

EVENT-BASED SEMANTICS

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Abstract: Semantic theories employing quantification of hidden variables ranging over events have been applied to a wide variety of linguistic problems, including the semantics of adverbial adjuncts, perception reports, thematic relations, nominalization, and Aktionsart. Event-based semantic theories differ in their representation of argument structure, and in their analysis of which predicates have event arguments.

The notion of **events** may be used in semantic theory in a wide variety of ways, but the term **event-based semantics** normally refers to semantic analyses which incorporate or adapt the proposal of Davidson (1967) that certain predicates take an implicit variable over events as an argument. In Davidson's original proposal, this event argument is accommodated by analyzing the predicate as having one more argument place than is assumed in more traditional analyses. The event variable is existentially quantified, with the result that Sentence (1)a. is assigned a logical structure like (1)b. rather than the more traditional (1)c.:

- (1) a. Jones buttered the toast.
b. $\exists e$ butter(Jones, the toast, e)
c. butter(Jones, the toast)

Thus *butter* is analyzed as expressing a three-place relation between an individual who butters, an object which gets buttered, and a buttering event; and the sentence is analyzed as asserting that such an event exists.

The initial motivation for this proposal is that it provides a way to analyze adjuncts such as locative, temporal and instrumental adverbial phrases. These are also treated as predicates of events—or more specifically as predicates of the same event as the verb. Each adjunct gives rise to its own clause in logical structure, and these are combined with the clause corresponding to the verb and its arguments by ordinary propositional conjunction. The existential quantifier binding the event variable takes scope over the whole structure, so that Sentence (2)a. is assigned a logical structure like (2)b., for example:

- (2) a. Jones buttered the toast with a knife in the bathroom at midnight.
b. $\exists e$ [butter(Jones, the toast, e) & with(e , a knife) & in(e , the bathroom) & at(e ,
midnight)]

This approach has an advantage over one in which the adverbials are treated as arguments of the verb, so that *butter* expresses a five-place relation as in (3):

(3) butter(Jones, the toast, a knife, the bathroom, midnight)

If we adopt a formula like (3), but continue to represent *Jones buttered the toast* as in (1)c., with a two-place relation, we would seem to deny that *butter* expresses the same meaning in both sentences, and claim instead that it is ambiguous. Nor is this a simple two-way ambiguity; *butter* will have to express different relations in each of the sentences in (4)

- (4)
- a. Jones buttered the toast with a knife.
 - b. Jones buttered the toast in the bathroom.
 - c. Jones buttered the toast at midnight.
 - d. Jones buttered the toast with a knife at midnight.
 - e. Jones buttered the toast with a knife in the bathroom.
 - f. Jones buttered the toast at midnight in the bathroom.

This massive ambiguity seems quite undesirable.

We might try to avoid the ambiguity by claiming that *butter* always expresses a five-place predicate, and that in examples in which fewer than five arguments appear overtly, the missing argument places are filled by implicit existentially bound variables. However, this strategy ignores the fact that additional adverbials can always be added, with no limit on the number; as long as adverbials are analyzed as arguments, one cannot specify a fixed number of argument places for the verb, even if one allows for implicit arguments.

These problems are avoided completely under Davidson's proposal; *butter* is consistently analyzed as a three place predicate. An unlimited number of adverbials may be added because these combine with the verb by ordinary conjunction, and not by filling argument places.

A second advantage to this analysis is that it correctly captures the fact that Sentence (2)a. entails all the examples in (4) as well as (1)a., that (4)d. entails (4)a, (4)c. and (1)a., etc. Without some extra stipulation, these entailment relations do not fall out of an analysis in which adverbials are arguments to the verb. Extra stipulations are also required to capture these entailment relations in other alternative approaches to the semantics of adverbials, such as an approach in which they are treated as higher-order predicates taking verb intensions as arguments, as in (5):

(5) [at-midnight(^in-the-bathroom(^with-a-knife(^butter)))](Jones, the toast)

Davidson limited his original proposal to "action sentences," and was explicit that it should not be applied to sentences such as $2 + 3 = 5$. Nonetheless, it is sometimes assumed that a similar analysis should be extended to some or all stative sentences (see especially Parsons (1987/1988, 1990). In analyses employing both states and events, the term **eventuality** (introduced by Bach 1986) is often used for the general category covering both.

The issue of which predicates have a hidden argument place for an eventuality and which do not is addressed in a well-known proposal by Kratzer (1995); see also Higginbotham (1983), Fernald (2000). Kratzer suggests that **individual-level** predicates do not have such an argument place, and that **stage-level** predicates do. This position is supported by the following pattern of

acceptability:

- (6)
- a. When Mary speaks French, she speaks it well.
 - b. *When Mary knows French, she knows it well.
 - c. When a Moroccan speaks French, she speaks it well.
 - d. When a Moroccan knows French, she knows it well.

Assuming that indefinites contribute free variables to semantic representation (as in File Change Semantics or Discourse Representation Theory), and that *when*-clauses serve to restrict the domain of an implicit generic quantifier which can bind these variables, the acceptability of (6)c.-d. is expected. The unacceptability of (6)b. follows from a simple prohibition on vacuous quantification: the *when*-clause contains no free variables for the generic quantifier to bind. Why then is (6)a. acceptable, since it does not contain any indefinite noun phrases either? Kratzer suggests it is because the stage-level predicate *speak* contributes a free Davidsonian event variable, while the individual-level predicate *know* does not.

Another area in which event variables have proven useful is in the semantics of **perception reports** (Higginbotham 1983, Vlach 1983, Parsons 1990). Sentences like (7)a. have been cited in support of thoroughgoing revisions to semantic theory of the kind adopted in Situation Semantics; but if we analyze this sentence as meaning that there is an event *e* of Mary's leaving, and an event *e'* of John's seeing *e*, we may assign it the logical structure in (7)b., and obtain a reasonable analysis without using resources beyond those of ordinary first-order logic:

- (7) a. John sees Mary leave.
b. $\exists e[\text{leave}(\text{Mary}, e) \ \& \ \exists e' \text{see}(\text{John}, e, e')]$

Davidson's technique of representing adjunct phrases as expressing separate logical clauses raises the possibility that major arguments of the verb such as the subject, direct object, etc., might be treated in the same way. Davidson himself rejected this sort of extension, but a variant of it has been very popular in later work. Often termed the **Neo-Davidsonian** approach, this style of analysis treats the verb as a one-place predicate of eventualities; the subject, direct object, etc. do not serve directly as arguments to the verb, but instead stand in **thematic relations** to an event which fills the verb's sole argument place. A sentence such as (8)a. thus receives a logical structure like that in (8)b.:

- (8) a. Brutus stabbed Caesar.
b. $\exists e[\text{stab}(e) \ \& \ \text{agent}(e, \text{Brutus}) \ \& \ \text{patient}(e, \text{Caesar})]$

This approach to thematic relations appears first to have been proposed by Parsons (1980, 1985, 1990); see also Carlson (1984), Krifka (1989, 1992). Note that this style of analysis requires an eventuality argument for all predicates that assign thematic roles, not just action predicates or stage-level predicates—at least on the assumption that thematic roles are represented in a uniform fashion for all predicates that assign them.

One advantage of this approach is that it allows a nice analysis of “semantically optional” arguments: The direct object of *stab* may be omitted, as in (9)a.; to give a logical form, we simply

omit the clause for the corresponding thematic relation, as in (9)b.:

- (9) a. Brutus stabbed.
b. $\exists e[\text{stab}(e) \ \& \ \text{agent}(e, \text{Brutus})]$

In a more conventional analysis, we might represent this sentence as in (10)a.:

- (10) a. $\exists x \text{stab}(\text{Brutus}, x)$
b. $\text{stab}(\text{Brutus})$

But as Parsons points out, this entails that Brutus stabbed something, while (9)a. does not: Brutus could have stabbed and missed. If we try to avoid this entailment by representing (9)a. as (10)b., we treat *stab* as ambiguous, expressing a different meaning in (9)a. than it does in (8)a.; but this is avoided in the Neo-Davidsonian analysis.

The idea that verbs are predicates of events has also been exploited in the analysis of certain types of **nominalization** (Higginbotham 1985, Parsons 1990). Combining the Neo-Davidsonian analysis with an assumption that nominals may express the same predicate of events as the verbs they derive from makes it possible to account for the validity of the argument in (11)a. in a very straightforward fashion. This argument is represented as in (11)b., which is licensed by standard principles of first-order logic:

- (11) a. In every burning, oxygen is consumed.

Agatha burned the wood.

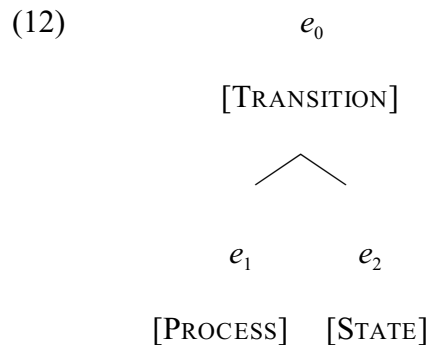
Therefore, oxygen was consumed.

b. $\forall e[\text{burn}(e) \rightarrow \exists e' [\text{consume}(e') \ \& \ \text{theme}(e', \text{oxygen}) \ \& \ \text{in}(e, e')]]$

$\exists e[\text{burn}(e) \ \& \ \text{agent}(e, \text{Agatha}) \ \& \ \text{patient}(e, \text{the wood})]$

$\exists e' [\text{consume}(e') \ \& \ \text{theme}(e', \text{oxygen})]$

Event arguments have also been used extensively in the analysis of **Aktionsart**. One line of research in this area, exemplified by Pustejovsky (1991, 1995), Grimshaw (1990), represents events of certain complex types as structurally composed of events of simpler types. For example, an accomplishment predicate such as *build* may be associated with events of the structure illustrated in (12):



Here e_1 represents the building process itself, while e_2 represents the resultant state of something having been built. As a telic predicate, *build* involves reference not just to the building process, but to its culmination in the transition to a result state, represented by e_0 .

A rather different approach to the event-theoretic representation of Aktionsart is developed by Krifka (1989, 1992). Here, a “sum” operation is assumed on events, so that for any two events e_1, e_2 , a complex event $e_1 \sqcup e_2$ consisting of them is assumed to exist. A part/whole relation is definable in terms of the sum operation: $e_1 \sqsubseteq e_2$ (“ e_1 is a part of e_2 ”) iff $e_2 = e_1 \sqcup e_2$. Predicates are assumed to denote sets of events, allowing aspectual classes to be defined in terms of closure conditions on these sets. **Cumulative** predicates are those denoting sets which are closed under the sum operation:

$$(13) \quad \text{CUM}(P) \leftrightarrow \forall x, y [[P(x) \ \& \ P(y)] \rightarrow P(x \sqcup y)]$$

For example, if x is a walking event, and y is a walking event, their combination is also a walking event. In contrast, **quantized** predicates denotes sets from which proper parts of their members are excluded:

$$(14) \quad \text{QUA}(P) \leftrightarrow \forall x, y [[P(x) \ \& \ P(y)] \rightarrow x \neq y]$$

For example, if x is an event of drinking a glass of wine, and y is also a glass of drinking a glass of wine, x cannot be a proper part of y . Cumulative and quantized predicates of events correspond roughly to the familiar categories of **atelic** and **telic** predicates, respectively. However, by assuming a sum operation and corresponding part/whole relation on individuals, and not just events, it is possible to apply these concepts to predicates of individuals as well. For example, if x is wine and y is wine, their sum must also be wine, establishing *wine* as a cumulative predicate; if x is a glass of wine and y is a glass of wine, x may not be a proper part of y , establishing *glass of*

wine as a quantized predicate. The status of a verb's arguments as cumulative or quantized often affects the aspectual category of the verb phrase or sentence; hence (15)a. is cumulative while (15)b. is quantized:

- (15) a. John drank wine.
b. John drank a glass of wine.

Assuming a Neo-Davidsonian representation of thematic relations, Krifka explores the mathematical properties such relations must have to give this effect.

Event-based semantics has also been fruitfully applied to a wide variety of other problems, of which space limitations prevent a discussion here: plurality (Lasnik 1990, 1995; Schein 1993; Landman 2000), temporal anaphora and narrative progression (Hinrichs 1986, Partee 1984), cognate objects (Mittwoch 1998), adjectives (Larson 1998), and many others. There is also a large philosophical literature on events, much of which relates directly to Davidsonian-style event-based semantics; see Davidson (1980), LePore and McLaughlin (1985), Higginbotham et al. (2000) and the references cited there.

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Keywords

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Adjuncts

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Nominalization

Plurality

Aktionsart

Biography

Peter Laserson completed his Ph.D. in linguistics at the Ohio State University in 1988. He has taught at the University of Texas at Austin, the University of California – Santa Cruz, and the University of Rochester; he is currently Associate Professor of Linguistics at the University of Illinois at Urbana-Champaign. He is the author of *A Semantics for Groups and Events* (Garland Publishing, 1990); *Plurality, Conjunction and Events* (Kluwer Academic Publishers, 1995); and several shorter articles.

Event-based semantic theories differ in their representation of argument structure and in their analysis of which predicates have event arguments. Do you want to read the rest of this chapter? Request full-text. In this paper we examine the role of events within a theory of lexical semantics. We propose a configurational theory of event structure and examine how it contributes to a lexical semantic theory for natural language. A Categorical Semantics of Event-based Architectures Jos  Luiz Fiadeiro¹ and Ant nia Lopes² 1. 2. Department of Computer Science, University of Leicester University Road, Leicester LE1 7RH, UK . Event-based interactions are now established as a major paradigm for large-scale distributed applications (e.g. [2,4,7,13,19]). In this paradigm, components may declare their interest in being notified when certain events are published by other components of the system. Semantics is the linguistic and philosophical study of meaning in language, programming languages, formal logic, and semiotics. It is concerned with the relationship between signifiers—like words, phrases, signs, and symbols—and what they stand for in reality, their denotation. In the international scientific vocabulary semantics is also called semasiology. The word semantics was first used by Michel Br al, a French philologist. It denotes a range of ideas—from the popular to the highly technical. It