

'The proper treatment of events'

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- tries to explain how verb tenses and (lexical and grammatical) aspect combine to generate the order and structure of the events described
- it thus starts from *discourse*, not sentences
- examples: what is the order and structure of events in
 - (1) a. Max fell. John pushed him.
b. Carlos was building a barn when a beam crushed his leg.
- the explanation starts from the hypothesis that *cognitive construction* of time, not 'real time' underlies tense – *and that an event is therefore much more than a chunk of space-time*, e.g. because of intentional features
- this way of proceeding is representative of 'cognitive semantics',
- the book can be seen as providing cognitive semantics with a mathematical underpinning, at least in the area of tense and aspect

Issues discussed today

- what is missing from (more traditional) formal semantics?
- cognitive constraints on meaning
- from time to tense: recapitulation of what events really are
- the importance of the future and the role of planning
- lexical and grammatical aspect

A patriarch of formal semantics: David Lewis' (1972)

'General Semantics' (1)

“It [is] possible to give very simple general answers to the questions

1. what sort of thing is a meaning?

2. what is the form of the semantic rules whereby meanings of compounds are built up from the meanings of their constituents?”

[Answer to (1):]

“A meaning for a sentence is something that determines the conditions under which the sentence is true or false. It determines the truth-value of the sentence in various possible states of affairs, at various times, at various places, for various speakers, and so on. [...] [More generally, an intension is] a function which yields as output an appropriate extension when given as input a package of the various factors on which an extension may depend.” [Such factors include: world, time, place, speaker, audience, previous discourse, assignment to variables ...; jointly called an *index*]

David Lewis' 'General Semantics' (2)

“My proposals will not conform to the expectations of those who, in analyzing meaning, turn immediately to the psychology and sociology of language users: to intentions, sense-experience, and mental ideas, or to social rules, conventions and regularities. I distinguish two topics: first, the description of possible languages or grammars as abstract semantic systems whereby symbols are associated with aspects of the world; and second, the description of the psychological and sociological facts whereby a particular one of these abstract semantic systems is the one used by a person or a population. *Only confusion comes of mixing these two topics.*” [emphasis added]

Comments

- this strongly suggests that the ‘psychological facts’ are causally independent of the ‘abstract semantic system’ adopted – but meanings must be grasped by a mind
- e.g. working memory must somehow compute the meaning associated to a sentence
- the mathematical structure of meaning must determine an algorithm, which in turn must be implemented in wetware
- in this sense one is not free to adopt a semantic formalism – it must be executable somehow
- Marr’s methodology of three levels: ‘informational’, ‘algorithmic’, ‘implementational’

What (if any) are the constraints on representational structures in formal semantics?

- avowed goal of traditional formal semantics: explaining observed entailment relations by virtue of *logical form*, which should comprise
 - choosing a formal language
 - relating natural language expressions to the formal language
 - providing a semantics (structures, satisfaction relation) for the language
 - providing a definition of validity
- this ideal is not always realized: e.g. (neo-)Davidsonian event semantics with its undefined primitive predicates `Cu1`, `Hold`, ...; also non-axiomatized uses of possible worlds, e.g. Dowty's 'inertia worlds'
- when the ideal is realized, is this all that can be asked of a semantics?
- cognitive semantics seems correct in emphasizing that semantics must be relevant to explaining language comprehension and production

Cognitive constraints on meaning: general

- representations of meaning should be *algorithmic* because most likely the mind processes information computably
- this rules out intensional semantics *à la* Lewis, in which expressions are represented by *arbitrary* functions of ‘indices’ to *sets* of objects
- Frege’s *Sinn* (‘Art des Gegebenseins’) and *Bedeutung*
- as an alternative to Lewis, compare Moschovakis’ formalization of Frege: “the *Sinn* of an expression is the algorithm which computes its *Bedeutung*”
- same idea in Miller & Johnson-Laird, *Language and perception* (1976): the *Sinn* of a referring expression is the set of computable tests which determine whether that expression applies to an object
- note: an algorithm is finite, even when the function computed is infinite

A specific cognitive constraint on meaning: tense as conditioned by cognition

- temporal notions in natural language include
 - temporal adverbials: ‘tomorrow’, ‘for two hours’ ...
 - tense: ‘grammaticalized localization of events in time’
 - aspect: ‘internal temporal contour of an event’
- the way temporal notions are encoded in natural language is determined by the human cognitive representation of time
- can the cognitive representation of time be formalized so as to serve as a *formal* semantics for tense?

Warm-up: puzzling phenomena related to tense and aspect

- English: the difference between (2-a) and (2-b), and (3-b) and (3-c)
 - (2) a. I lost my watch, but I found it again.
b. *I have lost my watch, but I found it again.
 - (3) a. If it rains, you should take your umbrella.
b. *If it'll rain, you should take your umbrella.
c. If it's going to rain, you should take your umbrella.
- French: independence of event order and sentence order
 - (4) a. Il faisait chaud. Jean ôta sa veste. (Imp, PS)
It was hot. Jean took off his sweater.
 - b. Jean attrapa une contravention. Il roulait trop vite. (PS, Imp)
Jean got a ticket. He drove too fast.
 - c. Jean appuya sur l'interrupteur. La lumière l'éblouissait.
(PS, Imp)
Jean pushed the button. The light blinded him.

Cognitive time: why memory has more to do with the future than with the past

- *implicit (skill) memory* concerned with patterns, not individual events
- *semantic memory* does not allow 'mental time travel' to past and future, represents general knowledge, not episodes; does not impose ordering on events
- episode: 'who did what to whom, where, when and why; and what happened next' – this is much more than a chunk of space-time!
- *episodic memory* as memory for experienced episodes is somehow responsible for temporal ordering, but ...
- episodic memory involves *construction* more than *reproduction*
 - episodic memory is not a static datastructure
 - episodic memories need semantic memory for their interpretation
 - which is often reconstruction rather than reproduction, e.g. because of incompleteness of the stored episode

‘Using goal-plan knowledge to merge the past with the present and the future in narrating events on line’

(Trabasso and Stein 1993)

- uses Berman and Slobin’s ‘Frog where are you?’ paradigm
- plans act like glue: ‘the plan unites the past (a desired state) with the present (an attempt) and the future (the attainment of that state) ... causality and planning provide the medium through which the past is glued to the present and the future’
- basic narrative unit: GAO – ‘goal-action-outcome sequence’; this is similar to episode as defined above
- the capacity to structure a narrative in GAOs develops gradually:
 - absent at 3 (almost no GAOs; story is basically a sequence of stills, none of the actions described relevant to the boy’s goal)
 - sharp increase GAOs starting age 4 until age 9
 - maximum reached at age 21

The role of working memory

“Inferring goals and plans involves considerable social and personal knowledge and places heavy demands on a narrator’s working memory. The child who narrates events needs to attend to and maintain the current event in working memory; to activate and retrieve prior knowledge relevant to events, either in general or from earlier parts of the story, in order to interpret and explain the current event; and to integrate these interpretations into a context within a plan, all within the limitations of knowledge and working memory. [...] In so doing, the child creates a changing mental model that results in a long-term memory representation of what has occurred.”

Why is planning possibly important?

- planning consists in setting a *goal* and proposing a *sequence* of actions which provably leads to the achievement of that goal, taking into account properties of, and events in, the world
- (hierarchical) planning occurs in humans and in nonhuman primates
- evolution of language: planning has been hypothesized to be co-opted for syntax because of 'recursive' structure (Lashley 1951; Greenfield 1991; Steedman 2002)
- Broca's area (involved in language) immediately adjacent to areas for motor planning (Greenfield et al. 1972)
- possibility for *discourse* may distinguish ape language/human language
- planning can organize (e.g. temporal features of) discourse so as to determine the event structure described by the discourse

Conclusions for natural language

- there is a cognitive asymmetry between past and future which is not captured by $(\mathbb{R}, <)$, nor even by branching time
- humans are *goal-oriented* and hence the future is represented in terms of goals, and ways of achieving these, i.e. *plans*
- more generally, events are cognitively represented not as space-time chunks but as goal-action-outcome structures – therefore verb meanings must also be so encoded
- planning is a *computable* procedure for ordering actions in time and therefore a prime candidate for a cognitive representation of time
- episode: ‘who did what to whom *when* and *why* and what happened *next*’
- semantics may have co-opted planning system in so far as it is concerned with ordering episodes in time
- the main task ahead: formalize the enriched notion of event

Types of events required by the semantics of natural language

- we argued that cognitively speaking events are not (just) chunks of space-time, but rather *episodes*:
- ‘who did what to whom, where, *when* and *why*; and what happened *next*’
- the next task is to see how this relates to the types of events required as denotations of natural language expressions, such as
- temporal adverbials: ‘today’, ‘last year’, ...
- tense: ‘grammaticalization of location in time’
- grammatical aspect: grammaticalized ‘internal temporal constitution of an event’; e.g. progressive, perfect(?) in English, (im)perfective in Slavic languages
- lexical aspect: *Aktionsart*, ‘kinds of actions described by verbs’
- nominalization: e.g. ‘the building of the house’, ‘building the house’

Plan for remainder of lecture

Identify important components of event structure necessitated by

- tense: future tenses in English
- grammatical aspect 1: progressive in English
- grammatical aspect 2: perfect in English
- lexical aspect: the language Kalam (New Guinea), a logician's dream
- nominalization (from VP to N or NP): perfect and imperfect

English future tense

The English future tense can be expressed by the syntactic present tense, the futurate progressive, and periphrastic constructions such as *will* and *be going to* (or *gonna*). Each of these has a different meaning.

- (5) a. The train leaves at 5.27 pm *(but will leave at least 20 min. later).
b. The train will leave at 5.27 pm *(but will leave at least 20 min. later).
c. The train is scheduled to leave at 5.27 pm (but will leave at least 20 min. later).
- (6) (Google) Tomorrow I am sleeping over at Samantha's house.
- (7) a. #Harry moves to Philadelphia.
b. Next Tuesday, Harry moves to Philadelphia.

The plot thickens ...

- (8) a. The sun rises at 5.50 a.m.
b. ?The sun will rise at 5.50 a.m.
- (9) a. *It rains tomorrow.
b. It will rain tomorrow.
- (10) a. John flies to Chicago tomorrow.
b. John is flying to Chicago tomorrow.
c. John will fly to Chicago tomorrow.
d. John is going to fly to Chicago tomorrow.

... and thickens ...

Note: Futurate progressive *be going* ≠ periphrastic future *be going to*!

- (11) a. *I go to Chicago unless my boss forbids me.
b. (Google) I am going unless some unknown demand stops me.
c. (Google) I will go unless there is severe or dangerous weather.
- (12) a. *I fly to Chicago if my boss asks me.
b. ?*I am going if you go.
c. (Google) I am going if my health allows me/if I am able.
d. (Google) Barak said to Deborah, "I will go if you go with me. I will not go if you don't go with me."
- (13) If/When you go out/*will go out in the rain, you will get wet.
- (14) a. *If it'll rain, you should take your umbrella.
b. If it's going to rain, you should take your umbrella.

Ad (12-b): Google did not find any instances of 'I am going if you go', or indeed any instance 'I am going if (*event phrase*)'. The examples found were all of the kind illustrated in (12-c).

Promises, promises ...

- (15) a. I will/am going to fly to Chicago.
b. I was going to fly to Chicago, but my boss forbade me.
- (16) (Comrie)
a. Bill will throw himself off the cliff.
b. Bill is going to throw himself off the cliff.
- (17) a. Pieper was going to be Chief Executive Officer of Philips in 2 years time.
b. (Google) Tony Blair in 1997: 'I am going to be a lot more radical in government than people think'.

Meaning of English future tense involves (at least) two dimensions

1. events viewed

(a) *per se*, ie. as space-time chunks

(b) as goals, to be achieved by executing a plan

2. the degree of certainty of the event, or of the desired outcome/goal

Present tense: space-time chunk, certain

Will: expresses intention, certain that it will be fulfilled

Gonna: expresses intention, not certain that it will be fulfilled

Grammatical aspect 1: the English progressive

The following small narratives (lifted from Google) make perfect sense:

- (18) a. By 1887, Adelicia *was building* a house in Washington and had sold Belmont to a land development company. Later that year, while on a shopping trip to New York, Adelicia contracted pneumonia and died in The Fifth Avenue Hotel.
- b. Carlos Thompson *was building* a house with neighbors one day in 1984 when a wooden beam fell and landed on his foot. Since that fateful day, Thompson's life has never been the same.

The following would have quite different implications:

- (19) *By 1887, Adelicia *built* a house . . .

Meaning of the English progressive

- little difference in meaning (if any) between ‘Mary ran’ and ‘Mary was running’
- but ‘Adelicia *built* a house’ implies she finished it, unlike Adelicia *was building* a house’
- ‘imperfective paradox’: in the meaning of ‘build a house’ a *goal* is implied; so how can its occurrence be denied in (18-a) and (18-b)?

Davidson/Parsons analysis

- verbs denote events—formally: interpretation of verb has event variable
- ‘event language’ has temporal predicates: $Cul(e, t)$, $Hold(e, t)$, and predicates for thematic roles: $Ag(e, x)$, $Obj(e, x)$
- ‘Mary drew a circle’ becomes
- $\exists e, x, t(circle(x) \wedge draw(e) \wedge Ag(e, m) \wedge Obj(e, x) \wedge \underline{Cul(e, t)} \wedge t < now)$
- ‘Mary was drawing a circle’ becomes
- $\exists e, x, t(circle(x) \wedge draw(e) \wedge Ag(e, m) \wedge Obj(e, x) \wedge \underline{Hold(e, t)} \wedge t < now)$
- this relies on intuitive understanding of the special predicates – one would like to know how these are represented cognitively, i.e. computationally
- more importantly: what is the x in $circle(x)$?

Possible worlds analyses

‘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.’ (De Swart)

Dowty (in *Word meaning and Montague grammar*) claims that the following are equivalent

1. ‘Mary is drawing a circle’ is true in the actual world
2. ‘Mary will have drawn a circle’ is true in all so-called ‘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’.

But what is the computational and cognitive significance of ‘inertia worlds’?

Grammatical aspect 2: the English perfect

The present perfect has present relevance

(20) a.*I have lost my watch but I have found it again.

b.I lost my watch but I (have) found it again.

Steedman: 'The past tense, unlike the perfect, demands that the past reference point be explicitly established, either by a modifier, such as a *when* clause, or by the preceding discourse. Thus (21-a) below, is inappropriate as the first utterance of the discourse, except that the reader *accommodates* a temporal referent, in Lewis' sense of the term – that is, *introduces* an appropriate individual in the database, as one often must at the beginning of a modern novel. But (21-b) is appropriate, on the assumption that the hearer can identify the time in the *when* clause:'

(21) a.*Chapman breathed a sigh of relief.

b.When Nixon was elected, Chapman breathed a sigh of relief.

The English perfect: between tense and aspect

Episode: 'who did what to whom, where, when and why; and what happened next'. After Reichenbach, one distinguishes between the *speech* time S , i.e. the time at which the sentence is uttered, the *event* time E and the *reference* time R , which takes care of 'what happened next'.

Past Perfect	Simple Past	Present Perfect	Future Perfect
<i>I had seen Joe</i>	<i>I saw Joe</i>	<i>I have seen Joe</i>	<i>I will have seen Joe</i>
$\overline{E \quad R \quad S} \rightarrow$	$\overline{E, R \quad S} \rightarrow$	$\overline{E \quad R, S} \rightarrow$	$\overline{S \quad E \quad R} \rightarrow$

Note that unlike the simple tenses, the perfect is future-oriented, in the sense that the reference time comes later than the event time. This determines the event order in

(22) I had seen Joe. I now related the content of our conversation to Bill.

Kalam: a language with lexical aspect almost formalized

Lexical aspect: 'internal temporal constitution of an event described by a verb or verb phrase'. One can distinguish some 4 classes here: states, activities, achievements, accomplishments.

Pawley (1987) on Kalam, which has verbs corresponding to abstract aspectual categories such as *state*, *goal*, *activity* ...

(23) wdn ñng- *see*
eye Internal state

(24) gos ñng- *think*
mind Internal state

(25) wsn ñng- *dream*
sleep Internal state

(26) d ñng- *feel (by touching)*
touch Internal state

Kalam: a language with lexical aspect almost formalized

The verb *d-* (seen translated as ‘touch’ in (26)) has the general meaning of ‘acting on an object without changing it’ and can be translated in context by such verbs as *get, hold, handle, grasp, capture, possess, finish...*

(27) *d ap bring*
get come

(28) *am d ap fetch*
go get come

(29) *B tw dp*
man axe took-he
The man took hold of an axe.

Kalam: a language with lexical aspect almost formalized

When the emphasis is on the actions themselves, a different verb is used: *g-*. Pawley translates this verb with such glosses as *do, act, make work, create, function* and *cause*. For example, the English VP *build a house* would be translated as:

(30) kotp g-
house create

while 'feeling hungry' also uses the same verb.

(31) yp ywan gp
me hunger it-acts
I feel hungry

Kalam: a language with lexical aspect almost formalized

pk- functions as a general verb for when objects are changed (as opposed to *d-*):

(32) kmn pk
game kill
kill game

(33) mon pk
firewood break
cut firewood

Kalam and the fine-structure of events

Kalam: With many intentional activities, event must be described in segmented fashion.

Kalam speakers rely on a schematic event sequence to describe complex events. For example, in reporting intentional actions, the schema is as follows:

1. Movement to Scene of First Action
2. Action (possibly iterated)
3. Movement from Scene of 2 to Present or Final Scene
4. Action(s) at Present or Final Scene (can be iterated)

(34) am/ mon pk/ d ap/ ay-
go/ wood strike/ get come/ put
gather firewood

Event structure explicitly coded in Kalam

In Kalam, to say the mono-clausal accomplishment *I am building a house for you* requires three separate clauses:

(35) kotp gy, np ñnp gspyn

house having-built you intending-to-give I-am-doing

I am building a house for you

(36) Recall

kotp g-:house create

g- : generic action

Note the separate clauses for the finished house (goal to be achieved in the future) and the building in progress (now) – this provides a clue to a language-independent cognitive representation of lexical expressions such as ‘build a house’.

A fundamental opposition in language: perfective and imperfective

- occurs in several areas of language: aspect, nominalization
- ‘*aspects* are different ways of viewing the internal temporal constituency of a situation’
- *nominalization*: the processes which turn verb phrases into nouns (or noun phrases)
- *perfective*: lack of explicit reference to the internal temporal constituency of a situation, viewing a situation from the outside
- *imperfective*: explicit reference to the internal temporal constituency of a situation, viewing a situation from the inside

Nominalization: perfect nominals (correct examples from Google)

- (37) a. The singing of the song
b. The saving of us (Stevenson)
c. Deidre Haren begins the play with her beautiful singing of 'A Poultry Tale'
d. the Passover slaying of Egypt's firstborn
e. It may be more difficult to imagine the aria's place in the drama or story of the whole opera when listening to *a recording of just that aria*.
f. On account of his deliberate buying up of stocks
g. *the Passover slaying Egypt's firstborn
h. *quickly cooking of the dinner.
i. *having cooked of the dinner.
j. *being able to cook of the dinner.
k. *not revealing of the secret.

Nominalization: imperfect nominals (correct examples from Google)

- (38) a. *The singing the song.
b. *beautiful singing the song.
c. He also plays Johny Seoighe after *singing the song beautifully*.
d. quickly cooking the dinner.
e. On account of deliberately buying up stocks
f. *Having cooked the dinner* in our house for a number of years now...
g. Lisa gets Martin tucked into bed. Martin tells her he is sorry for *not being able to cook the dinner* he had planned for her.
h. *Never having cooked sausage meat* before this was quite a gamble.
i. The Catholic Church has been criticised for *not revealing the extent* of its possible involvement or complicity in the Holocaust
...

What have we learnt about events from tense?

- (French past tenses:) the structure of the set of events is constructed from e.g. causal information, not just order of sentences; in a sense temporal relations are derived
- (French past tenses): Imparfait and Passé Simple refer to different kinds of events, or perhaps better: different perspectives on events – a matter of representation, not ontology
- (English) future tense shows evidence of linguistic encoding of planning (expressed by periphrasis) toward a goal (expressed by VP)

What have we learnt about events from aspect?

- the *perspective* on events is important (e.g. as perfective or imperfective, but also ingressive ...)
- progressive aspect highlights goal–plan organization
- (English) perfect can be seen as a ‘forward looking aspect’: it influences ‘what happens next’
- nominalization shows that events can be distinguished according to the operations which are applicable to them
- there seem to be different strategies languages can use in describing events
 - finer-grained segmentation as in many Austronesian languages
 - metonymic strategy (as in English) where one scene of the event is taken to stand for the whole; e.g. *load boxes* can be seen as shorthand for *pick up boxes, put them on the truck, keep doing so until truck is full*

Implications for encoding of lexical meaning

Croft(1998)

”The observations in this section lead us to two conclusions. The first is that the semantic representation of an event denoted by a verb must be complex, involving not only what we normally think of as ” what the verb means” but also the event leading up to it (the run-up process or preceding state) and the event leading out of it (resulting state or, in the case of cyclic achievements, the return to the original state). Hence we must be able to specify what part of the event is actually described in the sentence and what part is in the background”

Summary and outlook

- ‘Causality and planning provide the medium through which the past is glued to the present and the future.’ (Trabasso and Stein)
- ‘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, *Temporality*)
- ‘Il y a d’autres intuitions de base qui ont été évacuées par la logique, ainsi la distinction essentielle entre *parfait* et *imparfait*, distinction rendu en français par le choix des temps, en russe par le changement de verbe. Cette nuance n’existe pas dans le monde vériste.’ (Girard, *La logique comme géométrie du cognitif*)

Compare: Russell instants for the same situation

EXERCISE. Again let

$$E = \{a, b, c, d, e\}$$

with

$$P(a, c), P(a, e), P(a, d), P(b, e), P(c, e); O(a, b), O(b, c), O(b, d), O(d, e)$$

Show that the Russell instants are:

$$1 = \{a, b\}, 2 = \{b, c, d\}, 3 = \{d, e\},$$

and that we have the following correspondence of events to intervals:

$$a = [1], c = [2], e = [3], b = [1, 2], d = [2, 3]$$