imperfective (s. Comrie(1976)). The perfective describes the Aktionsart as a whole, but the imperfective describes it partially. See the following sentences:

(5) John painted a picture,

(5') John was painting a picture.

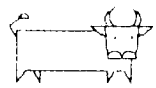
(5) describes the propositional content of (5) as a completed event, but (5') describes it in progress, i.e. when the speaker saw John, he had been painting the picture, and he would be painting it further. In Chap. 3, we treat the three aspects, progressive, perfect, and predetermined future. They are derived from the basic aspects, the perfective and the imperfective.[1]

As for tenses, I simply assume that the present, past and future set up an Aktionsart with a certain aspect at, before, and after the time of speech

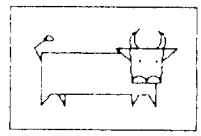
respectively.

The differences between the Aktionsart, the aspect, and the tense are illustrated as follows.

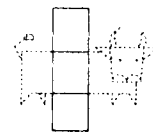
(7) a) Aktionsart:



b) Aspect: 1) 2)

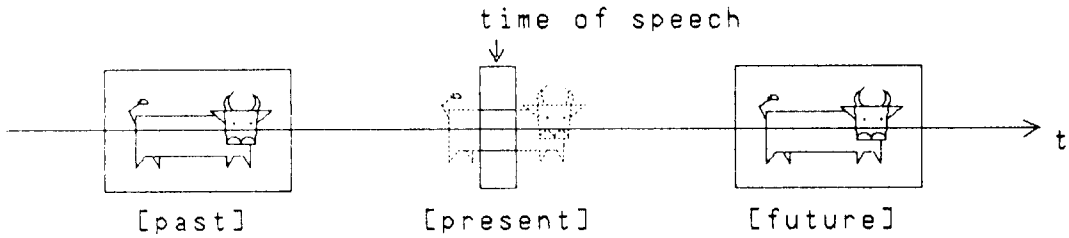


[perfective]



[imperfective]

c) Tense:



The cow in (7a) means that the Aktionsart is often a " temporal " individual with an internal structure. E.g., John's painting a picture in (5) is an individual called an event which occupies a time interval. And devided into sub-intervals, it's not the event of (5) any more.

(7b1) observes the Aktionsart perfectively, (7b2) imperfectively.

The tense is a location of the Aktionsart with some aspects in past, present, or future.

2. Logical Apparatus for Temporal Expressions

Prior(1967), the pioneer of tense logic, analyzed the tense analogous to the modal logic as follows:

(8) *Hp*,
Pp,
Gp,
Fp.

Hier, '*p*' stands for a sentence radical, i.e. a sentence without tense and aspect. And the operators '*H*' , '*P*' , '*G*' , '*F*' mean 'it was always the case that ...' , 'it was the case that ...' , 'it will always be the case that ..' , 'it will be the case that ...' respectively. '*H*' , '*G*' correspond

to '$\Box$', and 'P', 'F' to '$\Diamond$' in the modal logic. So it holds the temporal correspondence of the modal logical equivalence $\Diamond p \equiv \neg \Box \neg p$ that $Pp \equiv \neg H \neg p$, $Fp \equiv \neg G \neg p$. Otherwise, the Prior's tense logic is to understand as a two-fold modal logic, in the sense that it consists of the two modal parts, i.e. H-P-part and G-F-part.

From the logical point of view, his analysis has some interesting points, but in order to apply it to the semantic analysis of natural languages, it has some faults.

First, it cannot treat the accumulation of temporal expressions adequately. E.g., we cannot but analyze

(9) *Yesterday, John will leave town

either

(9a) YFp

or

(9b) FYp.

(Here, 'p' stands for the sentence radical 'He leaves town.', 'Y' is the operator which means 'yesterday, it was the case that ...'.) But (9a) means that he will leave town, and (9b) means that he left town yesterday. And neither of them explain the ungrammaticality of (9). To improve this, we must use a logical language by means of which the past tense and 'yesterday' are combined in parallel. The systems in Rescher/Urquhart(1971), Dowty(1979) make it possible. Based on this method, (9) is analyzed as

(9') $\bigvee t[\mathrm{Fut}(t) \wedge \mathrm{yesterday}(t) \wedge \mathrm{AT}(t,p)]$.

(9') means that there is a time point t, which belongs to the future and yesterday, where the event that John leaves town occurs. It's obviously false, which explains the semantic inconsistency of (9).

Prior's system treats the time in an implicit and egocentric form using the tense operators. But this system expresses time directly using the time point variable t. In fact, the latter system is an extension of the former. And we use the latter in what follows.

The second fault of Prior's system is that the formulae are interpreted with respect to a time point. As to the stative sentences, this method can be applied consistently. Then the stative sentence as (2) is considered to be true or false at every time point. But this method poses a difficulty with the non-stative sentences. 'non-stative' means a motion. And in order to identify the motion, we must compare the states of at least two time points and find out a locational difference between them. E.g., if (3) is true, the location of John's legs are different between two adjacent time points, and if (5) is true, we must identify John's painting a picture not at a time point, but in a time interval. For this reason, Dowty(1979) uses the interval semantics and interprets the sentences with respect to a time

interval.

In spite of the adequate appearance of interval semantics, there are some objections, such as Galton(1984, 1987), Löbner(1988) which advocate the event calculus. In the interval semantics, the stative as well as the non-stative are treated as a proposition. But they recognize a serious difference between them[2], and argue that the stative is a proposition, true or false with respect to every time point, but the non-stative is not a proposition, but an event. It's a "temporal" individual[3] constituted from atomic stative propositions. In fact, the Aktionsarten in (1) are originally constructed from stative propositions at each time point. In this sense, the difference between stative and non-stative resembles the one between mass nouns and count nouns as Mourelatos(1981:202ff.), Galton(1984:28) suggest. Necessarily, the event exists not at a time point, but in a time interval. Therefore, the interval semanticists interpret the non-stative sentences with respect to a time interval. But Galton(1987:171) argues that the event has no truth value, because it's an individual. Nonetheless, if a non-stative sentence has a truth value, it precisely means that such and such an event exists in the past, present, or future. But then, it's not a non-stative sentence any more, but a stative sentence. From this, Galton points out that the interval semanticists confuse the truth *at* an interval with the truth *of* an interval. The proposition cannot have an truth value at an interval, but only at a time point. And this refutes the position of interval semantics.

An advantage of event calculus is that it can express the difference between the state and the event clearly. I give in the following some examples for it from Galton(1984) and Löbner(1988):

(10) [Löbner]

a) Z(t) & Past*(t),

b) E(e) & Past*(τ (e)).

(10a) is an analysis of a stative sentence in the past tense, (10b) is its non-stative correspondence. Z represents a stative sentence radical, and denotes a set of time intervals. E represents a non-stative sentence radical, and it denotes an event. Past*(t) means that t is before the speech event e* of the sentence. τ is the function which assigns an occurence of the event E the interval which it occupies.

(11) [Galton]

a) *Perf E*,

b) *Prog E*,

c) *Pros E*.

Perf, *Prog*, *Pros* stand for 'perfect', 'progressive', 'prospective' respectively. But they are merely the event-form correspondence of the Prior's *P*, "now" -operator, and *F* without any aspectual implication.

The method in (10), (11) is apt to differentiate the event from the proposition, as well as the perfective from the imperfective. But it has a major defect, i.e. the event is treated as an 'individual', and it's hard to analyze its inner structure. E.g., the accomplishment sentence

(5) John painted a picture

can be analyzed as

(5') $\bigvee t$[Past(t) $\wedge$ AT(t, $\bigvee x$[picture(x) $\wedge$ paint(j,x)])].

In (5'), 'picture(x)' denotes a proposition, but 'paint(j,x)' an event. Then, $\wedge$ between them does not connect the propositions, but a proposition and an event. And it's not clear what kind of entity picture(x) $\wedge$ paint(j,x) is. Is it a proposition, an event, or any other entity?

Galton(1984) partly formulates the inner structure of an occurence of an event. E.g., (11a) is further analyzed into the following forms:

(12) a) *Perf Ingr* $p = P*(P \sim p \wedge p)$,

b) *Perf Po* $p = P*(P(P \sim p \wedge p) \wedge \sim p)$.

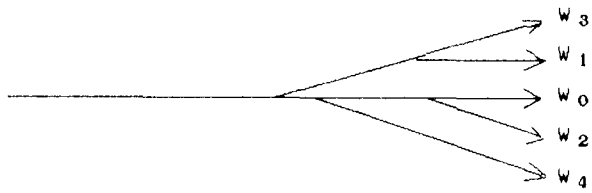
Here, *E* in (11a) is analyzed into *Ingr p* or *Po p*. *Ingr*, *Po* stand for ingressive and pofative respectively. *P** means non-past. So, '*Perf Ingr p*' means that a change from $\sim p$ to p occured in the past, and '*Po p*' means that p continued for a while in the past. It's an excellent analysis in that it grasps the two basic elements, the duration of a state and its change. But if we try to analyze the structure further, we have to face the same problem as in (5'). Moreover, (12) doesn't give the direct definition of the events *Ingr p* and *Po p*, but indirectly in a propositional context. In general, the complication of the system is a drawback of the two-sorted semantics, and because it does not seem to be able to set up a clearcut, simple theory which would hold the distinction between the state and the event, and avoid the above-mentioned difficulty, it's not adequate to use the event calculus for the precise analysis of temporal expressions.

Further, the Galton's refutation of interval semantics does not seem to be crucial. Even if he's right in saying that every sentence in natural languages is stative, it does not prevent us from interpreting a sentence radical - which is already a theoretical construction - as true or false with respect to an interval, in the sense that a sentence radical is true with respect to an interval iff an occurence of the event, which the sentence radical denotes, exists in the interval.

Although the distinction between the state and the event becomes vague in the interval semantics, no problem with the two-sorted semantics in the event calculus appears in the interval semantics, and the semantic interpreation is applied to the inner structure of the Aktionsarten elastically. For this reason, I use the interval semantics in the following, and derive various temporal properties which are often showed up clearly in the event calculus indirectly.

As to the interpretation of temporal expressions, the following two points should be also considered: The first problem concerns the epistemic asymmetry of the past and the future. The state of affairs in the past is definite, but a cognitive uncertainty is involved in the future. In order to grasp it, I assume - based on Dowty(1979) - the branching possible worlds in the course of time as follows:

(13)

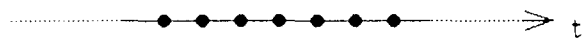


It becomes further important in the interpretation of the progressive. But notice that it does not mean the branching of time, because the time can be compared between different worlds, as in the following sentence:

(14) If I'd been there, I would be dead now.

The time as such is a strict linear ordering, i.e. a transitive, irreflexive, successive, linear ordering. For simplicity, I further assume the discreteness of time, so that the time structure is isomorph to the set of integers as follows:

(15)



The second problem concerns the interpretation of deictic expressions such as tense, adverbs such as 'yesterday' etc. I argued in Komatsu(1989) that, besides the indices of possible world and time, we need the index of context which is independent of them, in order to interpret deictic expressions. A logical formula ϕ is then interpreted with respect to a contextual-intensional model $\mathcal{L}$, possible world w, time interval i, context c, and variable assignment g as follows:

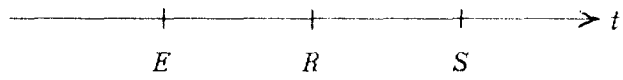
(16) $\mathcal{L}(w,i,c,g;\ \phi)$.

3. Temporal Expressions in English

First, I formalize the functions of tense and aspect by means of S, R, E, i.e. time of speech, time of reference, and time of event of Reichenbach (1947). E.g., (17), (18), (19), (20) are analyzed as (17'), (18'), (19'), (20') respectively:

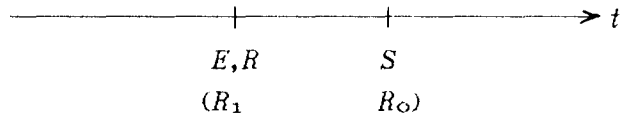
(17) I had seen John.

(17')



(18) I saw John.

(18')

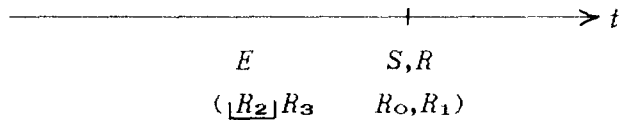


(19) I have seen John.

(19')

(20) I have been seeing John.

(20')



(18) means that the past tense sets R before S, and this R is E at the same time. And (20) means that the present sentence sets R at the same time as S, the perfect aspect sets E before R, and the progressive aspect extends this E.

In general, there is a series of time intervals as follows:

(21) $(S=)R_0 \rightarrow \cdots \rightarrow R_k \rightarrow R_{k+1} \rightarrow \cdots \rightarrow R_n(=E) \quad (0 \leqq k \leqq n-1)$

T $\quad As_k$ (T:tense, As_k:aspect)

Here, $S=R_0$, $E=R_n$. A tense T determines R_1 from R_0, and an aspect As_k $(k \geq 1)$ determines R_{k+1} from R_k. So in (18), the past tense directly determines $E(=R_1)$ from $S(=R_0)$. But in (20), E is determined as the last element of the series $R_0 \rightarrow R_1 \rightarrow R_2 \rightarrow R_3$.

But the aspect As_k further detemines if the state of affairs which occurs in R_{k+1} is viewed perfectively or imperfectively. If ϕ denotes such a state of affairs, Imp(ϕ) means that ϕ is viewed imperfectively, and Pft(ϕ) means that ϕ is viewed perfectively, and they are interpreted as

(22) $\mathcal{L}(w,i,c,g;\text{Imp}(\phi))=1$ iff for all $i' \subseteq i$ $\mathcal{L}(w,i',c,g;\phi)=1$,

(23) $\mathcal{L}(w,i,c,g;\text{Pft}(\phi))=1$ iff a) $\mathcal{L}(w,i',c,g;\phi)=1$, and b) there is no interval i' such that $i \subsetneq i'$, and $\mathcal{L}(w,i',c,g;\phi)=1$

respectively.

(22) implies that if Imp(ϕ) is true, then $R \subseteq E$, and if ϕ is true at E, then ϕ is true at every subinterval of E. And (23) implies that if Pft(ϕ) is true, then $E \subseteq R$, and there is no genuine subinterval of E where ϕ is true.

Now, a sentence with a tense and some aspects is formulated in the following scheme:

(24) $\bigvee t_1[\mathrm{T}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{As}_1(\cdots \mathrm{As}_k(\cdots \mathrm{As}_{n-1}(\phi)\cdots)\cdots))]$.

$\uparrow$ $\uparrow$ $\uparrow$

R_1 Past Prog

Pres Perf Imp

Fut Pdf R_{k+1} Pft

$\uparrow$ $\downarrow$ $\downarrow$

$\mathrm{As'}_k[n, t_{k+1}] \wedge \mathrm{AT}(t_{k+1}, \mathrm{Ak}_{k+1}$

Here, 'n' is not the deictic, but an aspectual 'now' -operator, is the same as 't' in 'AT(t,' directly left of it. (Cf. 1. in 5.5.)

3.1 Simple Tense

Following (24), a sentence with a simple tense is formulated as follows:

(25) $\bigvee t_1[\left|\begin{array}{l}\mathrm{Past}(t_1)\\ \mathrm{Pres}(t_1)\\ \mathrm{Fut}(t_1)\end{array}\right| \wedge \mathrm{AT}(t_1, \phi)]$.

The first problem about (25) concerns the interpretation of Past, Pres, Fut. As to Past, Fut, I simply assume the function as in (7c). But according to Dowty, the present tense contains the following problem: Stative sentences as

(26) John is a student

have a normal present meaning. But non-stative sentences as

(27) John runs,

(28) John dies,

(29) John paints a picture

can only be interpreted to mean a habit or to mean predetermined future. From this, Dowty assumes that the present sets up the interval which contains only the time point of speech. With this assumption, the normal reading of stative sentences and its lack in non-stative sentences are explained by means of (1a-d). In fact, we need to observe only one time point, in order to determine the truth value of stative sentences. But for non-stative sentences, we need to observe at least two time points. We can formulate this function of the present as follows:

(30) $\mathcal{L}(w,i,c,g;\mathrm{Pres}(t))=1$ iff i is an interval which contains only one time point, and $\mathcal{L}(w,i,c,g;t)=\mathrm{cn}$.

The next problem with (25) concerns the interpretation of ϕ. According to my linguistic intuition, the simple past and future of stative sentences is imperfective, and that of non-stative sentences is perfective. So the simple tenses are formulated as follows:

(31) [Present]

$\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1, \phi)]$.[4]

(32) [Past]

a) Stative: $\bigvee t_1[\mathrm{Past}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{Imp}(\phi))]$.

b) Non-stative: $\bigvee t_1[\mathrm{Past}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{Pft}(\phi))]$.

(33) [Future]

a) Stative: $\bigvee t_1[\mathrm{Fut}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{Imp}(\phi))]$.

b) Non-stative: $\bigvee t_1[\mathrm{Fut}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{Pft}(\phi))]$.

Imp, Pft in (32), (33) are default values of sentences without explicit aspectual determination.

3.2 Aspects

3.2.1 Progressive

According to Reichenbach(1947), Dowty(1979), the progressive aspect extends *R*. This explains the fact that

(34) John is painting a picture.

doesn't imply the completion of the picture. So we can define $\mathrm{Prog}_1(\phi)$ as follows:

(35) $\mathrm{Prog}_1(\phi) \equiv \bigvee t[n \subseteq t \wedge \mathrm{AT}(t, \mathrm{Pft}(\phi))]$.

But the progressive contains another problem called "imperfective paradox". I.e.

(36) John was painting a picture

doesn't imply

(6) John painted a picture.

In order to explain this, Dowty(1979) assumes a set of worlds which will appear after *R* in a normal course of time, and interprets that a progressive sentence is true iff, in each of such worlds and an extended interval of R, the sentence radical is true. Dowty calls such worlds inertia worlds. The lack of implication from (36) to (6) is explained as a case where the real world doesn't belong to the set of inertia worlds. I introduce the modal operator Inr which assign the set of inertia worlds to each possible world, and revise (35) to

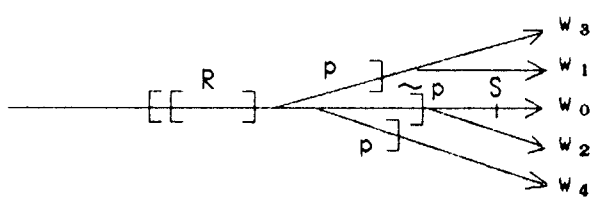
(37) $\mathrm{Prog}(\phi) \equiv \mathrm{Inr}(\bigvee t[n \subseteq t \wedge \mathrm{AT}(t, \mathrm{Pft}(\phi))])$.

(36) is then formulated as

(36') $\bigvee t_1[\mathrm{Past}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{Prog}(p))]$,

and its truth condition is illustrated as follows:

(36'')



Further, as the following deduction (38) shows, Prog(ϕ) implies Inr(Imp(Prog$_1$(ϕ))):

(38) Prog(ϕ)

$\Leftrightarrow$ Inr($\bigvee t[n \subseteq t \wedge \mathrm{AT}(t,\mathrm{Pft}(\phi))]$)

$\Rightarrow$ Inr($\bigwedge t_1[t_1 \subseteq n \rightarrow \bigvee t_2[t_1 \subseteq t_2 \wedge \mathrm{AT}(t_2,\mathrm{Pft}(\phi))]]$)

$\Leftrightarrow$ Inr($\bigwedge t_1[t_1 \subseteq n \rightarrow \mathrm{AT}(t_1, \bigvee t_2[n \subseteq t_2 \wedge \mathrm{AT}(t_2,\mathrm{Pft}(\phi))])]$)

$\Rightarrow$ Inr($\bigwedge t_1[t_1 \subseteq n \rightarrow \mathrm{AT}(t_1,\mathrm{Prog}_1(\phi))]$)

$\Rightarrow$ Inr(Imp(Prog$_1$(ϕ))).

I.e. a progressive sentence denotes a stative that ϕ is in progress with respect to each inertia world.[5]

3.2.2 Perfect

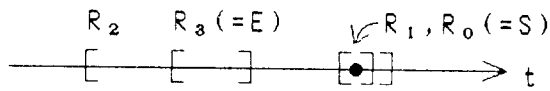
In spite of various discussions, there is no final solution to the meaning of the perfect yet. But when it comes to the present perfect, it seems to be commonly accepted that it describes

(39) a) an event in the past

b) in relation to the present.

Dowty(1979) - and already Bryan(1936) - formulates this as follows: The perfect sets up an interval R_2 which extends from the interval R_1 determined by the tense into the past, and expresses that the event denoted by the sentence radical occurs in a subinterval R_3 of R_2 perfectively. This formulation is illustrated as follows:

(40)



And the perfect is defined as

(41) Perf$_1$(ϕ) $\equiv \bigvee t_1[\mathrm{PN}(t_1) \wedge \mathrm{AT}(t_1, \bigvee t_2[t_2 \subseteq n \wedge \mathrm{AT}(t_2,\mathrm{Pft}(\phi))])]$.

(Here, 'PN' denotes the set of intervals whose last time point is the same as that of the interval which the tense determines.) In (40), R_2 expresses (39b), and R_3 (39a).

But in reality, (41) doesn't represent the meaning of (39b). Based on Comrie(1976:Chap.3), Löbner(1988) argues that (39b) implies one of the following meanings of the perfect:

(42) a) perfect of result,

b) experiential perfect.

If we interpret the following sentence

(43) Sie ist aufgestanden (Löbner,178)

(She's stood up.)

in the meaning of (42a), it means that she's standing now. This could be

generally captured as the state at the next moment of the interval where the sentence radical occurs. But Löbner(1988) points out that (43) can imply other factors, e.g., she is a patient, and her condition's got worse by her standing up, or conversely, she showed a sudden turn of her condition for the better etc.

Further,

(44) Bill has gone to America (Comrie,1976:59)

is an example of the perfect of result. But

(45) Bill has been to America (*Ibid.*)

expresses the experiential perfect. Then, the distinction between (42a) and (42b) is a lexical or contextual problem.

From this, it's concluded that the meaning of perfect is hardly captured semantically, but mostly belongs to the pragmatics. So I can at most add to (41) a pragmatic operator 'have' which implies the various meanings of perfect according to contexts, define the perfect as follows

(46) $\mathrm{Perf}(\phi) \equiv \mathrm{have}(\mathrm{Perf}_1(\phi))$,

and assume the following meaning postulate:

(47) $\Box[\mathrm{Perf}(\phi) \rightarrow (\mathrm{Perf}_1(\phi))]$.

The meaning of the sentence

(48) John has painted a picture

is then formulated as

(48') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{have}(\phi))]$
$(\phi \equiv \bigvee t_2[\mathrm{PN}(t_2) \wedge \mathrm{AT}(t_2, \bigvee t_3[t_3 \subseteq n \wedge \mathrm{AT}(t_3, \mathrm{Pft}(p))])]$,
p is the sentence radical of (48).),

and by means of (47), (48') implies

(48'') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1, \phi)]$.

3.2.3 Predetermined Future

Sometimes, sentences with the present tense are used to express an event in the future, as is observed in the following sentence:

(49) John leaves town tomorrow.

For these types of sentences, Dowty assumes the aspect of predetermined future which is expressed with ϕ -morpheme, and means that it's predetermined at the present that the event denoted by the sentence radical occurs at a moment in the future in all possible worlds which branch off in the future.

But it's a dubious argument because of the lack of the surface morpheme. There is the past tense form of this aspect. E.g., the following sentence

(50) I had cheeseburger with onions (Dowty,1979:160),

in the situation where the waiter brought a wrong order, or the following German sentence

(51) Morgen gab es den "Faust" im Theater. (Markus,1977:49)

(direct translation: There was the "Faust" in the theater tomorrow.)

But it does not seem to be a mere accident that other languages also lack the morpheme of this aspect. E.g., the following English sentence

(52) Tomorrow is Sunday

is also expressed in the present tense in other languages:

(53) a) German: Morgen ist Sonntag,

b) French: Demain, c'est dimanche,

c) Japanese: Asu wa nichiyobi da.

I think that this phenomenon stems from the character of the present which expresses an unmarkedness in a global sense. In the temporal dimension, the present was originally unmarked as to the tense. But the past tense morpheme complementarily gave the present tense the function of non-past, and the future tense further gave it the function of non-future, so that the present tense expressed the non-past and the non-future, i.e. the present. But the present tense rudimentarily posesses the unmarked temporal functions in the omnitemporal or tenseless statements:

(54) The earth goes round the sun,

(55) 1+1 is 2.

Likewise in the modal dimension, the indicative present expresses the state of the real world as its default value, and the subjunctive past expresses a modal distality, i.e. the state of an unreal world. E.g.:

(56) a) I'm rich,

b) I wish I were rich.

And in the dimension of knowledge, the present tense expresses the kernal of the speaker's knowledge as its default value, in contrast with the sentence with 'may', 'can', 'must' etc. which expresses an uncertainty or necessity of the speaker's knowledge. So the meaning of the sentences with the aspect of predetermined future should be explained in the dimension of the speaker's knowledge, as the kernel of the knowledge such as a definite plan etc.

In this sense, Dowty is basically false. But on the other hand, it's true that such an usage of the present has the above-mentioned temporal function, if the epistemic unmarkedness is projected into the time and modality. So I formulate the aspect of predertmined future symmetrically with the perfect aspect as follows:

(57) $\phi \equiv \bigvee t_1[\mathrm{NF}(t_1) \wedge \mathrm{AT}(t_1, \bigvee t_2[t_2 \subseteq n \wedge \mathrm{AT}(t_2, \mathrm{Pft}(\phi))])]$,

$\mathrm{Pdf}(\phi) \equiv$ predetermined $\boxed{f}(\phi)$.

'$\boxed{f}$' is an modal operator which assigns the set of all possible worlds which branch off in the future. 'predetermined' is a non-logical, perhaps pragmatic operator as 'have', and I assume the following meaning postulate which corresponds to (47):

(58) $\Box[\mathrm{Pdf}(\phi) \rightarrow \phi]$.

The meaning of the sentence

(49) John leaves town

is then formulated as

(49') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{Pdf}(\phi))]$

$(\phi \equiv \bigvee t_2[\mathrm{NF}(t_2) \wedge \mathrm{AT}(t_2, \bigvee t_3[t_3 \subseteq n \wedge \mathrm{AT}(t_3, \mathrm{Pft}(p))])]$

p is the sentence radical of (49).),

and by means of (58), (49') implies

(49'') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1, \phi)]$.

3.3 Temporal Adverbs

Dowty(1979) classifies the temporal adverbs into the following three categories:

(59) a) tense adverbs: $R_0(=S) \rightarrow R_1$,

b) aspect adverbs: $R_n(=E)$,

c) perfect adverbs: $R_2 \rightarrow R_3(=E)$ in (40).

Tense adverbs determine R_1 from S. Therefore,

(60) John painted a picture yesterday

is formulated as

(60') $\bigvee t_1[\mathrm{Past}(t_1) \wedge \mathrm{yesterday}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{Pft}(\phi))]$.

This also explains why the present perfect and a past adverb cannot coexist in a sentence. I.e.

(61) *John has painted a picture yesterday

is formulated as

(61') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{yesterday}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{Perf}(\phi))]$.

In (61'), '$\mathrm{Pres}(t_1)$' and '$\mathrm{yesterday}(t_1)$' are incompatible.

As aspect adverbs, I consider the following two: for an hour, and in an hour. But not all sentences are compatible with them, as the following examples show:

(62) a) John stayed in the town for an hour.

b) John slept for an hour.

c) *John died for an hour.

d) *John painted a picture for an hour.

(63) a) *John stayed in the town in an hour.

b) *John slept in an hour.

c) John died in an hour.

d) John painted a picture in an hour.

This can be explained as follows: Both 'for an hour' and 'in an hour' restrict E temporally. But they also determine if E is viewed perfectively or imperfectively - independent from the aspectual determination by tense. I.e. they both set up the time interval of an hour. But 'for an hour'

further requires that p is viewed imperfectively. But this imperfectivity must be compatible also with the activity, as is showed by (62b). I call this kind of imperfectivity amorphousness. (In fact, many linguists don't distinguish activity from stative. See also Note 2.) Therefore, I introduce the operator Imp*, and define its interpretation as follows:

(64) $\mathcal{L}(w,i,c,g;\text{Imp*}(\phi))=1$ iff i contains at least two time points, and for all $i' \subseteq i$ which contain at least two time points $\mathcal{L}(w,i',c,g;\phi)=1$.

Conversely, 'in an hour' requires that p is not viewed amorphously in any subinterval of E. Their semantic functions are then formulated as follows:

(65) ϕ for an hour: $\bigvee t_1[\text{T}(t_1) \wedge \text{AT}(t_1,\text{an-hour(n)} \wedge \text{Imp*}(\phi) \wedge \text{As}_1(\phi))]$,

(66) ϕ in an hour: $\bigvee t_1[\text{T}(t_1) \wedge \text{AT}(t_1,\text{an-hour(n)} \wedge \bigwedge t_2[t_2 \subseteq t_1 \rightarrow \text{AT}(t_2, \neg\text{Imp*}(\phi))] \wedge \text{As}_1(\phi))]$.

(Here, 'T' and 'As_1' are as in (30). 'ϕ' stands for the logical formula of the sentence radical of a sentence 'ϕ' without temporal adverbs which is formulated as '$\bigvee t_1[\text{T}(t_1) \wedge \text{AT}(t_1,\text{As}_1(\phi))]$'.) In terms of them, (62a-d), (63a-d) are formulated as

(62') a) $\bigvee t_1[\text{Past}(t_1) \wedge \text{AT}(t_1,\text{an-hour}(n) \wedge \text{Imp*}(p) \wedge \text{Imp}(p))]$,

b)-d) $\bigvee t_1[\text{Past}(t_1) \wedge \text{AT}(t_1,\text{an-hour}(n) \wedge \text{Imp*}(p) \wedge \text{Pft}(p))]$,

(63') a) $\bigvee t_1[\text{Past}(t_1) \wedge \text{AT}(t_1,\text{an-hour}(n) \wedge \bigwedge t_2[t_2 \subseteq t_1 \rightarrow \text{AT}(t_2, \neg\text{Imp*}(p))] \wedge \text{Imp}(p))]$,

b)-d) $\bigvee t_1[\text{Past}(t_1) \wedge \text{AT}(t_1,\text{an-hour}(n) \wedge \bigwedge t_2[t_2 \subseteq t_1 \rightarrow \text{AT}(t_2, \neg\text{Imp*}(p))] \wedge \text{Pft}(p))]$

respectively. Then, (62'), (63') explain the grammatical difference of (62), (63) by means of the compatibility between the aspect determined by the tense (Imp(p) or Pft(p)), determined by the aspect adverb (Imp*(p) or $\bigwedge t_2[t_2 \subseteq t_1 \rightarrow \text{AT}(t_2, \neg\text{Imp*}(p))$, and the Aktionsart ($p$). E.g., if '$p$' stands for the sentence radical 'John paints a picture.', Pft(p) can be true with respect to the interval I of one hour. But Imp*(p) cannot be true, unless John paints a picture in every subinterval of I which consists of two time points.

And this explains the oddness of (62d). But if 'p' stands for the sentence radical 'John dies.', Pft(p) is true with respect to the interval I of one hour, if there is only one subinterval of I which consists of two time points, and in which p is true. But then, because p cannot be true with respect to every subinterval of I which consists of two time points, $\bigwedge t_2[t_2 \subseteq t_1 \rightarrow \text{AT}(t_2, \neg\text{Imp*}(p))]$ is true. Therefore, (63c) can be true.

'since', 'during', 'up to', and also 'for' are examples of perfect adverbs. They occur with the perfect, but not with the simple tense, as the following example shows:

(67) John { a) *slept / b) has slept / c) *sleeps } since midnight.

In this paper, I treat 'since' and 'for'. (67b) and

(68) John has slept for an hour

are formulated as

(67b') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{have}(\bigvee t_2[\mathrm{PN}(t_2) \wedge \mathrm{AT}(t_2, \bigvee t_3[t_3 \subseteq n \wedge \bigvee t_4[\mathrm{midnight}(t_4) \wedge t_4 \leq n] \wedge \mathrm{Imp}*(p) \wedge \mathrm{AT}(t_3, \mathrm{Pft}(p))])]))]$

and

(68') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1, \mathrm{have}(\bigvee t_2[\mathrm{PN}(t_2) \wedge \mathrm{AT}(t_2, \bigvee t_3[t_3 \subseteq n \wedge \mathrm{an\text{-}hour}(n) \wedge \mathrm{Imp}*(p) \wedge \mathrm{AT}(t_3, \mathrm{Pft}(p))])]))]$

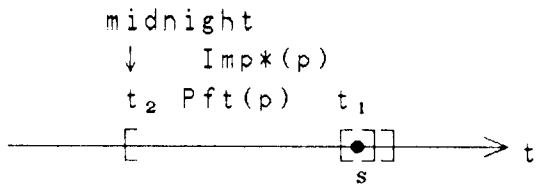
respectively. Perfective adverbs determine $R_3(=E)$ from R_2 in (40). I.e. $\bigvee t_4[\mathrm{midnight}(t_4) \wedge t_4 < n]$ in (67b') or an-hour(n) in (68') restrict t_2, but Imp*(p) indirectly restrict t_3 together with AT(t_3,Pft(p)), so that $t_3 = t_2$, and in this t_3, p occurs amorphously and perfectively. (67b'), (68') then get equal to

(67b'') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1, \bigvee t_2[\mathrm{PN}(t_2) \wedge \mathrm{AT}(t_2, \bigvee t_4[\mathrm{midnight}(t_4) \wedge t_4 \leq n] \wedge \mathrm{Imp}*(p) \wedge \mathrm{Pft}(p))])]$,

c) $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1, \bigvee t_2[\mathrm{PN}(t_2) \wedge \mathrm{AT}(t_2, \mathrm{an\text{-}hour}(t_2) \wedge \mathrm{Imp}*(p) \wedge \mathrm{Pft}(p))])]$

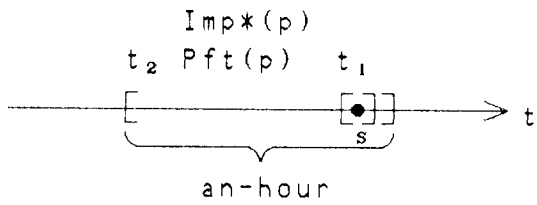
respectively, and are illustrated as

(67b''')



and

(68''')



respectively.

Perfect adverbs are an intermediate category between tense adverbs and aspectual adverbs which becomes possisble because of the many-storied structure of interval determination of the perfect.

3.4 Iterated Aspects

In this section, I only analyze the iteration of the progressive and the perfect, and the progressive and the predetermined future with a temporal adverb. The following sentence

(69) John has been working on this thesis for two years.

is treated in the same way as (68), but 'p' in (68) is replaced with 'Prog(p)', so that (69) is formulated as

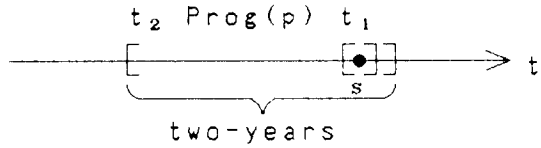
(69') $\bigvee t_1$[Pres(t_1) $\wedge$ AT(t_1,have($\bigvee t_2$[PN(t_2) $\wedge$ AT(t_2,$\bigvee t_3$[$t_3 \subseteq n \wedge$ two-years(n) $\wedge$ Imp*(Prog(p)) $\wedge$ AT(t_3,Pft(Prog(p)))])]))],

which implies

(69'') $\bigvee t_1$[Pres(t_1) $\wedge$ AT(t_1,$\bigvee t_2$[PN(t_2) $\wedge$ AT(t_2,two-years(t_2) $\wedge$ Imp*(Prog(p)) $\wedge$ Pft(Prog(p)))])],

i.e. the structure illustrated in

(69''')



In the following sentence

(70) John is leaving town tomorrow,

the progressive is applied to the sentence with the predetermined future, and the adverb 'tomorrow' is treated exceptionally as an aspect adverb, and introduced with the predetermined future. (70) is formulated as

(70') $\bigvee t_1$[Pres(t_1) $\wedge$ AT(t_1,Prog(predetermined f($\bigvee t_2$[NF(t_2) $\wedge$ AT(t_2,$\bigvee t_3$[$t_3 \subseteq n \wedge$ AT(t_3,tomorrow(n) $\wedge$ Pft(p))])]))),

As Dowty(1979:154ff.) says, the assertion of (70) is weaker than that of

(49) John leaves town tomorrow,

because of the progressive.[6]

4. Temporal Expressions in German

In this chapter, I compare the semantic functions of temporal expressions of German with English.

As to the tense, the German past and future have the same function as the English. But in German, the non-stative sentences with simple present are possible as

(71) Hans malt ein Gemälde.

(Hans is painting a picture.)

In order for (71) to be possible, E must contain at least two time points. (The progressive of its English translation suggests it.) This means that in German, the constraint on E becomes elastic, and E only needs to contain the time point of speech, so that the constraint on the length of E is the same as the past and the future.

But it's not certain if (71) has further modal implications of the

progressive. In fact, the following sentence

(72) Hans malte ein Gemälde,

the past form of (71), is interpreted only as the perfective past.[7] For this reason, I formulate the German simple tenses in the same way as English (31), (32), (33). But the interpretation of Pres is a bit altered as follows:

(30') $\mathcal{L}(w,i,c,g;\text{Pres}(t))=1$ iff $\mathcal{L}(w,i,c,g;t) \supseteq \text{cn}$.

And it's assumed that the progressive doesn't exist in German.

However, the other two aspects in English - the perfect and the predetermined future - exist also in German. We already saw an example of the predetermined future in (53a). And the following sentence

(73) Hans ist abgereist.

(He has left (town).)

is an example of the German present perfect. And these two aspects are formulated in the same manner as in English.

Insofar as tense adverbs occure in sentences with a simple tense, we can treat them as aspect adverbs. E.g., as formulations of

(60) John painted a picture yesterday,

(60') $\bigvee t_1[\text{Past}(t_1) \wedge \text{yesterday}(t_1) \wedge \text{AT}(t_1,\text{Pft}(\phi))]$,

and

(60'') $\bigvee t_1[\text{Past}(t_1) \wedge \text{AT}(t_1,\text{yesterday}(n) \wedge \text{Pft}(\phi))]$

are the same. But in English, if we treat 'yesterday' as an aspect adverb, we cannot explain the ungrammaticality of

(61) *John has painted a picture yesterday,

because it's formulated as

(61'') $\bigvee t_1[\text{Pres}(t_1) \wedge \text{AT}(t_1,\text{have}(\bigvee t_2[\text{PN}(t_2) \wedge \text{AT}(t_2, \bigvee t_3[t_3 \subseteq n \wedge \text{AT}(t_3,\text{yesterday}(n) \wedge \text{Pft}(p))])]))]$,

and (61) can be true. But if 'yesterday' is treated as a tense adverb, (61) is formulated as

(61') $\bigvee t_1[\text{Pres}(t_1) \wedge \text{yesterday}(t_1) \wedge \text{AT}(t_1,\text{Perf}(\phi))]$,

and (61') is always false. From this, we can conclude the existence of tense adverbs in English. But in German, adverbs which explicitely denote a past time can occur with the present perfect as

(74) Hans ist gestern abgereist.

Then, we need not to assume the tense adverbs in German.

Further, the German correspondence of English perfect adverbs occurs not with the present perfect, but with the simple present as

(75) Hans schläft seit Mitternacht.

(*Hans sleeps since midnight.)

In order to explain this, we only need to assume that such type of adverbs in German functions as aspect adverbs, which is clarified by

(75') $\bigvee t_1[\text{Pres}(t_1) \wedge \text{AT}(t_1, \bigvee t_2[\text{Mitternacht}(t_2) \wedge t_2 \leq n] \wedge \text{Imp*}(p) \wedge \text{Pft}(p))]$.

From this, we can conclude that there is only one category of adverbs, i.e. aspect adverbs, in German.

In conclusion, there are three tenses in German as in English. But the constraint on the present tense in German is more elastic than in English. German lacks the progressive, so that there are only two aspects, i.e. the perfect and the predetermined future. Further, there's no need to assume the tense adverbs and the perfect adverbs, so that only aspect adverbs are required in German.

From this, it can be concluded that English is - as to temporal expressions - more analytic than German. Conversely, the latter supplements the lack with pragmatic elements.

5. Formal Part

This chapter is a revised version of Dowty(1979,351-368), Komatsu(1989: 76-94).

5.1 Model Structure for the Aspectual Logic AL

$\mathfrak{A} = \langle E, W, M, C, <_M, R, Iw, \$ \rangle$ is a model structure for AL defined as follows:

(1) E is a non-empty set (the set of entities).

(2) W is a non-empty set (the set of possible worlds).

(3) M is a non-empty set (the set of moments of time).

(4) $<_M$ is a transitive, irreflexive, successive, discrete, and linear ordering on M. ($<_M$ is the erlier-than-relation on M, and is isomorph to the smaller-than-relation on the set of integers.)

(5) The set of time intervals I is the set of all subsets i of M such that if $i \in I$, then for all $m_1, m_2, m_3 \in M$, if $m_1, m_3 \in I$, and $m_1 <_M m_2 <_M m_3$, then $m_2 \in i$.

For $i_1, i_2 \in I$, $i_1 < i_2$ iff for all $m_1 \in i_1$, and $m_2 \in i_2$; $m_1 <_M m_2$. And $i_2 > i_1$, iff $i_1 < i_2$.

The minimal (maximal) element of i is $m \in i$ such that for all $m' \in i$, $m <_M m'$ ($m >_M m'$), or $m = m'$.

i_1 is a co-initial (co-final) interval of i_2 iff the minimal (maximal) element of i_1 is equal to the minimal (maximal) element of i_2.

$i_1 \leq i_2$ ($i_2 \geq i_1$) iff i_1 is a co-initial (co-final) subinterval of i_2.

(6) C is a non-empty set (the set of contexts).

For $c \in C$, cn is a time interval with only one time point in it (regarded as the time interval of speech in c), and ca $\in W$ (regarded as the actual world in c).

(7) Let "$i_1 \ll i_2$" abbreviate "for all $m_1 \in i_1$ there exists $m_2 \in i_2$ such that $m_1 < m_2$". Then R is a three-place relation in $W \times W \times I$ such that (a)

if $\langle w_1,w_2,i\rangle \in R$ then for all $i' \in I$ such that $i' \ll i$, $\langle w_1,w_2,i'\rangle \in R$, and (b) where R' is that two-place relation such that $\langle w_1,w_2\rangle \in R'$ iff for some i, $\langle w_1,w_2,i\rangle \in R$ R' is transitive, reflexive and symmetric. ("$\langle w_1,w_2,i\rangle \in R$" is read "world w_1 exactly like world w_2 at all times up to and including i" .

(8) Iw is a function from $W \times I$ into subsets of W such that if $w_1 \in Iw(\langle w_2,i\rangle)$, then $\langle w_1,w_2,i\rangle \in R$, for all $w_1,w_2 \in W$, $i \in I$. (I.e. the "inertia worlds" for a given index $\langle w,i\rangle$ are always a subset of the worlds that are exactly like w up to i, according to R.)

(9) \$ is a function that assigns to each $w_i \in W$ a set of sets of members of W, designated $\$_{w_i}$, such that (a) $\$_{w_i}$ is centered on w_i, (b) $\$_{w_i}$ is nested, (c) $\$_{w_i}$ is closed under unions, and (d) $\$_{w_i}$ is closed under non-empty intersections. (I.e. each set in $\$_{w_i}$ is a set of worlds that are all equally similar to w_i; cf. Lewis(1973:14).)

5.2 Definition of Types

The set of types is the smallest set T such that (1) e,t, and i are in T (regarded as the types of entities, truth values and time intervals respectively), and (2) if $a,b \in T$, then $\langle a,b\rangle \in T$.

5.3 Set of Possible Denotations, Intensions, and Characters

For each type $a \in T$, the set D_a of possible denotations of type a is defined recursively as follows: (a) $D_e=E$, (b) $D_t=\{0,1\}$ (the truth values "false" and "true" respectively), (c) $D_i=I$, and (d) $D_{\langle a,b\rangle}=D_b^{D_a}$.

Further, the set S_a (Ch_a) of possible intensions (characters) is defined as $D_a^{W\times I}$ (D_a^{C}).

5.4 Model for AL

$\mathcal{L} = \langle \mathcal{T},F,K \rangle$ is a contextual-intensional model for AL, and $\mathfrak{M} = \langle \mathcal{L},w,i,c,g \rangle$ is a model for AL.

The set of constants, variables, and indexicals with an arbitrary type a are expressed with Con_a, Var_a, and Ind_a respectively. Then:

F: $\mathrm{Con}_a \rightarrow D_a^{W\times I}$;

K: $\mathrm{Ind}_a \rightarrow D_a^{C}$;

$w \in W$;

$i \in I$;

$c \in C$;

g: $\mathrm{Var}_a \rightarrow D_a$.

If $u \in \mathrm{Var}_a$, and $x \in D_a$, then $g^{u}_{x}=(g \setminus \{\langle u,g(u)\rangle\}) \cup \{\langle u,x\rangle\}$.

5.5 Meaningful Expressions of AL and their Interpretation

The set of meaningful expressions of AL of type a, ME_a, is defined as follows, together with the recursive definition of the denotation of a meaningful expression α with respect to a model $\mathfrak{M}$, denoted by $\mathcal{L}(w,i,c,g;\alpha)$:

1. $\alpha \in Con_a$, then $\alpha \in ME_a$, and $\mathcal{L}(w,i,c,g;\alpha)=F(\alpha)(\langle w,i\rangle)$.
   j(i.e. John) $\in Con_e$;
   picture $\in Con_{\langle e,t\rangle}$;
   paint $\in Con_{\langle e,\langle e,t\rangle\rangle}$;
   an-hour, midnight, Mitternacht $\in Con_{\langle i,t\rangle}$;
   predetermined, have $\in Con_{\langle t,t\rangle}$;
   n (i.e. aspectual now) $\in Con_i$, and $\mathcal{L}(w,i,c,g;n)=i$.
2. If $u \in Var_a$, then $u \in ME_a$, and $\mathcal{L}(w,i,c,g;u)=g(u)$.
   $x,x_1,x_2,\ldots;y,y_1,y_2,\ldots \in Var_e$;
   $P,P_1,P_2,\ldots;Q,Q_1,Q_2,\ldots \in Var_{\langle e,t\rangle}$;
   $t,t_1,t_2,\ldots \in Var_i$;
   $p,p_1,p_2,\ldots \in Var_t$.
3. If $\alpha \in Ind_a$, then $\alpha \in ME_a$, and $\mathcal{L}(w,i,c,g;\alpha)=K(\alpha)(c)$.
   Past, Pres, Fut, yesterday, tomorrow $\in Ind_{\langle i,t\rangle}$, and for $\xi \in ME_t$,
   $\mathcal{L}(w,i,c,g;\text{Past}(\xi))=1$ iff $\mathcal{L}(w,i,c,g;\xi)<cn$;
   $\mathcal{L}(w,i,c,g;\text{Pres}(\xi))=1$ iff
   in English: $\mathcal{L}(w,i,c,g;\xi)=cn$,
   in German: $\mathcal{L}(w,i,c,g;\xi)\supseteq cn$;
   $\mathcal{L}(w,i,c,g;\text{Fut}(\xi))=1$ iff $\mathcal{L}(w,i,c,g;\xi)>cn$;
   $\mathcal{L}(w,i,c,g;\text{yesterday}(\xi))=1$ ($\mathcal{L}(w,i,c,g;\text{tomorrow}(\xi))=1$) iff $\mathcal{L}(w,i,c,g;\xi)$ is a subinterval of the day before (after) cn.
4. If $\alpha \in ME_{\langle a,b\rangle}$ and $\beta \in ME_a$, then $\alpha(\beta) \in ME_b$, and $\mathcal{L}(w,i,c,g;\alpha(\beta))=\mathcal{L}(w,i,c,g;\alpha)(\mathcal{L}(w,i,c,g;\beta))$.
5. If $\alpha, \beta \in ME_a$, then $[\alpha = \beta] \in ME_t$, and $\mathcal{L}(w,i,c,g;[\alpha=\beta])=1$ iff $\mathcal{L}(w,i,c,g;\alpha)=\mathcal{L}(w,i,c,g;\beta)$.
6. If $\phi \in ME_t$, then $\neg\phi \in ME_t$, and $\mathcal{L}(w,i,c,g;\neg\phi)=1$ iff $\mathcal{L}(w,i,c,g;\phi)=0$. (Similarly for $\wedge$, $\vee$, $\rightarrow$, and $\leftrightarrow$.)
7. If $\phi \in ME_t$ and $u \in Var_a$, then $\bigvee u\,\phi \in ME_t$, and $\mathcal{L}(w,i,c,g;\bigvee u\,\phi)=1$ iff there exists x such that $\mathcal{L}(w,i,c,g^u_x;\phi)=1$. (Similarly for $\bigwedge u\,\phi$.)
8. If $\phi \in ME_t$, then $\Box\phi \in ME_t$, and $\mathcal{L}(w,i,c,g;\Box\phi)=1$ iff $\mathcal{L}(w',i',c,g;\phi)=1$, for all $w' \in W$ and $i' \in I$.
9. If $\phi \in ME_t$, then $\boxed{f}\phi \in ME_t$, and $\mathcal{L}(w,i,c,g;\boxed{f}\phi)=1$ iff for all w' such that $\langle w,w',i\rangle \in R$, $\mathcal{L}(w',i,c,g;\phi)=1$.
10. If $\phi \in ME_t$, then Become $\phi \in ME_t$, and $\mathcal{L}(w,i,c,g;\text{Become}\,\phi)=1$ iff (1) for some co-initial interval j of i, $\mathcal{L}(w,j,c,g;\phi)=0$; (2) for some co-final interval k of i, $\mathcal{L}(w,k,c,g;\phi)=1$; and (3) there is no $i' \subsetneq i$ such that (1)

and (2) hold for i' as well as i.

11. If $\phi, \psi \in ME_t$, then [ϕ And ψ] $\in ME_t$, and $\mathcal{L}(w,i,c,g;$[ϕ And ψ]$)=1$ iff (1) for some $j \subseteq i$, $\mathcal{L}(w,j,c,g;\ \phi\ )=1$; (2) for some $k \subseteq i$, $\mathcal{L}(w,k,c,g;\ \psi\ )=1$; and (3) there is no $i' \subsetneq i$ such that (1) and (2) hold for i'.
12. If $\phi \in ME_t$, then Inr(ϕ) $\in ME_t$, and $\mathcal{L}(w,i,c,g;$Inr(ϕ))$=1$ iff for some i' such that $i \subsetneq i'$, and for all $w' \in$ Iw($\langle w,i \rangle$), $\mathcal{L}(w',i',c,g;\ \phi\ )=1$.
13. If $\phi, \psi \in ME_t$, then [$\phi \ \Box\!\!\rightarrow \psi$] $\in ME_t$, and $\mathcal{L}(w,i,c,g;$[$\phi \ \Box\!\!\rightarrow \psi$]$)=1$ iff either (1) there is no set $S \in \$_w$ for which there is $w' \in S$ such that $\mathcal{L}(w,i',c,g;\ \phi\ )=1$, or else (2) there is some set $S \in \$_w$ such that $\mathcal{L}(w',i,c,g;\ \phi\ )=1$ for some $w' \in$ S, and for all w'' $\in$ S, $\mathcal{L}(w'',i,c,g;\ \phi \rightarrow \psi\ )=1$. (Cf. Lewis(1973:16).)
14. If $\phi, \psi \in ME_t$, then [ϕ Cause ψ] $\in ME_t$, and $\mathcal{L}(w,i,c,g;$[ϕ Cause ψ]$)=1$ iff $\mathcal{L}(w,i,c,g;$[$\phi \ \Box\!\!\rightarrow \psi$]$)=1$ and $\mathcal{L}(w,i,c,g;$[$\neg\phi \ \Box\!\!\rightarrow \neg\psi$]$)=1$.[8]
15. If $\phi \in ME_t$, $\zeta \in ME_i$, then AT(ζ, ϕ) $\in ME_t$, and $\mathcal{L}(w,i,c,g;$AT(ζ, ϕ))$=1$ iff $\mathcal{L}(w,i',c,g;\ \phi\ )=1$, where $i'=\mathcal{L}(w,i,c,g;\ \zeta\ )$.
16. If $\zeta \in ME_i$, then PN(ζ) $\in ME_t$ (NF(ζ) $\in ME_t$), and $\mathcal{L}(w,i,c,g;$PN(ζ))$=1$ ($\mathcal{L}(w,i,c,g;$NF(ζ))$=1$) iff $\mathcal{L}(w,i,c,g;\ \zeta\ )$ is a co-final (co-initial) interval) of i.
17. If $\zeta, \xi \in ME_i$, then [$\zeta < \xi$] ([$\zeta \leq \xi$]) $\in ME_t$, and $\mathcal{L}(w,i,c,g;$[$\zeta < \xi$]$)=1$ ($\mathcal{L}(w,i,c,g;$[$\zeta \leq \xi$]$)=1$) iff $\mathcal{L}(w,i,c,g;\ \zeta\ ) < \mathcal{L}(w,i,c,g;\ \xi\ )$ ($\mathcal{L}(w,i,c,g;\ \zeta\ ) \leq \mathcal{L}(w,i,c,g;\ \xi\ )$).
18. If $\zeta, \xi \in ME_i$, then [$\zeta \subseteq \xi$] $\in ME_t$ ([$\zeta \subsetneq \xi$] $\in ME_t$), and $\mathcal{L}(w,i,c,g;$[$\zeta \subseteq \xi$]$)=1$ ($\mathcal{L}(w,i,c,g;$[$\zeta \subsetneq \xi$]$)=1$) iff $\mathcal{L}(w,i,c,g;\ \zeta\ )$ is a (genuine) subinterval of $\mathcal{L}(w,i,c,g;\ \xi\ )$.
19. If $\phi \in ME_t$, then Imp(ϕ) $\in ME_t$, and $\mathcal{L}(w,i,c,g;$Imp(ϕ))$=1$ iff for all $i' \subseteq i$ $\mathcal{L}(w,i',c,g;\ \phi\ )=1$.
20. If $\phi \in ME_t$, then Imp*(ϕ) $\in ME_t$, and $\mathcal{L}(w,i,c,g;$Imp*(ϕ))$=1$ iff i contains at least two time points, and for any $i' \subseteq i$ which contains at least two time points, $\mathcal{L}(w,i',c,g;\ \phi\ )=1$.
21. If $\phi \in ME_t$, then Pft(ϕ) $\in ME_t$, and $\mathcal{L}(w,i,c,g;$Pft(ϕ))$=1$ iff (1) $\mathcal{L}(w,i',c,g;\ \phi\ )=1$, and (2) there is no interval i' such that $i \subsetneq i'$, and $\mathcal{L}(w,i',c,g;\ \phi\ )=1$.

If $c \in C$, then $\langle$ca,cn,$c\rangle$ is an index of possible utterance. All interpretations of $\phi \in ME_t$ which corresponds to a sentence of a natural language begin with $\mathcal{L}$(ca,cn,$c,g;\ \phi$).

If $\phi \in ME_t$, ϕ is true in the context c with respect to $\mathcal{L}$ iff for all g' $\mathcal{L}$(ca,cn,$c,g';\ \phi\ )=1$.

ϕ is analytic iff for all c,g in an arbitrary $\mathcal{L}$, $\mathcal{L}$(ca,cn,$c,g;\ \phi\ )=1$.

In an obvious case, the square brackets '[ ]' are eliminated.

The following abbreviations are employed:

$\alpha(\beta, \gamma) \equiv \alpha(\gamma)(\beta)$,

for $\phi \in ME_t$:

$Prog_1(\phi) \equiv \bigvee t[n \subseteq t \wedge AT(t, Pft(\phi))]$,

$Prog(\phi) \equiv Inr(\bigvee t[n \subseteq t \wedge AT(t, Pft(\phi))])$,

$Perf_1(\phi) \equiv \bigvee t_1[PN(t_1) \wedge AT(t_1, \bigvee t_2[t_2 \subseteq n \wedge AT(t_2, Pft(\phi))])]$,

$Perf(\phi) \equiv have(Perf_1(\phi))$,

$Pdf(\phi) \equiv predetermined_{[f]}(\bigvee t_1[NF(t_1) \wedge AT(t_1, \bigvee t_2[t_2 \subseteq n \wedge AT(t_2, Pft(\phi))])])$.

5.6 Meaning Postulates

For the interpretation of meaningful expressions of AL, only the contextual-intensional models in which the following meaning postulates are analytic are permitted:

MP1. $\bigvee x \Box[\delta = x]$, where δ is j.

MP2. (Stative)

$\bigwedge x \Box[\gamma(x) \leftrightarrow \bigwedge t[t \subseteq n \rightarrow AT(t, \gamma(x))]]$, where γ translates a stative intransitive phrase.

MP3. (Activity)

$\bigvee P \bigwedge x \Box[\gamma(x) \rightarrow [P(x)\ \text{And}\ \neg P(x)]]$, where γ translates an activity intransitive phrase.

MP4. (Achievement)

$\bigvee P \bigwedge x \Box[\gamma(x) \leftrightarrow \text{Become}\ P(x)]$, where γ translates an achievement intransitive phrase.

MP5. (Accomplishment)

$\bigvee P \bigvee Q \bigwedge x \Box[\delta(x,y) \leftrightarrow P(x)\ \text{Cause Become}\ Q(y)]$, where δ translates an accomplishment transitive phrase.

In the following, let $\phi \in ME_t$.

MP6. $\Box[have(\phi) \rightarrow \phi]$.

MP7. $\Box[predetermined(\phi) \rightarrow \phi]$.

Notes

1 The stative and the imperfective might be considered as the same. But the former is a state of affairs as such, in contrast, the latter is a way of viewing it. In fact, the following sentence

(i) He's been to America before

is a stative, but perfective sentence, i.e. the state of his having been in America is viewed perfectively.

2 They treat the stative and the activity in (1) as the stative, and the accomplishment and the achievement as the non-stative. The motional difference between the stative and the activity in (1) is ignored.

3 This view is maintained by Löbner(1988). Galton(1987:176) gives the non-stative sentences the set of the pairs $\langle A,B\rangle$ as their denotations. A is the set of time points before an occurence of the event which a non-stative sentence denotes, B is the set of time points after the occurence. And the occurence of the event happens in the period between A and B. Anyway, $\langle A,B\rangle$ is another entity than the truth value.

4 This could also be formulated as follows:
(i) $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1,\mathrm{Imp}(\phi))]$.
In fact, (30) gives (31) and (i) the same truth condition. (i) also gives a unified formulation with the past and future correspondence (32), (33) with Imp(ϕ) or Pft(ϕ). Further, the present looks at the situation from inside, and, as Comrie(1976:4) says, this is also a property of imperfective. So, (i) seems to be preferable to (31). But, as we see in Chap.4, the opposition Pft/Imp is cancelled in German present. Further, (i) is derived from (31) using (30). For this reason, I formulate the semantic function of the present as (31).

5 Some linguists, e.g. Löbner, don't accept the existence of inertia worlds, and leave the properties of the progressive aspect, such as imperfective paradox, to pragmatics. Indeed, pragmatics is similar to a waste basket in which all that doesn't seem to be explained in semantics is squeezed. But Löbner's refutation concerns the branching of time(1988:183). And even if he intends the branching of possible worlds by that, the phenomenon which can be explained in the semantics must be expalined in it. And also Galton(1984:133-143) - though in an implicit, vague form - reaches the same conception as the Dowty's. For this reason, I adopted the branching structure of possible worlds here.

6 In general, it's better to begin the analysis with (69),(70) without adverbs, i.e.
(i) John has been working on this thesis,
(ii) John is leaving town.
In fact, Dowty(1979:359) analyzes the predetermined future with this method. But the formulations of (i), (ii), i.e.
(i') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1,\mathrm{have}(\bigvee t_2[\mathrm{PN}(t_2) \wedge \mathrm{AT}(t_2,\bigvee t_3[t_3 \subseteq n \wedge \mathrm{AT}(t_3,\mathrm{Pft}(\mathrm{Prog}(p)))])]))]$,
(ii') $\bigvee t_1[\mathrm{Pres}(t_1) \wedge \mathrm{AT}(t_1,\mathrm{Prog}(\text{predetermined } \boxed{f}(\bigvee t_2[\mathrm{NF}(t_2) \wedge \mathrm{AT}(t_2,\bigvee t_3[t_3 \subseteq n \wedge \mathrm{AT}(t_3,\mathrm{Pft}(p))])]))]$
contain some problems. I.e. (i') doesn't exclude the case that John isn't working on the thesis now, and (ii') the case that John leaves town in the non-future.

This might be considered as a defect of the present analysis. But the lack of the temporal adverbs in (i), (ii) doesn't seem normal to me. In fact, you feel like to ask "how long" or "when", if you hear (i) or (ii). So, I think that, in (69), (70) (and also (49)), the temporal adverbs appear obligatorily, and (i'), (ii') conversely explain the anomaly of (i'), (ii').

7 The German correspondence of

(i) Hans was painting a picture
must be expressed by totally other expressions, such as
(ii) Hans beschäftigte sich mit der Herstellung eines Gemäldes.

8 This formulation represents the necessary and sufficient reason in Spohn (1983:268).

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