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Events, Times and Worlds – An LF Architecture

In this paper we develop a theory of compositional interpretation that extends a Heim & Kratzer (1998) style semantics to intensional phenomena. We include the semantics of tense, aspect and modality in one integrated system. The system represents time and world variables in the Logical Form. This allows us a transparent discussion of such implicit variables in the nominal domain, which at this stage reveals important open questions for semantic theory.

1. Introduction

This paper is a development of our lecture notes for a jointly taught course on Event Semantics at the Universität Tübingen in 2006. Event semantics is commonly employed for the analysis of many interesting semantic phenomena (like pluractionality, nominalization, adverbial modification and so on). At the same time, it is not part of the prominent introductions to compositional semantics (like Dowty, Wall & Peters (1981), Gamut (1991), Heim & Kratzer (1998) and others). We noticed when teaching the course that bringing standard assumptions in compositional semantics together with an event framework raises non-trivial questions. The aim of this paper is to offer one possible way of integrating standard composition theory with event semantics. We were encouraged to produce a worked-out version of the course by a certain interest in the unpublished lecture notes, indicating that other semantics, too, found composition with events challenging.

We focus on the interaction of an event semantics for the VP with operators higher in the structure, in particular tense and modal operators. We provide not so much a discussion of the semantics of temporal and modal phenomena as a discussion of how to compose all the semantic ingredients in one consistent theory of the syntax/semantics interface. The architecture we present is couched in a Heim & Kratzer style framework which is extensional and representational. This means that world, time and event variables (we also call them implicit variables) show up in the object language: the syntax of LF. The choice of framework is guided by observations by Fodor (1970) and Enç (1981), a.o., discussed e.g. in von Stechow & Heim (2010), Percus

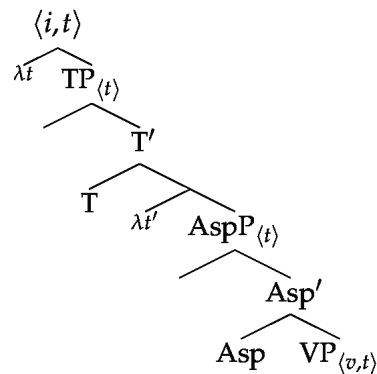
(2000) and Keshet (2011), regarding choice of values for such implicit variables (see also Rapp (2013) and Rapp & von Stechow (this volume)). Generally speaking, the observation is that assignment of values to implicit variables in NPs enjoys a degree of freedom while the assignment of values to implicit variables in the verbal domain does not. This point, and hence the LF architecture we present, is important for the overarching topic of this volume, situation arguments in NP. It may turn out that ultimately a representational framework like the one presented in this article is an overkill, but before we decide that, we ought to see what it would look like. This is what we work out here.

Section 2 introduces the event argument into the VP and combines the VP with aspect and tense semantics higher up in the tree, following suggestions by von Stechow (2009) and others. Section 3 develops a parallel combination of the VP with modality, based on an ontology by Kratzer (1989). The resulting overall sentence architecture is illustrated in section 4, as is some of the motivation for it from the Enç, Fodor and Percus examples. In section 5 we discuss some important related issues like the analysis of negation and quantifiers, standard strengths of an event framework like nominalization and so on. Conclusions are drawn in section 6.

2. Events and Times

In this section we build up a clause structure along the hierarchy indicated in (1), following Paslawska & von Stechow (2003):

- (1) $[\langle i, t \rangle \lambda t [\text{TP tense } \lambda t' [\langle \rangle \text{ AspP Asp } [\langle v, t \rangle \text{ VP }]]]]$



We explain the structure bottom up.

2.1. Event Arguments of Verbs

Davidson (1967) argues that verbal predicates have event arguments. The meaning of (2a) is the same as (3), namely (2b), and (3) transparently talks about an event.

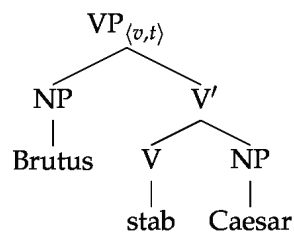
- (2) a. Brutus stabbed Cesar.
 b. "There was an event e which is a stabbing of Cesar by Brutus."
 (3) A stabbing of Cesar by Brutus occurred.

We add events to our inventory of denotation domains and of semantic types ((4) is preliminary; an overview of the final version of the interpretation component is given in the appendix):

- (4) a. semantic types:
 e , t and v are types.
 If a, b , are types then $\langle a, b \rangle$ is a type.
 Nothing else is a type.
 b. $\langle v \rangle$ is the type of eventualities.

How are events introduced into the semantics? Following Davidson, we assume that lexical verbs have an event argument slot. Different lexical entries and correspondingly different internal compositions of the VP have been envisioned in the literature. We follow Davidson, who simply adds the event argument slot to the functional structure of the verb. Our simple example can be composed as follows:

- (5) a. [VP $\langle v, t \rangle$ Brutus [stab Cesar]]



- b. $[[\text{stab}]] = \lambda y. \lambda x. \lambda e. \text{stab}(e)(y)(x)$ type $\langle e, \langle e, \langle v, t \rangle \rangle \rangle$
 c. $\lambda e. \text{stab}(e)(C)(B)$
 "e is a stabbing of Cesar by Brutus."

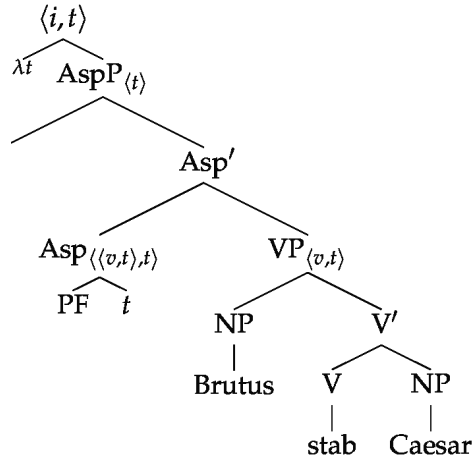
(5) integrates events into a Heim & Kratzer (1998) framework. We have made the event argument the last argument of the verb. The VP then expresses a property of events. See below for some motivation of this implementation of Davidson.

Other ways of integrating events into the semantics have been proposed. Parsons (1990) relates events to their participants via thematic roles. Kratzer (1994, forthcoming) relates the subject argument to the event via a thematic role located in a separate syntactic head *v*. We will not go into this discussion here. The alternative systems can be thought of as different options for the internal structure of what we call VP in (5). See von Stechow & Sternefeld (1988), von Stechow (1991a) and Sternefeld (2006) on the (non-) role of thematic roles for this kind of syntax/semantics interface, and Kratzer (1994, forthcoming) for her specific theory. Davidson's is the simplest view of what happens inside VP, and VP's internal make-up is not our topic in this paper. What is important for our purposes is that the VP denotes a description of events, type $\langle v, t \rangle$. This is the input to further composition.

2.2. Aspect

Aspect existentially binds the event argument and locates the event relative to a time interval (Klein (1994)). It thus gets us from events to times. The default aspectual operator is what is called perfective in Klein (1994); it locates the run time of an event within a time interval. An analysis of our example that includes the aspect layer is given below. $\langle i \rangle$ is the type of times, to be added as a basic type to the inventory in (4). This semantics for the perfective aspect goes back to Krifka (1989).

- (6) a. Brutus stabbed Cesar.
 b. $[\langle i, t \rangle \lambda t [\langle v, t \rangle \text{AspP} [\text{PF } t] [\langle v, t \rangle \text{VP Brutus} [\text{stab Cesar}]]]]$



- c. $\lambda t. \exists e[\tau(e) \subseteq t \ \& \ \text{stab}(e)(C)(B)]$
 "there is an event whose run time is included in t which is a stabbing of Cesar by Brutus."

- (7) Perfective aspect:
 $[[\text{PF}]] = \lambda t. \lambda P. \exists e[\tau(e) \subseteq t \ \& \ P(e)] \quad \langle i, \langle \langle v, t \rangle, t \rangle \rangle$

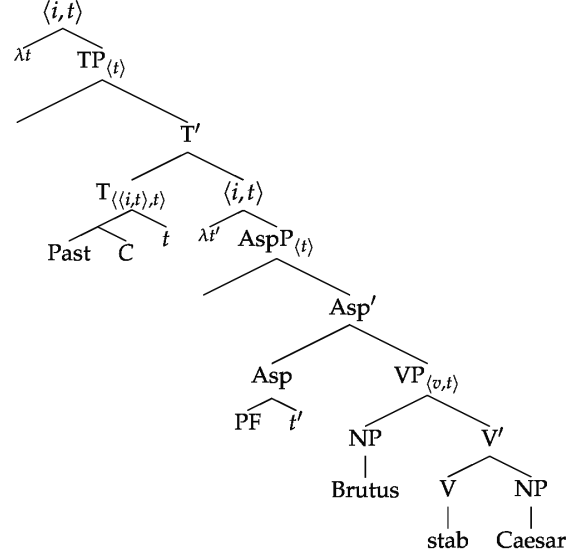
By contrast, there doesn't seem to be the one semantics of 'non-perfective aspects' (see e.g. Paslawska & von Stechow (2003)). We comment on the English progressive below, after we have introduced intensional operators.

In (6b), the time argument slot of the perfective is saturated immediately by a covert time variable. All variables show up in the syntax of LF, including the implicit ones. Higher in the tree, we abstract over the time variable. Abstraction is represented in the LF structure (indicating the application of Heim & Kratzer's rule Predicate Abstraction). We assume that abstraction over types other than $\langle e \rangle$ may be inserted in the LFs to adjust semantic types.

2.3. Tense and Times

We are now ready to move on to the TP layer in (1) and talk about the semantics of temporal operators like Past. Below is an analysis of our example that includes tense information on top of the structure that we have already discussed.

- (7) $[\langle i, t \rangle \lambda t [\text{TP} [\text{Past C } t] [\langle i, t \rangle \lambda t' [\text{AspP} [\text{PF } t'] [\langle v, t \rangle \text{ Brutus } [\text{stab Caesar }]]]]]]$



$$(8) \quad [[\text{Past}]] = \lambda C. \lambda t. \lambda i. \exists t' [t' < t \ \& \ C(t') \ \& \ I(t')] \quad \langle \langle i, t \rangle, \langle i, \langle \langle i, t \rangle, t \rangle \rangle \rangle$$

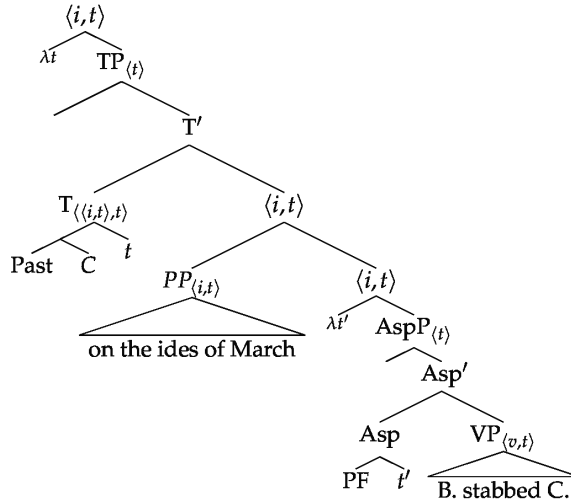
$$(9) \quad \lambda t. \exists t' [t' < t \ \& \ C(t') \ \& \ \exists e [\tau(e) \subseteq t' \ \& \ \text{stab}(e)(C)(B)]] \quad \langle i, t \rangle$$

"there is a relevant time t' before t such that there is an event whose run time is included in t' which is a stabbing of Cesar by Brutus."

Some comments: We assume that when a temporal proposition (type $\langle i, t \rangle$) is asserted at a certain time - let's call this time t_{now} -, this is understood to claim that the proposition is true at t_{now} . In the example, asserting (2) today claims that a stabbing of Cesar by Brutus occurred before now. The time that ends up being t_{now} is the first argument of the Past operator. The operator is an existential quantifier (see e.g. Kusumotu (2005), von Stechow (2009) for recent versions). Like other quantifiers, it is given a contextual restriction. Von Fintel & Heim (2010) discuss how Barbara Partee's (1973) famous example "I didn't turn the stove off" can be reconciled with such an existential semantics.

Under such an analysis, the English present tense is simply vacuous. Of course there is a lot more to be said about temporal operators; see e.g. von Stechow (2009), Kusumotu (2005), von Fintel & Heim (2010) as well as references therein. We confine ourselves to giving an example with a temporal modifier below, to illustrate how the framework determines via semantic type the location of the modifier. It combines intersectively above the aspect node.

- (10) a. Brutus stabbed Caesar on the Ides of March 44 B.C.
 b. $\lambda t_{\langle i,t \rangle} [\text{Past } C \ t]_{\langle i,t \rangle} [\text{on the Ides of M. 44B.C. } \lambda t' [\text{PF } t']_{\langle v,t \rangle} [\text{B. stab C.}]]]$



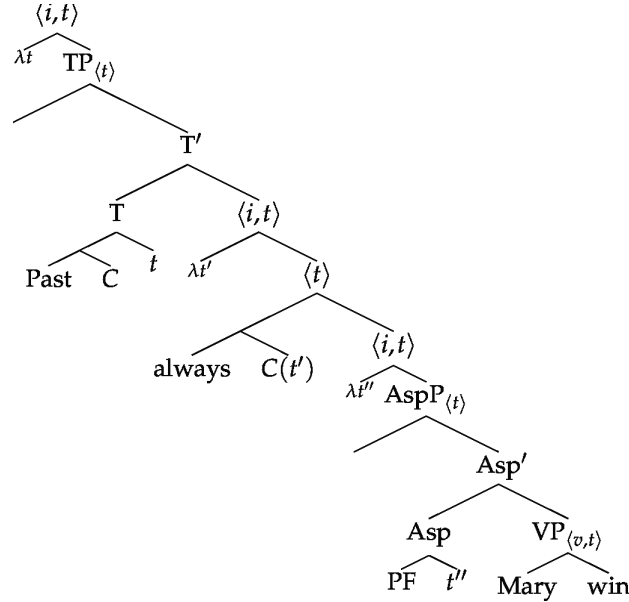
- c. $\lambda t. \exists t' < t \ \& \ C(t) \ \& \ t' \subseteq \text{March 15th 44 BC} \ \& \ \exists e [\tau(e) \subseteq t' \ \& \ \text{stab}(e)(C)(B)]]$

- (11) $[\text{on the Ides of March 44 B.C.}] = \lambda t. t \subseteq \text{March 15th 44 B.C.} \quad \langle i, t \rangle$

And since it will become relevant below, we also illustrate how an adverbial temporal quantifier would work in this system (see e.g. von Stechow (1991b) and von Fintel (1994) for more discussion of such quantifiers). (12) is the example, its LF is (13) and the semantics in (14). (12) could be uttered for example in a situation in which we played many rounds of a game. The adverb would then quantify over the rounds, that is the relevant subparts of the relevant past time. A covert quantifier domain variable *C* models this.

- (12) Mary always won.

- (13) $[\langle i,t \rangle \lambda t \text{ Past } C' \ t]_{\langle i,t \rangle} [\lambda t' [\text{always } C(t)]_{\langle i,t \rangle} \lambda t'' [\text{AspP } \langle v,t \rangle [\text{PF } t'']]_{\langle v,t \rangle} [\text{Mary win}]]]$



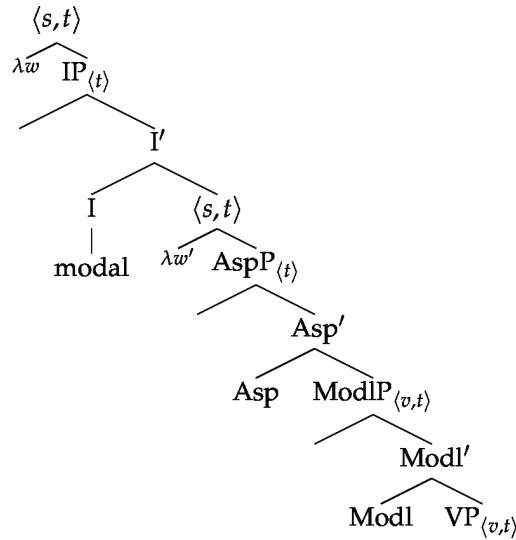
- (14) a. $[[\text{always}]] = \lambda q_{\langle i,t \rangle} . \lambda p_{\langle i,t \rangle} . \forall t' [q(t') \rightarrow p(t')]$
 b. $\lambda t . \exists t' [t' < t \ \& \ C(t') \ \& \ \forall t'' [C(t')(t'') \rightarrow \exists e [\tau(e) \subseteq t'' \ \& \ \text{win}(e)(\text{Mary})]]]$
 "There is a past time t' such that all relevant times are such that they include an event of Mary winning." e.g.: All times that are relevant subintervals of t_{Game} include an event of Mary winning.

The output of our semantics at this point is a temporal proposition type $\langle i,t \rangle$. Clearly, we are still missing intensionality and type $\langle s \rangle$.

3. Events and Worlds

This section considers the world parameter in the semantics and the operators that work on it. Our semantics is modeled after the reasonably established theory for times and temporal operators, and follows standard assumptions about modal operators. For simplicity, we leave out the tense layer in this section. This will be remedied in section 4 when times and worlds are combined. The clause structure is developed to (15) in this section. We add type $\langle s \rangle$ to the inventory of types in (3); the denotation domain of $\langle s \rangle$ is possible worlds.

- (15) $[\langle s, t \rangle \lambda w [_{IP} \text{modal} [\langle s, t \rangle \lambda w' [_{AspP} \langle t \rangle \text{Asp} [_{ModIP} \langle v, t \rangle \text{Modl} [\langle v, t \rangle \text{VP}]]]]] \langle s, t \rangle$



3.1. Modl locates eventualities in a world

We adopt the ontology of Kratzer (1989) according to which situations or eventualities are parts of possible worlds. Worlds are the maximal situations. In accord with convention, we still call their type $\langle s \rangle$. Each eventuality/situation is part of exactly one world.

In order to move from events to worlds, example (2) should include in its semantics the information that the event talked about is part of a possible world:

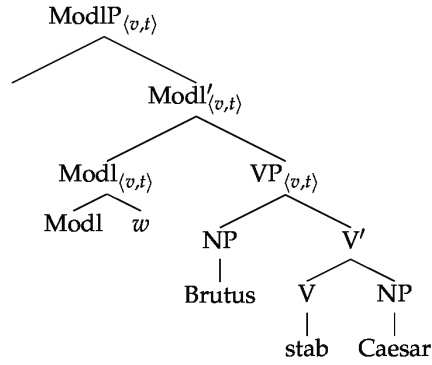
- (16) a. Brutus stabbed Cesar.
 b. $\lambda e. e \leq w \ \& \ \text{stab}(e)(C)(B)$

The simplest possible way to bring this about would be to write it into the lexical entry of the verb:

- (17) $[[\text{stab}]] = \lambda y. \lambda x. \lambda e. e \leq w \ \& \ \text{stab}(e)(y)(x)$

This is not what we do here. Similar to the Asp operator which locates an event temporally, we assume a Modl head which locates an event in a world.

- (18) a. Brutus stabbed Caesar.
 b. $[\text{ModIP}_{\langle v,t \rangle} [\text{Modl } w]_{\langle v,t \rangle} [\text{VP}_{\langle v,t \rangle} \text{Brutus} [\text{stab Caesar}]]]$



- c. $\lambda e. e \leq w \ \& \ \text{stab}(e)(C)(B)$

- (19) a. $[[\text{Modl}]] = \lambda w. \lambda e. e \leq w$
 b. $[[\text{Modl } w]] = \lambda e. e \leq w$

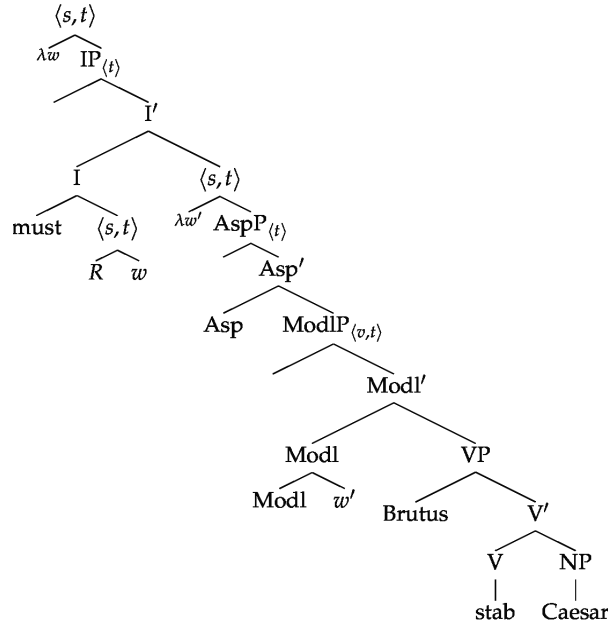
Since Asp existentially closes off the event argument, Modl needs to be below Asp. It should not be confused with sentence mode (subjunctive vs. indicative mode). Rather, it is to be seen as parallel to aspect in the domain of worlds instead of times, locating the event argument of the verb. It is combined intersectively. Modl is not parallel to Asp in that Asp, but not Modl, existentially closes off the event argument slot.

3.2. Intensional Operators

Introducing the world argument into the semantics is preparatory to tackling the semantics of intensional operators like modal verbs. We give an example below.

- (20) Brutus must stab Caesar.

- (21) $[\lambda w_{[\text{IP}]} [\text{must } R(w)] [\lambda w'_{[\text{AspP}]} \text{PF } t [\text{ModIP} [\text{Modl } w'] [\text{VP } B. [\text{stab } C.]]]]]]]$



- (22) a. $\lambda w. \forall w'[R(w)(w') \rightarrow \exists e[\tau(e) \subseteq t \ \& \ e \leq w' \ \& \ stab(e)(C)(B)]]$
 b. Imagine that t is "now". Suppose also that the relevant worlds are the ones in which Brutus reaches his actual goals. Then:
 "All worlds in which Brutus reaches his actual goals are such that they include an event of him stabbing Caesar."

(23) $[[must]] = \lambda q_{\langle s, t \rangle}. \lambda p_{\langle s, t \rangle}. \forall w'[q(w') \rightarrow p(w')]$

Modal verbs are quantifiers over possible worlds. Modals like *must*, *should*, *have to* are universal quantifiers and modals like *can*, *may*, *might* are existential quantifiers (e.g. Kratzer (1991)). Like other natural language quantifiers, modals are restricted: Brutus doesn't stab Caesar in all logically possible worlds, but in all relevant worlds - for example in all worlds in which he reaches his goals (or in all worlds in which the rules are obeyed, etc.). The restriction of the modal quantifier is modelled with an accessibility relation which relates other possible worlds to the actual world. For example:

(24) $R(w)(w')$ iff in w' the rules of w are obeyed

In the LF in (21), the restriction " $R(w)$ " of the modal *must* is represented as a covert constituent in the structure.

The output of this calculation is a proposition $\langle s, t \rangle$. As with temporal propositions, we assume that asserting a proposition in a world $@$ amounts to claiming that the proposition is true in $@$. We have ignored tense in the above example (and accordingly had to ignore the proper contribution of aspect). The next section completes the picture by integrating tense.

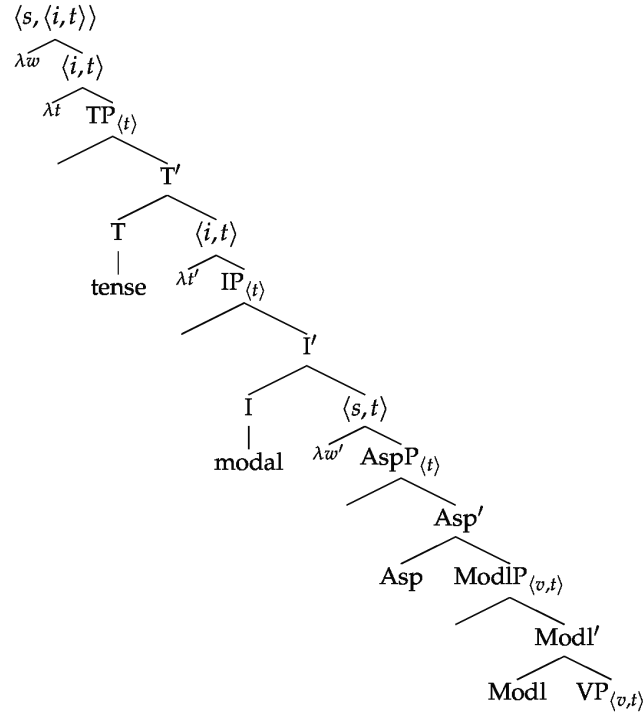
4. Putting Things Together

In subsection 4.1. we discuss the clause hierarchy that results when we put all our assumptions together. It is interesting to see temporal and modal operators in interaction. Subsection 4.2. relates our analysis to the one in Hacquard (2006). In subsection 4.3. we turn to the problem of binding the implicit variables in our LFs. It has been observed that there is a degree of freedom for choosing a binder in the nominal domain. This motivates the extensional, representational framework in which we couch our analysis. It has also been observed, however, that there have to be severe constraints on the binding of implicit variables. We will see that our analysis helps with stating those constraints.

4.1. The Architecture - Illustrating Examples

The complete LF skeleton of a clause, according to our analysis, is represented in (25):

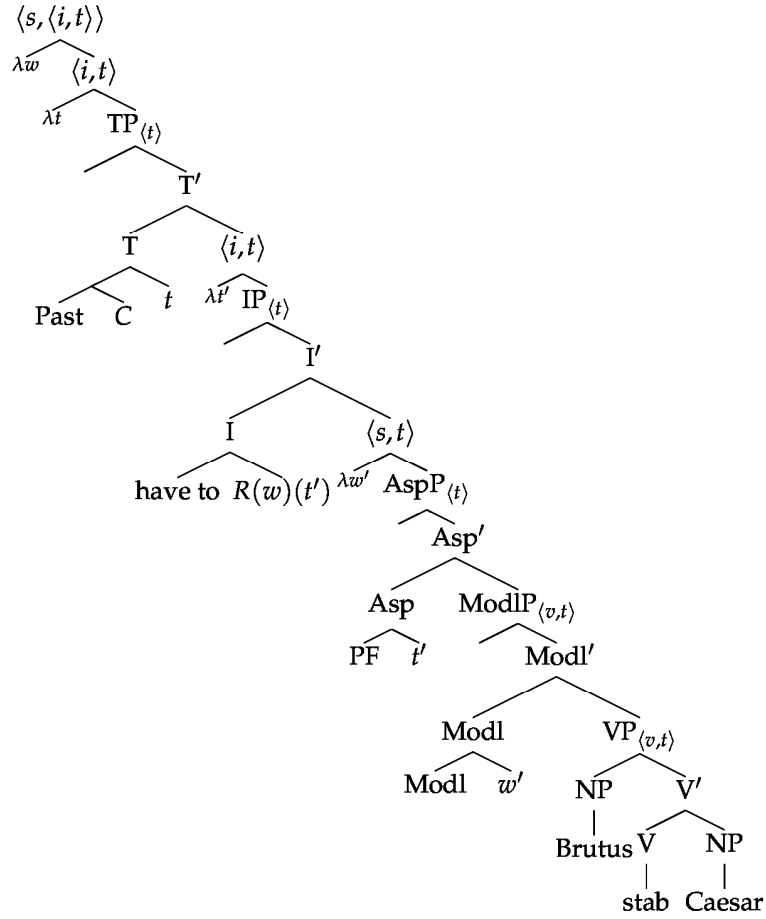
$$(25) \quad \lambda w \lambda t [\langle \rangle \text{ TP tense } \lambda t' \\ \quad \quad \quad [\langle \rangle \text{ IP modal } \lambda w' \\ \quad \quad \quad \quad [\langle \rangle \text{ AspP Asp} \\ \quad \quad \quad \quad \quad [\langle v, t \rangle \text{ ModIP ModI } [\langle v, t \rangle \text{ VP}]]]]]]$$



First, we take a closer look at modals, which will further motivate and refine this setup. (26) is an example with a modal in the past tense. It expresses a past obligation. It is therefore clear that the modal has to be interpreted in the scope of the tense operator. See Chen et al. (to appear) for recent discussion of the interaction of modals and tense.

(26) Brutus had to stab Cesar.

(27) $\lambda w \lambda t [_{\langle \rangle} [_{\text{Past C } t}] \lambda t'$
 $[_{\langle \rangle} [_{\text{have to } R(w)(t')}] \lambda w'$
 $[_{\text{AspP } \langle \rangle} [_{\text{PF } t'}] [_{\text{ModIP } \langle v, t \rangle} [_{\text{Modl } w'}] [_{\text{VP } \langle v, t \rangle} \text{B. stab C.}]]]]]]]]$

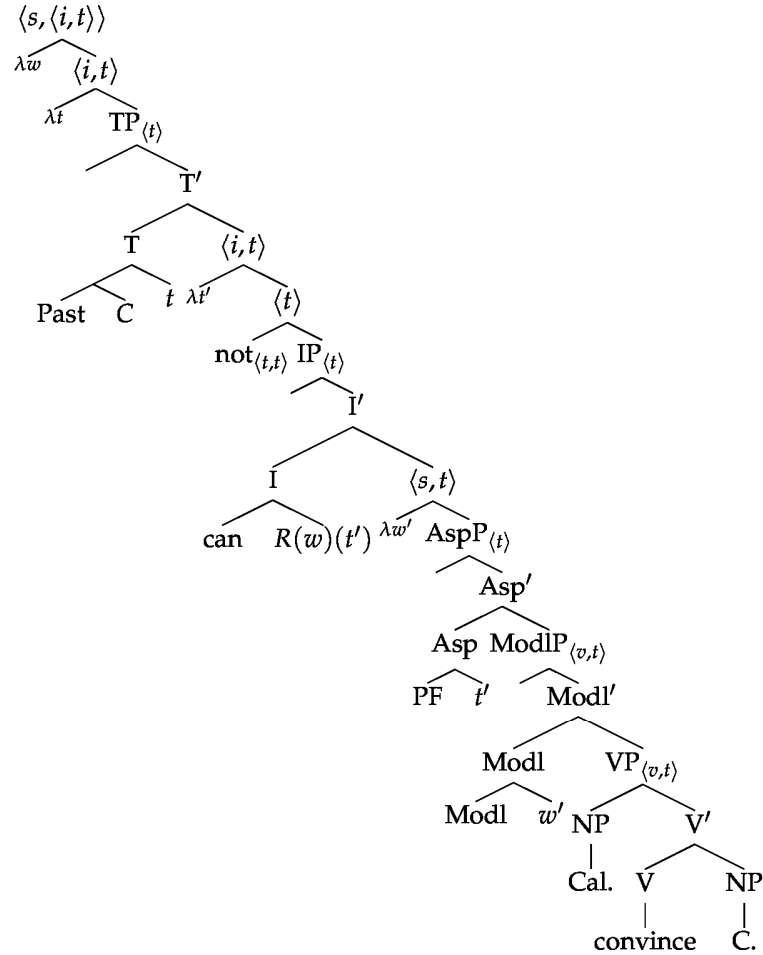


- (28) a. $\lambda w. \lambda t. \exists t' [t' < t \ \& \ C(t') \ \& \ \forall w' [R(w)(t')(w') \rightarrow \exists e [\tau(e) \subseteq t' \ \& \ e \leq w' \ \& \ stab(e)(C)(B)]]$
 b. There is a time t' before t_{now} such that in all worlds w' that are relevant in @ at t' , an event of Brutus stabbing Caesar is part of w' and included in t' .

(29) is an example illustrating the relative scopes of tense, negation and modal:

- (29) Calpurnia couldn't convince Cesar.

- (30) $\lambda w \lambda t [_{\langle \rangle} [_{\langle \rangle} [\text{Past } C \ t] \ \lambda t'$
 $[_{\langle \rangle} \text{not } [_{\langle \rangle} [\text{can } R(w)(t')] \ \lambda w'$
 $[_{\text{AspP } \langle \rangle} [_{\text{PF } t'}] [_{\text{ModIP } \langle v, t \rangle} [_{\text{Modl } w'}] [_{\text{VP } \langle v, t \rangle} \text{Cal con. C}]]]]]]]$

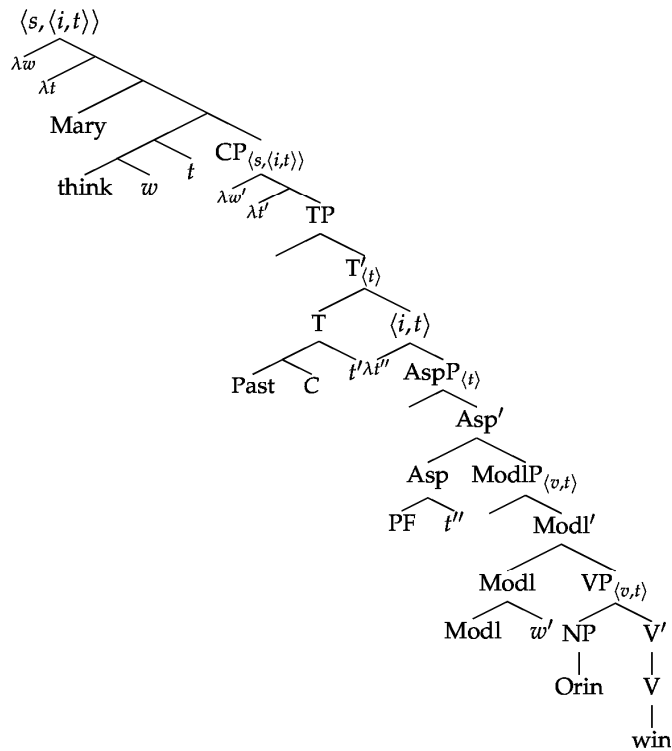


- (31) a. $\lambda w. \lambda t. \exists t' [t' < t \ \& \ C(t') \ \& \ \neg \exists w' [R(w)(t')(w') \ \& \ \exists e [\tau(e) \subseteq t' \ \& \ e \leq w' \ \& \ \text{convince}(e)(C)(\text{Cal})]]]$
 b. There is a relevant time t' before t_{now} such that there is no world that is relevant in @ at t' , such that it includes an event of Calpurnia convincing Cesar.

Let us also take a brief look at an example with a propositional attitude verb. Propositional attitude verbs are also intensional quantifiers and will be relevant in the discussion of Percus's examples in the next subsection. We adopt the standard analysis of propositional attitude verbs as quantifiers over worlds. We give the verb *think* world and time parameters and not an event parameter for simplicity - see Katz (1995), (2000a), (2000b) for discussion of which predicates have event argument slots.

(32) Mary thinks that Orin won.

(33) $\lambda w \lambda t [M. [\text{think } w, t [\lambda w' \lambda t'. [\text{Past } C \ t'] \lambda t'' [\text{AspP } PF \ t'' [\text{ModIP } \text{Modl } w' \text{O. win}]]]]]$



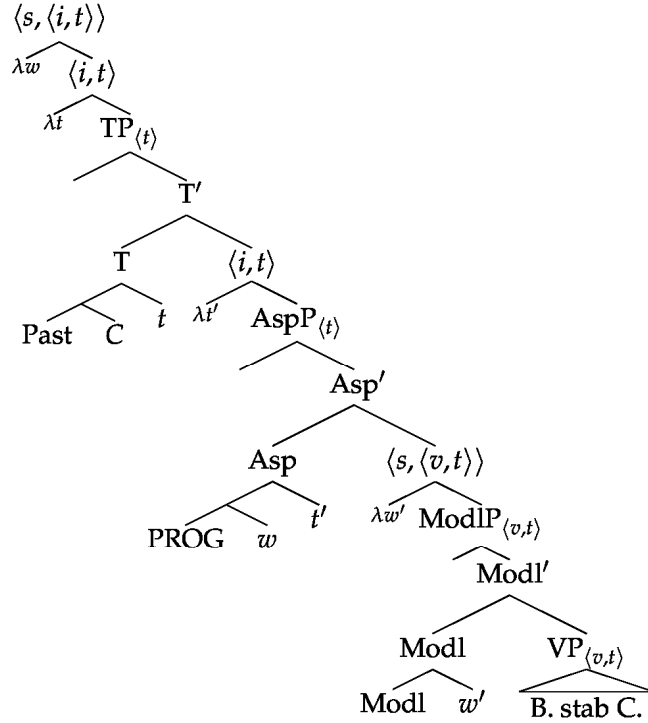
- (34) a. $[[\text{think}]] = \lambda w. \lambda t. \lambda p_{\langle s, \langle i, t \rangle \rangle}. \lambda x. \forall w' [w' \in \text{BEL}(x)(w)(t) \rightarrow p(w')(t)]$
 b. $\forall w' [w' \in \text{BEL}(M)(w)(t) \rightarrow \text{Orin_won}(w')(t)]$
 $= \forall w' [w' \in \text{BEL}(M)(w)(t) \rightarrow$
 $\exists t' [t' < t \ \& \ C(t') \ \& \ \exists e [\tau(e) \subseteq t' \ \& \ e \leq w' \ \& \ \text{win}(e)(O)]]$
 c. All worlds that are compatible with what Mary believes in @ at t_{now} are such that Orin won; i.e.:
 All worlds w' that are compatible with what Mary believes in @ at t_{now} are such that there is a relevant time t' before t_{now} and an event of Orin winning occurring during t' in w' .

And finally, let us come back to the progressive, an aspectual operator postponed in section 2. We postponed its discussion because the English progressive must be seen as an intensional operator.

- (35) Brutus was stabbing Cesar

We report here a version of Dowty's (1979) classical analysis. See Hacquard (2006) for recent discussion and further references. According to Dowty (1979), (35) is true in a world w at a time t , if there is an earlier time t' such that t' is part of an interval t'' which contains, in all worlds in which nothing untoward occurs, a stabbing of Cesar by Brutus. More formally:

- (36) $\lambda w \lambda t. \exists t' [t' < t \ \& \ C(t') \ \& \ \forall w' [w \text{ INERT}_{t'} w' \rightarrow$
 $\exists t'' [t' \text{ is a non-final part of } t'' \ \& \ \exists e [\tau(e) \subseteq t'' \ \& \ \text{stab}(e)(C)(B) \ \& \ e \leq w']]]]$
- (37) PROG following (Dowty, 1979):
 $[[\text{PROG}]] = \lambda w. \lambda t. \lambda P_{\langle s, \langle v, t \rangle \rangle}. \forall w' [w \text{ INERT}_t w'$
 $\rightarrow \exists t' [t' \text{ is a non-final part of } t' \ \& \ \exists e [\tau(e) \subseteq t' \ \& \ P(w')(e)]]]$
- (38) $\lambda w \lambda t [[\text{Past C } t] \lambda t'$
 $[\text{Aspp } [\text{PROG } w, t'] \lambda w' [\text{ModIP } [\text{ModI } w'] [\text{VP } B. [\text{stab } C.]]]]]$



Some further comments: $w \text{ INERT}_t w'$ iff the world histories of w and w' are identical up to t and the future of w' from t on is according to the normal course of things in w up to t . The world w' is an *inertiaworld* of w accessible from t . The term is due to David Lewis. Recently this has been called a metaphysical accessibility following Thomason und Condoravdi, and accordingly, w' is a metaphysical alternative to w (Condoravdi, 2002). The progressive is one interpretation of the Russian and Romance imperfective. The imperfective has other meanings (see once more Hacquard (2006) for discussion).

4.2. Hacquard's (2006) compositional theory

An anonymous reviewer points out that there is a significant overlap between the analysis developed here and the analysis in Hacquard (2006). Let us briefly relate the two systems.

Hacquard (2006) analyses actuality entailments that some modal statements have, and their interaction with aspect. An example of such an actuality entailment from French is given below.

- (39) Jane a pu prendre le train. \implies actuality entailment:
 Jane could-PF take the train Jane took the train.
 'Jane could take the train.'

Hacquard's empirical goals affect certain aspects of her theory in such a way as to be incompatible with our assumptions. In particular, (i) for her verbs have both an event and a world argument, and (ii) events occur in many worlds, not just in one world. Both these properties are visible in her analysis of (39) below. We appreciate that (i) and (ii) allow Hacquard to analyse data like (39) (and we do not ourselves develop an alternative analysis of actuality entailments). But we see no semantic motivation for letting lexical verbs have both an event and a world argument in addition to introducing the information " $e \leq w$ " elsewhere, beyond explaining the actuality entailment. And we understand Hacquard's ontology rather less well than the one we adopt (see her chapter 2.2. for discussion).

- (40) a. Jane could-PF take the train.
 b. $\lambda w. \lambda t. \exists t'[t' < t \ \& \ \exists e[e \leq w \ \& \ \tau(e) \subseteq t'] \ \& \ \exists w'[R(w, w') \ \& \ \text{take_the_train}(e, w')(J)]$
 c. $[\lambda w3 \lambda t [[\text{Past } t] [\lambda_{\text{asp}} [\text{Asp } w3] [\lambda e2 [\text{could } [\lambda w1 [\text{vp } J. \text{ take the train } e2 \ w1]]]]]]]]$

It is also visible in (40) that Hacquard's work has certain things in common with the plot of our paper: both analyses add eventualities, aspect, tense and modality to a basic Heim & Kratzer style theory. The implicit variables and their binders are visible in the Logical Forms. Hacquard actually pushes this plot a little further by assuming that such operators, aspect in particular, may move at LF. This movement is similar to QR and leaves a trace of type $\langle v \rangle$. It can be viewed as resolving a type mismatch similar to the problem of quantified NPs in object position. This proposal is compatible with our suggestions, although we haven't implemented it above.

In sum, there are significant similarities regarding the overall architecture of the interpretive system, but there are also significant incompatibilities regarding ontology and verb meanings.

4.3. Implicit Variables in the nominal domain

All our LFs up to this point have been characterised by the following generalization:

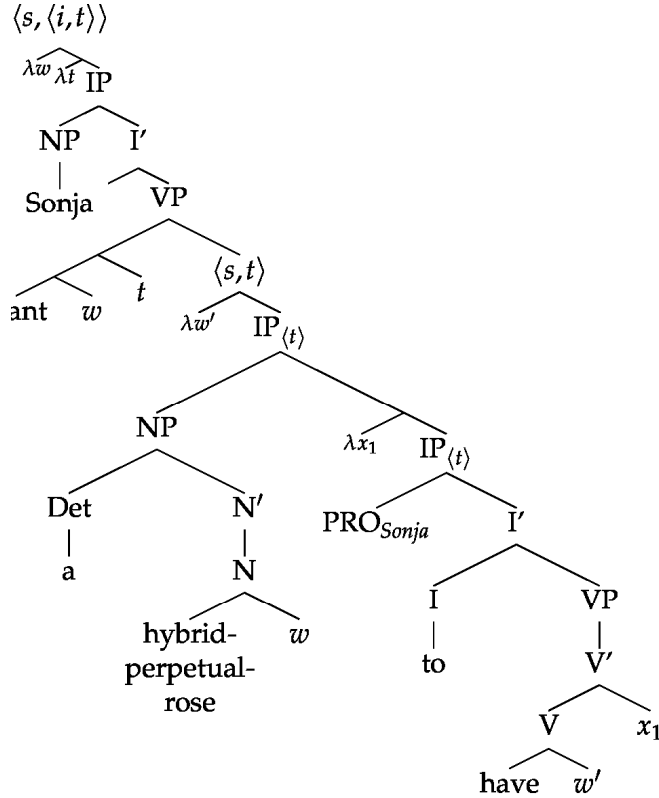
- (41) All implicit variables are bound by the closest possible binder.

It has been argued (e.g. Fodor (1970), Enç (1981)) that there are counterexamples to this generalization for both world and time variables. Some of them are explained below (example in (a), the relevant reading in (b) and a paraphrase in (c)).

- (42) a. The hostage was greeted by the president.
 b. $\exists t'[t' < t \ \& \ \text{the } x: \text{hostage}(t')(x) \text{ was greeted by the president at } t']$
 c. "At a time t' before now, the unique individual who had been a hostage at t' was greeted by the president."
- (43) a. Sonja wants to have a hybrid perpetual rose.
 b. $\forall w[w' \in \text{DES}(S)(w) \rightarrow \exists x[\text{hybrid_perpetual_rose}(w)(x) \ \& \ \text{own}(w')(x)(S)]]$
 c. "In all of Sonja's desire worlds, she owns something which is actually a hybrid perpetual rose."
 Context: Sonja has discovered the rose 'Sidonie' in my garden. She is enchanted, and would like to have such a rose herself. She mistakenly thinks that it is a Bourbon rose. But I report her desire (correctly) with (43a).
- (44) a. Einmal war kein Verstorbener da. (German; from Heim (1991))
 once was no deceased there
 'Once, no deceased was present.'
 b. $\exists t'[t' < t \ \& \ \neg \exists x[\text{deceased}(t)(x) \ \& \ \text{present}(t')(x)]]$
 c. "At a time t' before now, nobody who is now deceased was present."

The implicit variables in the NPs (or DPs - what we call NP here is often analysed as DP) "the hostage", "a hybrid perpetual rose", "no deceased" are not bound by the Past operator or the intensional verb *want* just above them. In our framework, it is easy to give an LF for the relevant reading of, say, (43) as in (45). In this LF, the world variable in the NP/DP "a hybrid perpetual rose" is not bound by the closest binder.

- (45) $[\lambda w \lambda t. [S [[\text{want } w, t] [\lambda w' [[\text{a hybrid_perpetual_rose}(w)] [\lambda x_1 [\text{PRO}_S \text{ to have}_{w'} t_1]]]]]]]]$



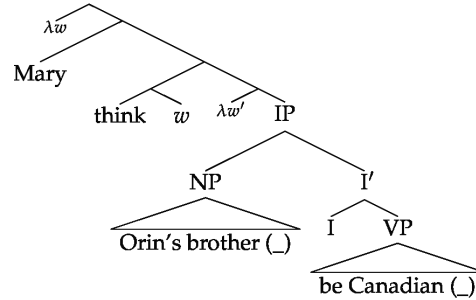
An alternative to the closest binder - generalization would be to suppose that predicates may freely choose their indices. This is what our framework would predict if we add nothing to what has been said so far. The point of Percus (2000)'s paper is that this is not the case. It is not completely arbitrary what binds an implicit variable. This would predict readings that are definitely impossible. Some examples of impossible readings are given below. Let's begin with his (46).

- (46) Mary thinks that my brother is Canadian.
- (47) a. Mary has the following belief: Orin's brother is Canadian.
 b. Of Orin's actual brother, Mary believes that he is Canadian.
 c. # Mary believes of some actual Canadian that he is Orin's brother.

Let us simplify and consider world variables as the only implicit parameters for this example. The relevant structure is sketched in (48). The implicit ar-

guments of 'brother' and 'be Canadian' are indicated by the dashes "_". The observation in (47) says that while the implicit argument of the NP/DP could be either the actual world w or a belief world of Mary's w' , the implicit argument of the predicate 'be Canadian' has to be w' .

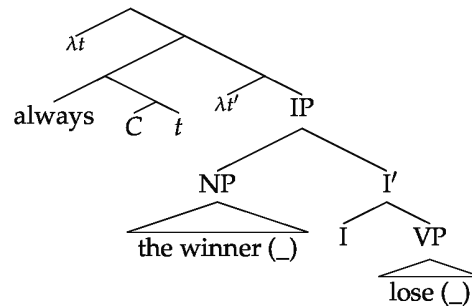
(48) $\lambda w.[\text{Mary} [\text{think } w [\lambda w' [\text{Orin's brother}(_) \text{be Canadian}(_)]]]]$



We can look at (49) in a parallel way. Instead of the propositional attitude verb, we have the adverb of quantification. Let's recycle the context with many rounds of a game being played, with each round being won or lost by the players as well as the overall game. The two implicit variables in the scope of the adverb exhibit a parallel behaviour to the propositional attitude example: the NP/DP variable can be bound by the higher binder, but the predicate variable has to be bound by the closest binder.

(49) The winner always lost.

(50) $[\langle_{i,t} \lambda t [[\text{always } C(t)] [\langle_{i,t} \lambda t' [\langle_{\langle} \text{the winner}(_) \text{lose}(_)]]]]]]]$



- (51) a. For every relevant time t' , the winner at t' lost at t' .
 (contradictory)
 b. For every relevant time t' , the overall winner lost at t' .
 c. # For every relevant time t' , the winner at t' was an overall loser.

The examples clearly show that if we simply allow all predicates to freely choose their implicit parameters, we vastly overgenerate. Let us state a first generalization from these examples as in (52) (this is not Percus's generalization, but it would subsume the data above). The system we have developed here requires an - as yet unstated - constraint that derives this generalization. Percus (2000) calls this a 'binding theory' for implicit variables.

- (52) All implicit variables must be bound by the closest possible binder, unless they are the implicit variable of an NP/DP.

What suggestions are there in the literature to account for this type of data? And what is the generalization for implicit variables in NPs/DPs - are they completely free?

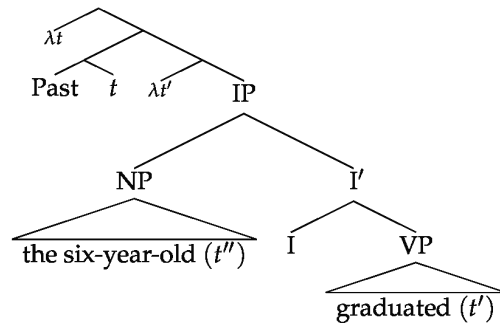
Beginning with the second question, it does not seem to be the case that implicit variables in NP/DP are completely free. The work of Musan (1995), Kusumotu (2005), Rapp (2013) and Rapp & von Stechow (this volume) makes a distinction between definite and indefinite NPs, in that the former but not the latter can be temporally independent (i.e. interpreted with a different time variable than the main predicate of the sentence). It is suggested that the definite article brings its own existential binder for time variables contained in the NP with it. Notice, however, that it is not clear that this can capture the behaviour of (44). Also, we need to ask if world variables ought to be distinguished from time variables in this respect, because (43) involves an indefinite NP which would be modally independent.

The need for a restrictive system motivates Keshet (2011) to relate choice of implicit variable to syntactic scope. According to this analysis, an implicit variable may escape being bound by a binder by moving out of its scope at LF. He solves the problem that (43) poses for such a theory by allowing QR of the NP *hybrid perpetual rose* as well as the DP *a hybrid perpetual rose*, but has to locate e.g. certain uses of definite descriptions outside the scope of his analysis. One such example is given in (53). The sketch of its LF in (54) shows that the time variable t'' of 'the six-year-old' is not plausibly one of the variables in the sentence (t which is t_{now} or t' which is two years ago); rather, it is the time of the previous sentence in the discourse. (Note that (54) assumes that the time variable in the NP is free and refers to a salient time. By contrast, the works cited above assume that such variables are existentially bound by a quantifier over times that the definite determiner brings with

it. While the difference between the two assumptions is theoretically quite clear, it may be fairly difficult to test empirically.)

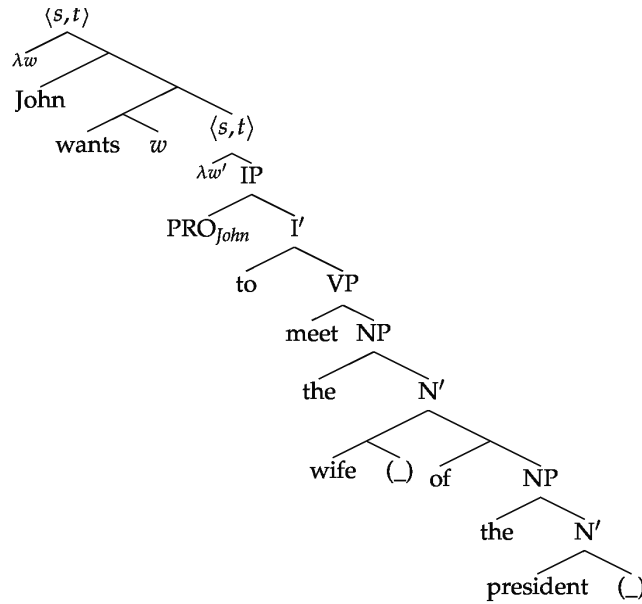
- (53) When I last visited my friend, he had two children: a six-year-old and a ten-year-old.
The six-year-old graduated from med school two years ago.

- (54) λt [Past t [$\lambda t'$ [[the six-year-old (t'')] graduated (t')]]]



In support of his analysis, on the other hand, Keshet points out that constituency plays a role for choice of implicit variable. His example is (55), (56). We add to it the temporal, but otherwise parallel (57)-(59). See also Rapp (2013) and Rapp & von Stechow (this volume) for relevant data and discussion.

- (55) a. John wants to meet the wife of the president.
b. λw [J. wants [$\lambda w'$ [PRO to meet [_{NP} the wife() of the president()]]]

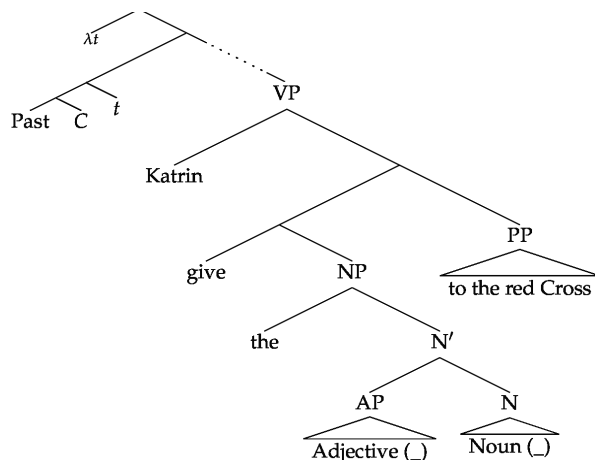


- (56) a. ok: w, w (John wants to meet Michelle Obama.)
 w', w' (John's desire: "I meet the president's wife (whoever these people are)".)
 w', w (John wants to meet Obama's wife, whoever she is.)
 b. # w, w' (the actual wife of whoever John thinks is president is such that John wants to meet her.)

(57) Suppose that Katrin used to own a pair of white trousers (at t_1). She got tired of having to wash them after wearing them for half an hour, so she died them purple (at t_2). One very hot day last summer, she cut off the legs (at t_3).

- (58) a. Katrin gave the white trousers to the red cross yesterday. ok
 b. Katrin gave the purple shorts to the red cross yesterday. ok
 c. Katrin gave the white shorts to the red cross yesterday. #
 (should be ok if 'white' is evaluated at t_1 and 'shorts' at t_3)

(59) λt [Past C t $\lambda t'$ [Katrin give [the Adj($_$) Noun($_$)] to the red cross]]



The intuition is that readings that are mixed between the noun and the AP index are very difficult. This would support the feature of Keshet's analysis that takes QRability to be a prerequisite for readings in which an implicit variable is not locally bound.

It seems fair to say that there is no agreement yet on what generalizations precisely a binding theory for implicit variables should derive. Are world and time variables parallel? Should we systematically distinguish definite from indefinite NPs/DPs? Can implicit variables be free? We do not have a generalization or an analysis to offer at the moment either and must leave it at that. We take our semantic framework to be well suited to explore the matter further because it makes the semantic issues transparent.

5. Further Issues

This section provides some more illustration of how our system works by applying it to a few more phenomena, quantifiers in subsection 5.1. and adverbs in subsection 5.2.

5.1. Negation and Quantifiers

For us, AspP is the smallest $\langle t \rangle$ category. All quantification has to be above the existential event quantifier because positions below are uninterpretable.

This seems to match the generalizations proposed in the literature. Consider (60).

(60) Everyone stabbed Caesar.

(61) below represents an interpretation in which the subject quantifier would have narrow scope relative to the existential quantification over events. This would be one event with many agents. This is considered impossible. An event has exactly one agent. Compare e.g. Kratzer (forthcoming) (though note that the one agent may well be a group acting collectively).

(61) $\lambda w.\lambda t.\exists e[\tau(e) \subseteq t \ \& \ e \leq w \ \& \ \forall x[P(x) \rightarrow \text{stab}(e)(C)(x)]]$

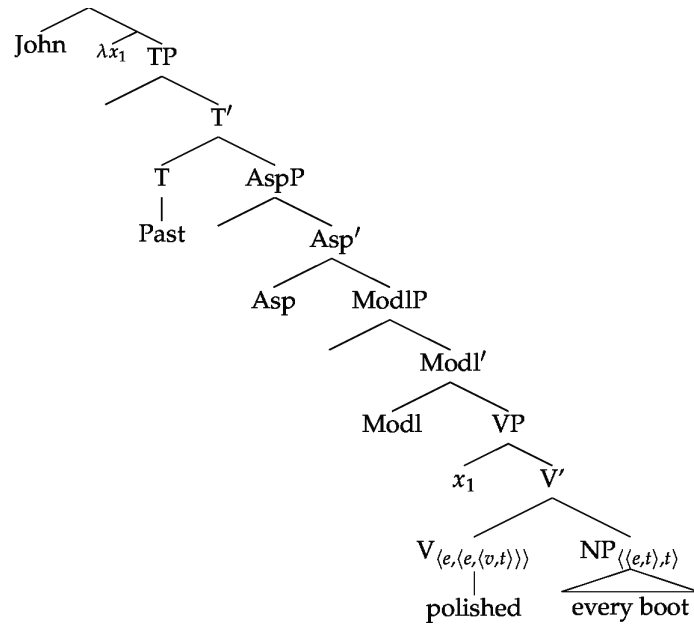
The other option is to give the nominal quantifier wide scope relative to Aspect and the existential quantification over events. This is represented below. It means that for every individual, there is a stabbing event. This is considered the correct semantics of such examples; see also Cresswell (1979) on (63).

(62) $\lambda w.\lambda t.\forall x[P(x) \rightarrow \exists e[\tau(e) \subseteq t \ \& \ e \leq w \ \& \ \text{stab}(e)(C)(x)]]$

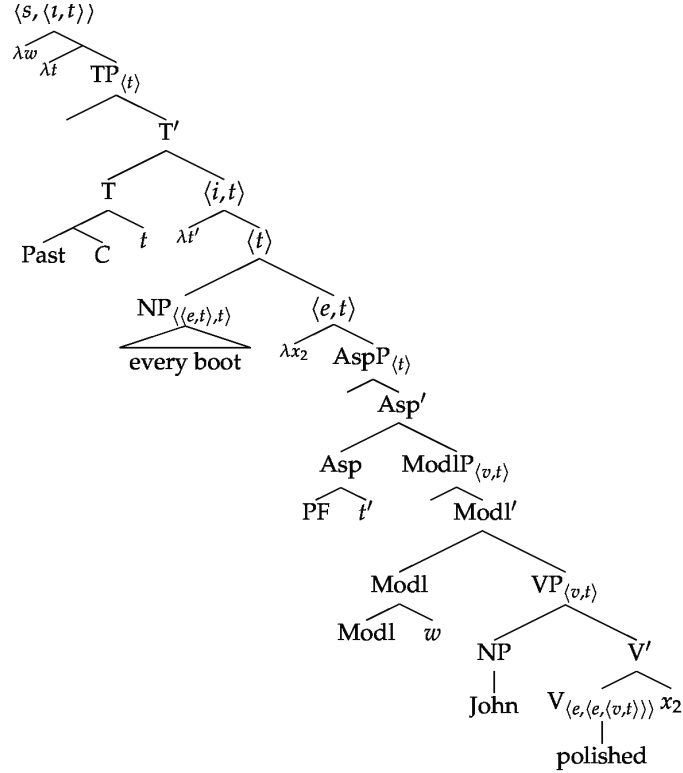
(63) a. John polished every boot. (Cresswell, 1979)
 b. $\lambda w.\lambda t.\forall x[\text{boot}(x) \rightarrow \exists e[\tau(e) \subseteq t \ \& \ e \leq w \ \& \ \text{polish}(e)(x)(J)]]$

Thus quantifiers have wide scope relative to Aspect. This is indeed what our framework would lead us to expect. From a surface structure that looks roughly like (64), the object quantifier 'every boot' has to be QRed in order to be interpretable; its landing site has to be of type $\langle t \rangle$ (Heim & Kratzer (1998)). As can be seen in the LF (65), the first type $\langle t \rangle$ category is AspP. This derives the semantics in (63).

(64) [TP John Past
 [AspP PF [ModIP ModI [VP t1 [polished] $\langle e, \langle e, \langle v, t \rangle \rangle \rangle$ [every boot] $\langle \langle e, t \rangle, t \rangle$]]]]]]



- (65) $\lambda w \lambda t$ [TP [Past C t] $\lambda t'$
 [$\langle \triangleright$ AspP [every boot] λx [$\langle \triangleright$ AspP [PF t']
 [ModIP $_{\langle v, t \rangle}$ [ModI w] [VP $_{\langle v, t \rangle}$ John [polished x]]]]]]



Another example is given in (66). Here it is particularly clear that existential quantification over events ought to take narrow scope.

- (66) Cassius stabbed noone with a dagger.
 - a. ok: $\lambda w \lambda t. \neg \exists x [P(x) \ \& \ \exists y [D(y) \ \& \ \exists e [\tau(e) \subseteq t \ \& \ e \leq w \ \& \ \text{stab}(e)(x)(C) \ \& \ \text{with}(y,e)]]]$
 - b. # $\lambda w \lambda t. \exists e [\neg \exists x [P(x) \ \& \ \exists y [D(y) \ \& \ \tau(e) \subseteq t \ \& \ e \leq w \ \& \ \text{stab}(e)(x)(C) \ \& \ \text{with}(y,e)]]]$

- (67) a. You offended me by every method. (Pride & Prejudice)
 - b. $\lambda w \lambda t. \forall y [M(y) \rightarrow \exists e [\tau(e) \subseteq t \ \& \ e \leq w \ \& \ \text{offend}(e)(me)(you) \ \& \ \text{by}(y,e)]]]$

Thus we derive correctly the generalization in (68):

- (68) Quantifiers take wide scope relative to aspect.

5.2. Nominalization and Adverbs

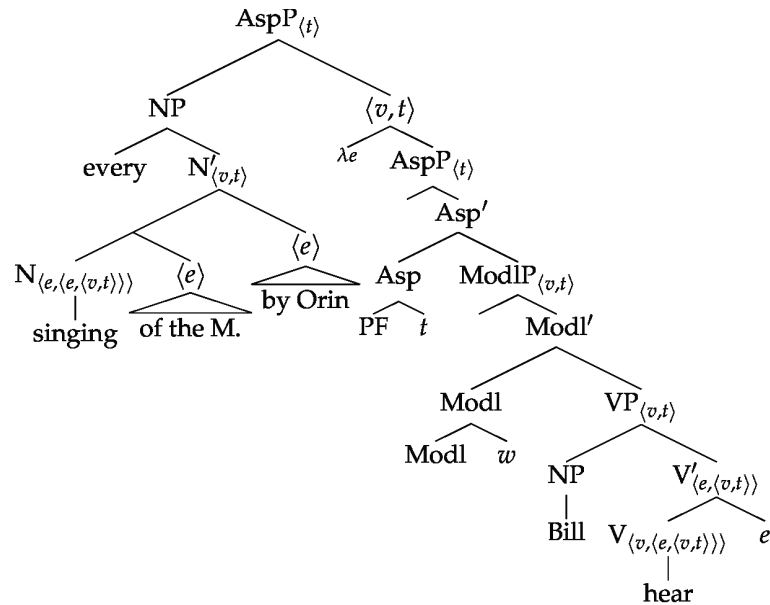
Nominalizations and agent-oriented adverbs provide further illustration of how the system works for classic data in event semantics. We give an example of each in turn.

Nominalizations with the *-ing* suffix and bare infinitives are generalised existential quantifiers over events.

- (69) Bill heard every singing of the Marseillaise by Orin.
 $\forall e[\text{sing}(e)(M)(O) \rightarrow \exists e'[\text{hear}(e')(e)(B)]]$

The suffix *-ing* converts the verb into a noun. A noun cannot case-mark its subject and object arguments, hence both are introduced by prepositions.

- (70) $[[\text{every } [\langle v, \langle e, \langle v, t \rangle \rangle] \text{ singing of the M by O}]] [\langle v, \langle e, \langle v, t \rangle \rangle] \lambda e [\text{Asp PF } t [\text{Modl Mod } [\text{VP B } [\text{hear } e]]]]]$



- (71) *hear* is of type $\langle v, \langle e, \langle v, t \rangle \rangle$:
 $\lambda e \lambda x \lambda e'. \text{hear}(e')(e)(x)$ "e' is a hearing of event e by subject x"

- (72) $\llbracket \text{singing} \rrbracket = \lambda y. \lambda x. \lambda e. \text{sing}(e)(y)(x)$
 $\llbracket \text{singing of the Marseillaise} \rrbracket = \lambda x. \lambda e. \text{sing}(e)(M)$
 $\llbracket \text{singing of the Marseillaise by Orin} \rrbracket = \lambda e. \text{sing}(e)(M)(O)$

The nominal has scope over aspect and its existential event quantifier. This is not the only *-ing* suffix; there are many nominalizations. A classic reference is Zucchi (1993).

Finally, let's take a brief look at adverbs. An example is given in (73).

- (73) Anna kaufte das Haus gern von Franz.
 Anna bought the house willingly from Franz.

gern/willing has an individual argument which will be identified as the subject - in other words, it is a subject oriented adverb.

- (74) *gern/willing* is of type $\langle\langle e, \langle v, t \rangle \rangle, \langle e, \langle v, t \rangle \rangle\rangle$:
 $\llbracket \text{gern} \rrbracket = \lambda P_{\langle e, \langle v, t \rangle \rangle}. \lambda x. \lambda e. P(x)(e) \ \& \ e \text{ is pleasant for } x$

This semantics presupposes a Davidson-semantics of the verb. The LF for the example is given in (76).

- (75) $\llbracket \text{buy} \rrbracket = \lambda e \lambda x \lambda y. \text{buy}(e)(x)(y)$
 (76) $[_{AspP} PF \ t \ [_{ModIP} ModI \ [_{VP} Anna \ [_V \ [_V \ \text{buy the house}] \ \text{willingly}]]]]]$

6. Conclusions

There is not much in the way of new semantic discoveries in the above discussion. But we hope to have shown how a standard semantic theory like the one in Heim & Kratzer (1998) can be extended conservatively to develop analyses for lots of phenomena that a simple extensional semantics does not cover. Our hope is that providing one integrated theory will help bring to light questions and generalizations relevant to further developing the theory of semantic composition. We have included some examples that illustrate this. A focus has been the binding of implicit variables including issues of scope, in particular the nominal domain, in keeping with the other papers in this volume.

Appendix

Semantic types

$\langle e \rangle$, $\langle t \rangle$, $\langle v \rangle$, $\langle i \rangle$ and $\langle s \rangle$ are basic types.
 If $\langle a \rangle$ and $\langle b \rangle$ are types, then $\langle a, b \rangle$ is a type.
 Nothing else is a type.

Denotation domains

Let D_a be the denotation domain of expressions of type $\langle a \rangle$.
 The denotation domain of type $\langle e \rangle$ D_e is D , the set of individuals.
 The denotation domain of type $\langle t \rangle$ D_t is $\{0, 1\}$, the set of truth values.
 The denotation domain of type $\langle v \rangle$ D_v is E , the set of eventualities.
 The denotation domain of type $\langle i \rangle$ D_i is T , the set of time intervals.
 The denotation domain of type $\langle s \rangle$ D_s is W , the set of possible worlds,
 where $W \subseteq E$.
 The denotation domain of type $\langle a, b \rangle$ $D_{\langle a, b \rangle}$ is the set of functions from D_a
 to D_b .

Interpretation principles

Lexical Terminal Nodes (LTN):

If α is a lexical item, then for any g : $[[\alpha]]^g = [[\alpha]]$ which comes from the lexicon.

example: $[[\text{snore}]] = [\lambda x. \lambda e. x \text{ snore in } e]$

Pronouns and Traces (P&T):

If α_i is a pronoun or a trace, then for any g : $[[\alpha_i]]^g = g(i)$

Function Application (FA):

If $\alpha = [\beta \gamma]$ then for any g : if $[[\beta]]^g$ is a function whose domain includes $[[\gamma]]^g$, then: $[[\alpha]]^g = [[\beta]]^g([[\gamma]]^g)$

Predicate Abstraction (PA):

If $\alpha = [i \beta]$ where i is a binder index or such an index on a relative pronoun,
 then for any g : $[[\alpha]]^g = \lambda x. [[\beta]]^{g[x/i]}$

Generalized Predicate Modification (PM):

For any branching tree with daughters β and γ of type $\langle a, t \rangle$ and any g :
 $[[\beta \gamma]]^g = \lambda x. [[\beta]]^g(x) = [[\gamma]]^g(x) = 1$

References

- Chen, Sihwei Chen, Vera Hohaus, Rebecca Laturnus, Meagan Louie, Lisa Matthewson, Hotze Rullmann, Ori Simchen, Claire K. Turner, Jozina Vander Klok (to appear): Past possibility cross-linguistically: Evidence from 13 languages, Parts I and II. To appear in Ana Arregui, Mará Luisa Rivero and Andrés Pablo Salanova (eds.): *Modality across Syntactic Categories*. Oxford University Press.
- Condoravdi, Cleo (2002): Temporal Interpretation of Modals: Modals for the Present and for the Past. In *The Construction of Meaning*, eds. D. Beaver, S. Kaufmann, B. Clark and L. Casillas, 59-88: CSLI Publications.
- Cresswell, M. J. (1979): Interval Semantics for some Event Expressions. In *Semantics from Different Points of View*, eds. Rainer Bäuerle, Urs Egli and Arnim von Stechow. Berlin: Springer, 90-116.
- Davidson, D. (1967): The Logical Form of Action Sentences. In *The Logic of Decision and Action*, ed. N. Rescher, 81-95. Oxford: Oxford University Press.
- Dowty, David (1979): *Word Meaning and Montague Grammar*: Synthese Language Library. Dordrecht: Reidel.
- Dowty, David R., Robert E. Wall, and Stanley Peters (1981): *Introduction to Montague Semantics*. Dordrecht: Kluwer Academic Publishers.
- Enç, Mürvet (1981): "Tense without Scope: An Analysis of Nouns as Indexicals." PhD thesis. Madison: University of Wisconsin.
- von Fintel, Kai. (1994): *Restrictions on Quantifier Domains*. Ph.D. Dissertation, University of Massachusetts.
- Von Fintel, Kai and Irene Heim (2010): "Intensional Semantics." Lecture Notes, Spring 2010, Massachusetts Institute of Technology, Cambridge.
- Fodor, J.: 1970, The linguistic description of opaque contents., PhD thesis, Massachusetts Institute of Technology.
- Gamut, L.T.F. (1991): *Logic, Language and Meaning*. The University of Chicago Press, Chicago and London.
- Hacquard, Valentine (2006). *Aspects of Modality*. PhD thesis, MIT.
- Heim, Irene (1991): Artikel und Definitheit. In: *Semantik: Ein internationales Handbuch der zeitgenössischen Forschung*. Ed. by Arnim von Stechow and Michael Herwig. Berlin: De Gruyter. 487-535.
- Heim, Irene, and Kratzer, Angelika (1998): *Semantics in Generative Grammar*. Oxford: Blackwell.
- Katz, Graham (1995): *Stativity, Genericity, and Temporal Reference*, University of Rochester: PhD Dissertation.
- Katz, Graham (2000a): Anti neo-Davidsonianism: against a Davidsonian semantics for state sentences. In *Events as Grammatical Objects*, eds. C. Tenny and J. Pustejovsky, 393-416. Stanford, CA: CSLI Publications.

- Katz, Graham (2000b): A semantic account of the stative adverb gap. In *Approaching the Grammar of Adjuncts*, eds. C. Fabricius-Hansen, E. Lang and C. Maienborn. Berlin, 135-151.
- Keshet, Ezra (2011): Split Intensionality: A New Scope Theory of De Re and De Dicto. *Linguistics and Philosophy* 33(4), 251-283.
- Klein, Wolfgang (1994): *Time in Language*. London, New York: Routledge.
- Kratzer, Angelika (1989): Lumps of Thought. *Linguistics & Philosophy* 12, 607-653.
- Kratzer, Angelika (1991): “Modality.” In: *Semantik: Ein internationales Handbuch der zeitgenössischen Forschung*. Ed. by Arnim von Stechow and Michael Herwig. Berlin: De Gruyter, pp. 639–650.
- Kratzer, Angelika (1994): On External Arguments. In *Functional Projections*, eds. Elena E. Benedicto and Jeffrey T. Runner, 103-130. Amherst: Graduate Linguistic Student Association.
- Kratzer, Angelika (forthcoming): The event argument. MIT press.
- Krifka, Manfred (1989): *Nominalreferenz und Zeitkonstitution: Studien zur Theoretischen Linguistik*. München: Wilhelm Fink.
- Kusumotu, Kiyomi (2005): “On the Quantification over Times in Natural Language.” In: *Natural Language Semantics* 13.4, pp. 317–357.
- Musan, Renate (1995): “On the Temporal Interpretation of Noun Phrases.” PhD thesis. Cambridge: Massachusetts Institute of Technology.
- Parsons, Terence (1990): *Events in the Semantics of English. A Study in Subatomic Semantics*. Cambridge MA: MIT Press.
- Partee, Barbara (1973). “Some Structural Analogies between Tenses and Pronouns in English.” In: *Journal of Philosophy* 70.18, pp. 601–609.
- Paslawska, Alla, and von Stechow, Arnim (2003): Perfect Readings in Russian. In *Perfect Explorations*, ed. Alexiadou, Rathert, von Stechow. Berlin: Mouton de Guyter, 307-362.
- Percus, O. (2000): Constraints on Some Other Variables in Syntax, *Natural Language Semantics* 8(3), 173–229.
- Rapp, Irene (2013): On the temporal interpretation of present participles in German. *Journal of Semantics*, 0, 2014: 1–47. doi:10.1093/jos/ffu005
- Rapp, Irene & Arnim von Stechow (this volume): The temporal orientation of past participles in German.
- Sternefeld, Wolfgang (2006): *Syntax*. Tübingen: Staufenburg Verlag.
- von Stechow, Arnim, and Sternefeld, Wolfgang (1988): *Bausteine syntaktischen Wissens. Ein Lehrbuch der generativen Grammatik*. Opladen: Westdeutscher Verlag.
- von Stechow, Arnim. 1991a. Syntax und Semantik. In *Semantik - Ein internationales Handbuch zeitgenössischer Forschung*, eds. Arnim von Stechow and Dieter Wunderlich, 90-148. Berlin/ New York: de Gruyter.

- von Stechow, Arnim (1991b). Intensionale Semantik, eingeführt anhand der Temporalität. Available at <http://www.sfs.uni-tuebingen.de/~astechow/Aufsaeetze/index.html>
- von Stechow, Arnim (2009): "Tenses in Compositional Semantics." In: *The Expression of Time*. Ed. by Wolfgang Klein and Ping Li. Berlin: De Gruyter, pp. 129–166.
- Zucchi, Alessandro (1993): *The Language of Propositions and Events*. Dordrecht: Reidel.