

Lexical and grammatical aspect formalized

‘The semantics of tense and aspect is profoundly shaped by concerns with goals, actions and consequences . . . temporality in the narrow sense of the term is merely one facet of this system among many.’ (Steedman)

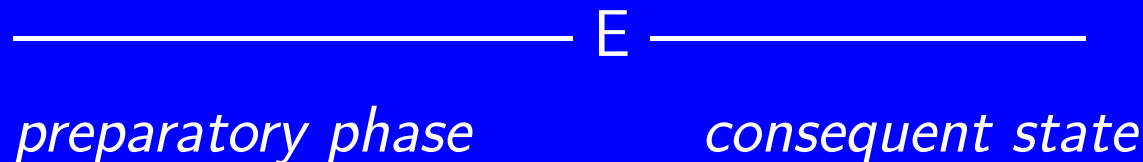
- tense: grammaticalization of location of events in time
- traditional definition of aspect: ‘ways of looking at the internal *temporal* contour of an eventuality’
- lexical aspect (*Aktionsart*): what kind of eventualities are described by VPs in the languages of the world?
- grammatical aspect: morphological marking of aspect
- we know by now that aspect must involve more than *temporal* contour of an eventuality:
- most likely eventualities are cognitively organized as a *goal-plan-action* structure (plus causal theory)

Eventualities

An *eventuality* is a structure composed of *four* parts

1. activity (in the strict sense)
2. changing, partial object or parametrized state
3. culminating event
4. consequent state

Cf. Moens/Steedman (1988, 1997) picture:



Claim: eventualities provide matrix for the semantics of verbs and verb phrases, a guide to the construction of appropriate scenarios.

If VP is represented by (f_1, f_2, e, f_3) , then these are related as follows

- f_1 is a fluent which corresponds to an activity,
- f_2 is a fluent which corresponds to a partial object which changes under the causal influence of f_1 (thus f_2 will in general contain variables)
- f_1 is not allowed to occur in *Releases* and in the third argument of *Trajectory*, but may occur in the latter's first argument: activities are often volitional and must hence be initiated and terminated by actions. For f_2 it is the other way around; this fluent is conceptualized as passive, hence is not allowed as the first argument in *Trajectory*.
- The relationship between the fluents f_1 and f_2 is given by the dynamics, i.e. a statement of the form (where $S(\dots)$ consists of $(\neg)HoldsAt$'s): $S(f_1, f_2, t, d) \rightarrow Trajectory(f_1, t, f_2, d)$.
- e is the culminating (or *goal-*) event of the activity
- the consequent (or *goal-*) state f_3 is usually an instantiation of f_2

Formal definition of Aktionsart: varying $(\bullet, \bullet, \bullet, \bullet)$

Recall the various *Aktionsarten*: states, activities, achievement, accomplishments, points (semelfactives). We will distinguish these by looking at what entries of $(\bullet, \bullet, \bullet, \bullet)$ must be filled.

States and activities (strict, i.e. viewed intransitively):

	Releases	Traj.₁	Traj.₃
States	+	−	+
Activity (strict)	−	+	−

Extension to all Aktionsarten

+’s indicate what entries have to be filled:

State	(-, -, -, +)
Point	(-, -, +, -)
Achievement	(-, -, +, +)
Activity (strict/intran.)	(+, -, -, -)
Activity (wide/tran.)	(+, +, -, -)
Accomplishment	(+, +, +, +)

- a scenario for a VP should at least connect the positive entries in the corresponding quadruple
- are there any other possibilities?
- recall scenarios correspond to suitable spreading activation networks

Example of an achievement: 'reach the top'

Here the scenario need not contain more than

1. *Initiates(reach,be-at-the-top,t)*.

Example of a transitive activity: 'drink wine'

1. $HoldsAt(f_2(g(t)), t) \rightarrow Trajectory(drink, t, f_2(g(t + d)), d),$ where $f_2(x)$ means something like 'quantity x of wine consumed'
2. $Initiates(start, drink, t)$
3. $Initially(f_2(a)),$ where a is a contextually determined parameter

In this case it is not necessary to mention a canonical terminating event.

Example of an accomplishment: 'build a house'

1. $Initiates(start, build, t)$
2. $Initiates(finish, house(c), t)$
3. $Terminates(finish, build, t)$
4. $HoldsAt(build, t) \wedge HoldsAt(house(c), t) \rightarrow Happens(finish, t)$
5. $Releases(start, house(x), t)$
6. $HoldsAt(house(g(t)), t) \rightarrow Trajectory(build, t, house(g(t + d)), d)$
7. $Initially(house(a))$
8. Stipulation: $House(house(c))$ (i.e. we identify the object *house* with a particular construction stage)

Here, a is a real parameter fixing the initial stage of the construction process. Statements 5 and 6 are jointly called the *dynamics*. Together, these eight statements describe a goal and actions/activities leading toward the goal.

The default character of Aktionsart

Compare

(1) a. I love her.

b. *I am loving her.

c. I am loving her more and more, the more I get to know her.

- the first two sentences seem to indicate that *love* is a state
- in the third sentence, *love* is more like an activity
- therefore, there is no *fixed* association of VP and scenario: *coercion*

Grammatical aspect

- main opposition: perfective/imperfective
- ‘perfectivity indicates the view of the situation as a single whole, without distinction of the various separate phases that make up that situation; while the imperfective pays essential attention to the internal structure of the situation’ (Comrie)
- grammaticalized in Russian, where each verb comes in a perf./imp. pair; perfectivizing prefixes such as po-, pro-, pere-, raz-, za-, pri-, pod-, do-, ot-, ...
- ‘the situation as a single whole’ \neq ‘punctual situation’!

Perfectivity and hierarchical planning

- hierarchical planning in robotics/humans: to construct a motor plan, start with most general action and decompose until level of motor instructions is reached; e.g.
- walk to the door \rightsquigarrow take a step \rightsquigarrow lift the right foot \rightsquigarrow ...
- perfective::imperfective = action::decomposed-action
- provides formalization of notion of 'aspectual pair' in Russian
- recall *hierarchical* planning is old, evolutionary speaking (cf. McGo-nigle's experiments with squirrel monkeys)

Perfectivity and hierarchical planning, formally

- given a fluent f , events $start_f$, $finish_f$,
- define a new event e by
$$Happens(start_f, s) \wedge Happens(finish_f, t) \wedge HoldsAt(f, r) \wedge s < r < t \rightarrow Happens(e, r)$$
- after completion, the temporal extension of e is that of f comprised between $start_f$ and $finish_f$
- $\neg \exists r Happens(e, r)$ if either $start_f$ or $finish_f$ does not occur
- the triple $(start_f, f, finish_f)$ represents an eventuality viewed *imperfectively*, e represents the same eventuality viewed *perfectively*
- ‘perfectivity indicates the view of the situation as a single whole, without distinction of the various separate phases that make up that situation; while the imperfective pays essential attention to the internal structure of the situation’ (Comrie)

The progressive and the 'imperfective paradox'

- (2) Carlos was building a house, when a beam crushed his leg [presumably terminating building before completion of the house].
- It belongs to the meaning of the accomplishment *build a house* that the activity ('build') is directed toward the consequent state of a finished ('built') house,
 - but the actual occurrence of that consequent state can be denied without contradiction.
 - So how can a seemingly essential component of the meaning be denied, without affecting the meaning itself?

Possible worlds solutions are based upon the idea that

The progressive picks out a stage of a process/event which, if it does not continue in the real world, has a reasonable chance of continuing in some other possible world [1, p. 355]

References

[1] H. de Swart. Aspect shift and coercion. *Natural Language and Linguistic Theory*, 16:347–385, 1998.

Example: Dowty's 'inertia worlds': worlds which are identical with the present world until 'now', but then continue in a way most compatible with the history of the world until 'now'.

A logical observation

- ‘Davidsonian’ approach: *existential* quantifier over events; no type/token distinction.
- A scenario is a universal theory, which contains a name for a culminating event *type*, but
- nothing is said about the occurrence of the corresponding event *token*!

When is 'Carlos was building a house' true on a model \mathcal{M} ?

\mathcal{M} must satisfy

1. $Initiates(start, build, t)$
2. $Initiates(finish, house(c), t)$
3. $Terminates(finish, build, t)$
4. $HoldsAt(build, t) \wedge HoldsAt(house(c), t) \rightarrow Happens(finish, t)$
5. $Releases(start, house(x), t)$
6. $HoldsAt(house(g(t)), t) \rightarrow Trajectory(build, t, house(g(t + d)), d)$
7. $Initially(house(a))$
8. the integrity constraint $?HoldsAt(build, t), t < now$ must succeed.
(Here a is a real parameter fixing the initial stage of the construction process.)

‘Default’ character of the progressive

It is now a mathematical consequence (and not a definition!) that a house will be finished in an ‘inertia world’, i.e. the minimal model, although not in all models, of the theory describing the situation.

Theorem Let \mathcal{P} be the theory (logic program) consisting of the axioms of the event calculus, the scenario 1 – 7, and the integrity constraint 8. Then $comp(\mathcal{P})$ has a unique model, and in this model there is a time $t \geq now$ for which $HoldsAt(house(c),t)$. By virtue of the stipulation that $House(house(c))$, there will therefore be a house at time t .

The imperfective paradox resolved

- (3) Carlos was building a house, when a beam crushed his leg [presumably terminating building before completion of the house]

New scenario: 1 – 7 plus

8. *Terminates*(*beam-crushes-leg*, *build*, *t*)

9. the integrity constraint

?Happens(*beam-crushes-leg*, *t*), *HoldsAt*(*build*, *t*), *t* < *now*

succeeds

The prediction of the theorem can now no longer be derived.

Why does it work?

The essence of the solution of the imperfective paradox is the distinction between *sense* and *denotation*. The sense of the expression 'build a house' comprises at least 1 – 7 of the scenario (but is generally determined by context, i.e. what other lexical material is activated). The (temporal) denotation of 'build a house' is computed on the basis of additional 'episodic' information such as 8 or 9.