Mismatches at the syntax-semantics interface

Markus Egg

Universität Saarbrücken

Proceedings of the HPSG04 Conference

Center for Computational Linguistics
Katholieke Universiteit Leuven

Stefan Müller (Editor)

2004

CSLI Publications

http://csli-publications.stanford.edu/

Abstract

Recent analyses of mismatches at the syntax-semantics interface investigate e.g. modification of agentive nouns (Larson, 1998), modification of quantifying pronouns (Abney, 1987), or recursive modification (Kasper, to appear). Each of these analyses is tailored to a specific set of data, and it is not immediately obvious how they could be generalised to cover a larger set of data.

I propose a unified analysis for these mismatches that attempts to bring out their common ground. This analysis shares some of its basic intuitions with the one of Kasper, but is more general because the mismatches are handled locally in the CONT feature. Its pivot is an elaborate syntax-semantics interface that is based on a surface-oriented syntactic analysis. This analysis generalises easily to the mismatches at the morphology-semantics interface for German separable-prefix verbs that were discussed in Müller (2003).

1 Introduction

Semantic scope of constituents often depends on their syntactic constellation.[1] In this respect, the syntax-semantics interface (SSI) is *iconic*: Configurational asymmetries of syntactic tree structures are mapped onto semantic asymmetries. The crucial notion here is (unilateral) *c-command*: If a constituent C_1 c-commands a constituent C_2 (but not vice versa), C_1 has wide scope over C_2.[2]

Evidence for this iconicity can be found e.g. in cases of multiple modification by scope-bearing modifiers. Here the syntactic order of the modifiers determines their scope. Consequently, switching the order of modifiers around in such cases of multiple modification has an impact on their meaning. Consider e.g. (1a) and (1b), which differ in the order of the modifiers:

(1) (a) a former apparent politician

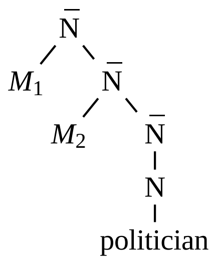
(b) an apparent former politician

Their meanings are different, 'a person who used to resemble a politician' for (1a) and 'a person who resembles someone who used to be a politician' for (1b), respectively. This semantic difference is due to the fact that the preceding modifier M_1 c-commands the following modifier M_2, but not vice versa. Following Kiss (1995) I assume that the Mittelfeld of German sentences is binary-branching, too. The relevant part of the syntactic structure in (1a) und (1b) can then be rendered schematically by (2):

[1]Scope relations of nominal quantifiers among themselves are a well-known exception here.

[2]C-command relates nodes in a syntax tree. A node A c-commands a node B iff (a) A and B are dominated by the same branching nodes in the tree, (b) A does not dominate B or vice versa, and (c) $A \neq B$.

(2)



However, in many modification structures there is no such iconicity, because the syntactic asymmetry does not directy map onto a semantic one. In these cases, the modifier has scope (optionally or obligatorily) only over a *part* of the expression it modifies.

As a first example, consider (3). Its preferred reading can be approximately rendered as 'person who usually dances beautifully'.[3]

(3) beautiful dancer

The preferred reading can be derived in two steps. First, we break down the semantics of agentive nouns like *dancer* in the stem and the affix meaning, where the stem semantics emerges as an argument of the functor which is the semantic contribution of the affix:

(4) $\underbrace{\text{‘person who usually’}}_{\text{affix meaning}} \ \ldots \ \underbrace{\text{‘dances’}}_{\text{stem meaning}}$

Second, we then let the adjective pertain to the *verb stem* only, which means that it ends up in the scope of the affix *-er*. This follows directly from applying the affix meaning 'person who usually X-es' (where X is the meaning of the scope domain of the affix) to the meaning of the stem only *after* modification by the adjective.

In addition, (3) also has a reading 'beautiful person who usually dances'. Here the adjective pertains semantically to the modified noun as a whole, hence, semantic construction for this reading is trivial.

Examples like (5), where an 'indefinite' pronoun like *everyone* or *something* is modified, are equally anti-iconic, because their modifiers pertain semantically only to the *restriction* of the quantification as introduced in the pronoun semantics (e.g., for *everyone*, the property of being a person). I.e., while the semantics of *everyone* is 'set of properties such that every person has them', the meaning of (5a) is 'set of properties such that every person *in this room* has them'. In a similar fashion, the meaning of (5b) emerges: The meaning of the modified pronoun is 'set of properties such that at least one thing has them', hence, by pertaining the semantic contribution of the modifier to the restriction of the quantification we obtain the meaning of (5b) as 'set of properties such that at least one blue thing has them'.

[3] I do not attempt to reconstruct the semantics of these agentive nominals fully, since for the line of argumentation in the present paper the exact spellout of the affix semantics is not relevant. All that matters is that it comprises an operator that has the verb stem semantics in its scope.

(5) (a) everyone in this room

(b) something blue

(3) differs from (5) in that the latter have only the anti-iconic reading while (3) is ambiguous between the sketched anti-iconic reading and the iconic reading 'beautiful person characterised by dancing'. This is due to the fact that an application of the modifier semantics to the semantic contribution of the modified expression as a whole is feasible for (3), but not for (5).

Some conclude from such syntax-semantics mismatches that semantic structure reflects (and is iconic to) a not directly visible layer of syntactic structure like *Logical Form*. This layer may differ considerably from syntactic surface structure, but in this way the iconicity of syntax and semantics could be upheld. In particular, generative grammarians propose such analyses of this kind for data like (3) and (5) (Larson 1998 and Abney 1987, respectively).[4] However, the analysis proposed in this paper assumes only a surface-oriented syntactic structure.

Kasper (to appear) has pointed out that the modification of modifiers is yet another puzzle for semantic construction. The challenge is to derive their semantic representation in a way that models the fact that the scope of the modifier of a modifier *M* may only extend over *M* but not over the expression modified by *M*. E.g., the intensionalisation expressed in *potentially* in (6) relates only to the adjective but not to the noun modified by the full AP. Thus, (6b) refers to abstract items whose being a plan is undisputed, but whose controversiality is not:

(6) (a) potentially controversial

(b) potentially controversial plan

While this puzzle seems to be unrelated to the phenomena discussed so far, I will show that in Kasper's analysis modification of modifiers emerges as yet another instance of the syntax-semantics anti-iconicity exhibited by (3) and (5).

The structure of the paper is the following. After giving a more formal account of the data in section 2, I will discuss competing approaches, in particular, Kasper's analysis, in section 3. After a brief introduction to the formalism on which my analysis is based and its implementation as the semantic component of an HPSG grammar (Pollard and Sag, 1994) in section 4, I will present my own analysis (section 5). In the outlook section 6 I will point out that this analysis is easily extendable to other problematic issues of relating the semantics of a larger constituent to the semantic contributions of its parts, with a focus on the 'bracketing paradox' as noted by Lüdeling (2001) and analysed by Müller (2003) for German nominalisations like *Losgerenne*, which refers to a repeated beginning of a running.

[4] See also Sag (1997) and Kathol (1999) for further discussion of Abney's analysis of (5).

2 Formalisation of the data

The goal of this section is to make the argument of the paper more transparent by reformulating the data in terms of expressions of the λ-calculus. Their reformulation will follow the order in which they were presented in the preceding section.

2.1 Agentive nouns

First comes the modification of agentive nouns. If we ignore issues of argument binding for the purposes of this paper, the semantics of the agentive affix *-er* can be defined as in (7a) as a function from the verb semantics P to the set of individuals that are identical to an individual x such that when x participates in an eventuality[5] e (this is expressed by the relation **in**), then e is usually a P-eventuality where x is the agent. Here '$\vec{y}$' is shorthand for a sequence of zero or more individual arguments of the verb.

The definition (7b) of the generic quantifier GEN is (one version of) the quantifier as discussed in Krifka et al. (1995):

(7) (a) $\lambda P \lambda z.\mathrm{GEN}[e,x](x \textbf{ in } e \wedge z = x, \exists \vec{y}.P(x,\vec{y})(e))$

(b) $\mathrm{GEN}[e,x](R(x)(e), C(x)(e))$ iff $R(x)(e)$ usually entails $C(x)(e)$

The meaning of *dancer* is then (8a), the set of people such that when they are participating in an eventuality, it is usually an eventuality of them dancing. Here the semantic contribution of the verb stem is underlined. If we now pertain the semantics of the adjective to only this underlined part, we obtain the representation (8b) for the preferred reading of (3). Here the adjective semantics is in the scope of GEN, thus, the expression refers to people who are usually dancing beautifully. Its other reading is represented by (8c), which refers to beautiful people who are usually dancing:

(8) (a) $\lambda y.\mathrm{GEN}[e,x](x \textbf{ in } e \wedge y = x, \underline{\textbf{dance}'(x)}(e))$

(b) $\lambda y.\mathrm{GEN}[e,x](x \textbf{ in } e \wedge y = x, \textbf{dance}'(x)(e) \wedge \textbf{beautiful}'(e))$

(c) $\lambda y.\mathrm{GEN}[e,x](x \textbf{ in } e \wedge y = x, \textbf{dance}'(x)(e)) \wedge \textbf{beautiful}'(y)$

2.2 Indefinite pronouns

For *something blue*, the semantic representations are (9a) for the modified expression (set of properties that some thing has), and (9b), for the whole expression (set of properties that some blue thing has). Once more one can derive the semantics for the whole expression by pertaining the modifier semantically only to a part of the semantics of the modified expression, viz., the restriction of the quantifier, which is

[5] This term refers to states of affairs of all kinds; following Davidson (1967), verbs and their projections have an additional eventuality arguments in their semantics.

underlined in (9a). In fact, there is no other alternative, since the modifier semantics is a function from individual sets to individual sets and the pronoun semantics, a set of individual sets. (5a) works analogously.

(9) (a) $\lambda P \exists x.\underline{\mathbf{thing'}}(x) \wedge P(x)$

(b) $\lambda P \exists x.\mathbf{thing'}(x) \wedge \mathbf{blue'}(x) \wedge P(x)$

2.3 Modifiers

Next, I will show that Kasper's analysis is just another instance of this syntax-semantics mismatch. The semantics of *potentially* is (10a), which maps properties P on the property of being potentially P. Here $\diamond p$ is true in a world w iff p is true in some possible world. Following Kasper, this modifier of the adjective does not pertain to the whole ('attributive') semantics of the adjective (10b), a function from properties P to the intersection of P with the property of being controversial, but only to its 'predicative' part (the underlined property **controversial′**). This returns the desired semantic representation (10c) for (6a), a functor intersecting properties P with the property of being potentially controversial. Note that in this representation the λ-abstracted property P (which eventually emerges as the semantics of the noun modified by *potentially controversial* as in (6b)) is outside the scope of the diamond operator $\diamond$.

(10) (a) $\lambda P \lambda x. \diamond (^\wedge P(x))$

(b) $\lambda P \lambda x.\underline{\mathbf{controversial'}}(x) \wedge P(x)$

(c) $\lambda P \lambda x. \diamond (\hat{}\,\mathbf{controversial'}(x)) \wedge P(x)$

The goal of this section was to outline my claim that the presented phenomena are all instances of the same syntax-semantics mismatch. The next section is devoted to previous approaches to these phenomena.

3 Previous analyses of the data

This section discusses previous approaches to the three phenomena outlined in the previous sections. These approaches concentrated on one phenomenon in isolation each and did not attempt to generalise the proposed analyses.

3.1 Agentive nouns: Larson (1998)

The modification of agentive nouns was discussed in Larson (1998). He accounts for agentive modification in terms of a suitable underlying syntactic structure. (11) is assigned the semantic representation (12) in his analysis:

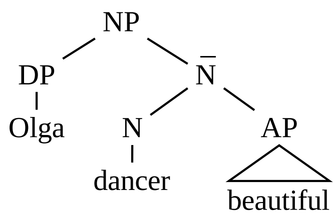
(11) Olga is a beautiful dancer

(12) $\Gamma e[\mathrm{Con}(\mathbf{olga}', e) \wedge \mathbf{dance}'(\mathbf{olga}', e)]\ \ [\mathbf{beautiful}'(e)]$

'Γe' is a generic quantifier for eventualities, 'Con' holds for an individual x and an eventuality e iff e is contextually relevant and contains x. In prose, (12) means that usually contextually relevant eventualities where Olga dances are beautiful.

The derivation of (12) is based on the syntactic structure (13):

(13)



(13) is only a part of Larson's syntax tree for (11), viz., the main part of the complement of *be*. As the subject of the predicate nominal *dancer*, *Olga* occupies SpecN (Chomsky, 1995). To receive case and to agree with the finite verb and the adjective, it moves to the specifier position of the $\mathrm{Agr_S P}$. ($\mathrm{Agr_S}$ is the functional head for subject-verb agreement.) Attributive adjectives follow their head nouns.

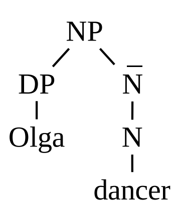
(12) is derived from (13) in the style of Diesing's (1992) *Mapping Hypothesis*, where the scope of a strong quantifier is determined by lower material in a syntax tree, its restriction, by higher material: The scope of the generic quantifier (which is contributed by *dancer*) is determined by the AP, and its restriction, by the rest of the syntax tree, which yields (12). I.e., the semantics of *dancer* comprises both $\mathrm{Con}(x, e)$ and $\mathbf{dance}'(x, e)$. (*Olga* is an argument of *dancer*, hence, in the derivation of (12) the meaning of *dancer* applies to the meaning of *Olga*.)

But this begs the question of how Larson would derive the semantic representation (15) for (14) from the syntax tree (16). His interpretation of (14) is that usually contextually relevant eventualities (where Olga is a participant) are eventualities where Olga dances:

(14) Olga is a dancer

(15) $\Gamma e[\mathrm{Con}(\mathbf{olga}', e)]\ \ [\mathbf{dance}'(\mathbf{olga}', e)]$

(16)

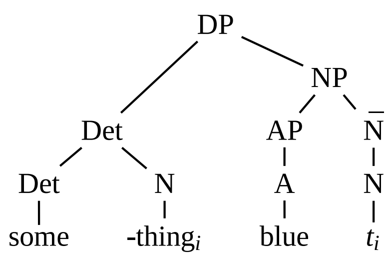


It is unclear how to derive (15) from (16) by the Mapping Hypothesis. In particular, it seems difficult to derive the fact that in this example, the semantics of the noun must provide both the restriction and the scope for the generic quantifier.

3.2 Indefinite pronouns: Abney (1987)

For the case of the indefinite pronouns, several *movement analyses* have been proposed, e.g., Kishimoto (2000) und Abney (1987), the latter of which will be sketched in the following. Abney puts down these pronouns to an *incorporation* of a nominal head (*-body*, *-thing* etc.) into a determiner head as the result of head-to-head movement. The nominal head can be modified just like any other noun but is enclitic, i.e., must find itself a host to attach to. E.g., he gives the following syntactic structure for (5b):

(17)



If we assume that the structure before movement is relevant for semantic construction, the desired semantic representation of (5b) follows immediately.

A potentially problematic prediction of this analysis is that it presupposes *morphological transparency* of the pronoun, which works out for English, but not for languages like German, whose indefinite pronouns (e.g., *jemand* 'someone' or *etwas* 'something' are morphologically opaque. In addition, the analysis must stipulate that words like *one* or *body* are ambiguous between a free and a bound variant with considerably different interpretations.

3.3 Modifiers: Kasper (to appear)

Finally, I will discuss Kasper's analysis of the modification of modifiers. He divides the attributive meaning of a modifier into its predicative meaning ('inherent content', IC) and the rest ('combinatorial semantics', CS). Modifiers lexically determine the semantics S of the head-adjunct phrase in which they are the head of the adjunct: Their CS specifies the way in which S is composed from the semantic contributions of head and adjunct (e.g., for *controversial*, in an intersective fashion).

However, their own semantic contribution (their IC) cannot fully determine the semantics S of the adjunct as a whole, since the adjunct might be a head-adjunct phrase itself, as in (6b). Here the IC is not the one of its head *controversial*, instead, it is the one of *potentially*.

A modifier M' of a modifier M should now affect only the IC of M. This happens in the usual fashion in that the semantics of M' is also the semantics of this local head-adjunct structure. E.g., for *potentially controversial*, the semantics is the one of *potentially*. In contrast, the CS of M must percolate to the phrase headed by M. Thus, the CS of *potentially controversial* is the one of *controversial*.

The implementation of this analysis relegates the CS of a modifier to a MOD feature ECONT, while its IC is the value of its CONT feature. In addition, the semantics *S* of the phrase headed by *M* shows up in a MOD feature ICONT. The 'traditional' MOD feature is now MOD|ARG. For instance, the relevant part of the lexical entry for *controversial* is (18):

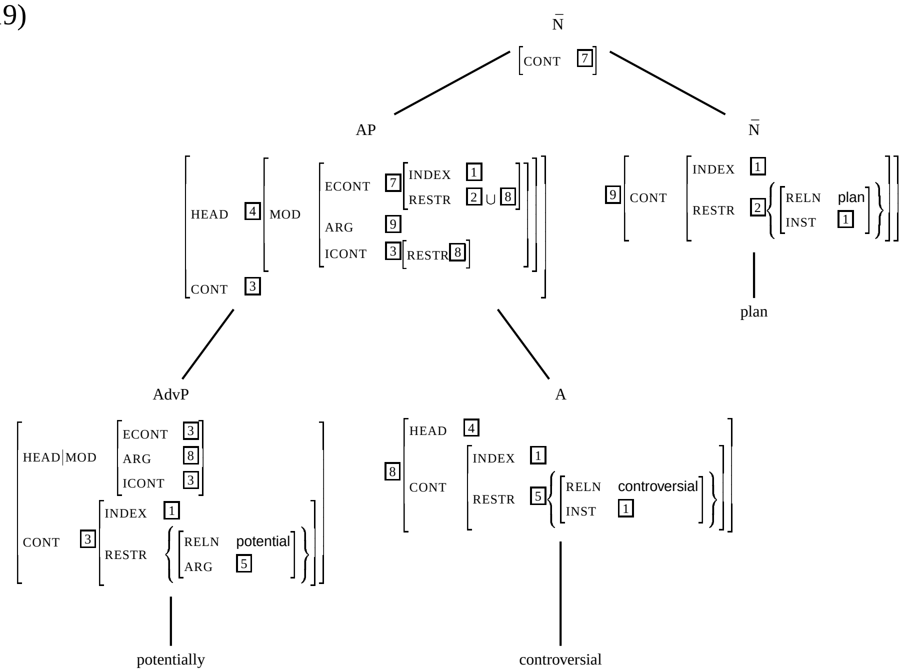
(18)
$$\begin{bmatrix} \text{HEAD}|\text{MOD} & \begin{bmatrix} \text{ARG}|\text{CONT} & \begin{bmatrix}\text{INDEX} & \boxed{1}\\ \text{RESTR} & \boxed{2}\end{bmatrix}\\ \text{ICONT}|\text{RESTR} & \boxed{3} \\ \text{ECONT} & \begin{bmatrix}\text{INDEX} & \boxed{1}\\ \text{RESTR} & \left[\boxed{2}\cup\boxed{3}\right]\end{bmatrix}\end{bmatrix}\\ \text{CONT} & \begin{bmatrix}\text{INDEX} & \boxed{1}\\ \text{RESTR} & \left\{\begin{bmatrix}\text{RELN} & \textsf{controversial}\\ \text{INST} & \boxed{1}\end{bmatrix}\right\}\end{bmatrix}\end{bmatrix}$$

The ECONT value is specified lexically, but the ICONT value is not. In particular, it is not equated with *M*'s semantic contribution as specified in its own CONT value. Being head features, ECONT and ICONT percolate from *M* to the phrase headed by *M*. This percolation is not affected by modification of *M* itself, which may only replace the CONT value of *M* by its own CONT value.

The semantics principle then determines the meaning of a head-adjunct phrase as the adjunct's CS by coindexing the CONT value of the phrase with the MOD|ECONT value of the adjunct. In addition, the MOD|ICONT value of the adjunct is coindexed with its CONT value. I.e., once a modifier has been projected to a full phrase (a precondition for its function as an adjunct in a head-adjunct structure), its current CONT value is identical to the semantics of the whole phrase (the ICONT value), because the phrase cannot be extended any further.

Kasper's analysis of (6b) is sketched in a slightly adapted form in (19):

(19)



The semantics principle applies twice in this derivation, once for either head-adjunct structure. Its first application determines the $\bar{\text{N}}$ semantics as the ECONT value $\boxed{7}$ of the AP. The restriction of this ECONT value is defined in the head feature $\boxed{4}$ of the lexical entry for *controversial* as the union of the restrictions of the modified noun $\boxed{2}$ and of the semantic contribution $\boxed{8}$ of the AP as a whole (as specified in its ICONT value $\boxed{3}$), respectively. The first application of the semantics principle also identifies the AP's ICONT and CONT values ($\boxed{3}$).

The second application of the semantics principle defines the AP's CONT value $\boxed{3}$ as the ECONT value of the adverbial. Since the adverbial takes scope over the expression it modifies, its ECONT and ICONT values are identical. Due to the second application of the semantics principle, the ICONT value of the adverbial is equated with its CONT value. Thus, $\boxed{8}$ is identified as the adverbial's restriction, where the potential-relation has the CONT|RESTR value $\boxed{5}$ of the adjective as its argument.

In sum, the semantics $\boxed{7}$ of the whole expression emerges as an intersection of the noun semantics and the semantics of the *adverbial*, the adjective semantics is the argument of the adverbial semantics.

There are two points worth noting for Kasper's analysis. First, it predicts that if a modifier may pertain semantically to only part of the expression it modifies syntactically, it must do so. But cases like (3) differ in this respect, i.e., the analysis cannot be generalised to capture the common ground between (3) and (6). Second, Kasper's interface machinery is designed for modification of modifiers, as it heavily uses the MOD feature. This begs the question of how to extend the scope of the analysis to the other phenomena presented in the preceding sections. In section

5, I will propose an analysis of the mismatch that is more flexible than Kasper's yet preserves his insights. Here the mismatch is handled locally within the CONT feature of linguistic signs.

4 The semantic representation formalism

This section introduces the representation formalism in which my own analysis of the presented syntax-semantic mismatches is cast. The semantic description of these mismatches calls for a suitable *underspecification formalism*, e.g., UDRT (Reyle, 1993), MRS (Copestake et al., 2003), or Constraint Language for Lambda Structures (Egg et al., 2001) (used in an abbreviated form here). Expressions of such a formalism are *constraints* that describe a set of semantic representations (here, λ-terms), one for each reading of a structurally ambiguous expression. Constraints are underspecified in that they deliberately abstract away from the differences between their solutions (in particular, w.r.t. scope relations between the fragments). These formalisms allow an adequate representation of structual ambiguity and, what is more, they provide the necessary flexibility in the SSI.

Representations described by (or compatible with) a constraint are its *solutions*. Here we only need *constructive* solutions consisting of the material explicitly mentioned in the constraint. In this case, constraints can be regarded as a kind of jigsaw puzzle: Parts of a semantic representation are given together with some instructions on how to put them together. Any possible way of putting them together yields one of the solutions of the constraint.

I will now outline the proposed solution with the semantic representation and construction for (6a) in the simplified form of CLLS employed in this paper. The constraint for its meaning is (20). In such constraints, '$[\![\mathtt{C}]\!]$' indicates the main fragment of a constituent $\mathtt{C}$ and '$[\![\mathtt{C_S}]\!]$', the secondary fragment of $\mathtt{C}$. '$[\![\mathtt{C}]\!]{:}F$' expresses that the main fragment of $\mathtt{C}$ is defined as fragment F:

(20)

$$[\![\mathtt{AP}]\!] : \boxdot$$

$$[\![\mathtt{AP_S}]\!] : \lambda P \lambda x. \boxdot(x) \wedge P(x) \qquad \lambda x. \diamond(^\wedge \boxdot(x))$$

$$\mathbf{controversial'}$$

(20) comprises the three ingredients out of which the simplified CLLS expressions are constructed, viz., fragments of λ-terms, not yet known parts of these fragments, indicated by 'holes' (□), and *dominance relations* (depicted by dotted lines) that relate fragments to holes. When a fragment is dominated by a hole it is an (im-)proper part of whatever the hole stands for. Dominance relations model scope. Structures like (20) are called *dominance diamonds*. (They are characteristic for quantifier scope ambiguities, too, see section 5 below.)

To paraphrase (20), we do not know what the structure as a whole stands for (thus, there is only a hole on top) but both the semantic contribution of the modifier (the right fragment) and the combinatorial semantics of the adjective (the left fragment) are its immediate parts. In addition, the adjective's inherent content (the bottom fragment) has narrowest scope, as it is dominated by the other two fragments.

Resolving the ambiguity in constraints is modelled as adding information monotonically, in particular, by strengthening dominance relations between holes and fragments to *identity*. For (20), there are in principle two choices: Identifying the CS fragment with the top hole, the modifier fragment, with the hole in the CS fragment, and the IC fragment, with the hole in the modifier fragment yields (10c). The other choice (starting this procedure with the modifier fragment) is blocked due to the types of the involved fragments: The hole in the modifier fragment cannot be identified with the CS fragment. I.e., there is no danger of unwanted overgeneration for the cases of modification of modifiers (neither for indefinite pronoun cases like (5)), while for ambiguous cases like (3) both choices would return a solution of the constraint. See the bottom of section 5 for the semantic representations of these cases.

5 The proposed analysis

The pivot of my analysis is the syntax-semantics interface. It models the discussed anti-iconic structures as *potential scope ambiguities*. The basic assumption is that the semantic contribution of a (lexical or complex) constituent *C* breaks down into a *secondary part* (which ends up in the scope of all constituents that unilaterally c-command *C*) and a *main part*, whose scope is determined differently. The rules of the syntax-semantics interface can handle *both kinds* of fragments, therefore the analysis can be based on a very *surface-oriented* syntactic structure. Thus, when *C* is modified, the modifier outscopes *C*'s secondary part semantically, but the scope between the modifier and *C*'s main part is deliberately left open. E.g., for *controversial* its inherent content constitutes the secondary, and its combinatorial semantics, the main part of its semantic contribution. Consequently, in the semantics of *potentially controversial*, the adverbial outscopes the IC of *controversial*, but the scope of its CS and the adverbial is open. Wide scope of the former is possible, which yields the desired interpretation (10c) for (6a).

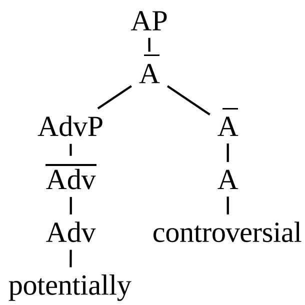
The resulting expressions of the semantic formalisms thus look just like the expressions that model sentences with two scopally ambiguous quantifying NPs. Here the bottom fragment of the dominance diamond comprises the verb that syntactically subcategorises for the scope-bearing NPs. The two NPs contribute the two scopally ambiguous fragments of the diamond. See Egg et al. (2001) or Reyle (1993) for details.[6]

[6]Note that the kind of elaborated syntax-semantics interface that is needed to derive the semantic representations for the phenomena which are analysed in this paper is also required to derive these representations for quantifier scope ambiguities. I.e., the proposed treatment of these phenomena

5.1 The syntax-semantics interface

The interface derives the constraint (20) from the syntactic structure for (6a), which is (21):

(21)



Deriving constraints like (20) uses lexical entries as the one of *controversial*. Here the inherent content of the adjective, which modifi ers might pertain to exclusively, is set off in a fragment $[\![\mathtt{A_S}]\!]$ of its own. The combinatorial semantics of the adjective constitutes the $[\![\mathtt{A}]\!]$ fragment:

(22)
$$\begin{array}{l} [\![\mathtt{A}]\!] : \lambda P \lambda x.\ \boxdot(x) \wedge P(x) \\ \quad [\![\mathtt{A_S}]\!] : \ \mathbf{controversial}' \end{array}$$

This kind of semantic information is encoded in the CONT feature of linguistic signs. Its value, a feature structure of type *cont*, has a list-valued feature CONSTR for the constraint itself. Two auxiliary features FST and SND identify main and secondary fragment of a constituent among the fragments appearing in CONSTR (fragments can be modelled by feature structures, too):

(23)
$$\left[\begin{array}{ll} \text{FST} & \boxed{1} \\ \text{SND} & \boxed{2} \\ \text{CONSTR} & \left\langle \ldots \boxed{1} \ldots \boxed{2} \ldots \right\rangle \end{array}\right]_{cont}$$

First of all, a constituent inherits the constraints Con_1 and Con_2 of its immediate constituents C_1 and C_2. The interface rules specify for each constituent C how Con_1 and Con_2 are combined into a new constraint Con for C. Rules are implemented as phrases that may themselves contribute to Con. They combine Con_1 and Con_2 via the FST and SND values of C_1 and C_2 and determine these features for C. This kind of semantic construction is familiar e.g. from semantic construction in MRS (Copestake et al., 2003).

As an introduction to the way in which these rules are written, consider the (trivial) rule that nonbranching $\overline{\mathtt{X}}$ constituents inherit their fragments from their

---

does not introduce additional complexity into the syntax-semantics interface.

heads. Recall that ‘$[\![\mathtt{C}]\!]$’ stands for the main and ‘$[\![\mathtt{C_S}]\!]$’, for the secondary fragment of a constituent $\mathtt{C}$; ‘$[\![\mathtt{C}]\!]$:F’ indicates that the main fragment of $\mathtt{C}$ is defined as F:

(24) $[_{\overline{\mathtt{X}}}\ \mathtt{X}] \quad \overset{(SSS)}{\Rightarrow} \quad [\![\overline{\mathtt{X}}]\!] : [\![\mathtt{X}]\!] \qquad [\![\overline{\mathtt{X}}_\mathtt{S}]\!] : [\![\mathtt{X_S}]\!]$

The modification interface rule is (25): The emerging constituent $\overline{\mathtt{X}}_1$ inherits its main fragment $[\![\overline{\mathtt{X}}_1]\!]$ from the modified expression. Its secondary fragment $[\![\overline{\mathtt{X}}_{1\mathtt{S}}]\!]$ is defined as the modifier fragment $[\![\mathtt{Mod}]\!]$ applied to a hole that dominates the secondary fragment $[\![\overline{\mathtt{X}}_{2\mathtt{S}}]\!]$ of the modified expression. This makes $[\![\mathtt{Mod}]\!]$ and $[\![\overline{\mathtt{X}}_1]\!]$ scopally ambiguous and yields the bottom half of a dominance diamond. Recall that $[\![\overline{\mathtt{X}}_2]\!]$ dominates $[\![\overline{\mathtt{X}}_{2\mathtt{S}}]\!]$ (they are fragments of the same constituent) and is equal to $[\![\overline{\mathtt{X}}_1]\!]$. Equating the modifier fragments ($[\![\mathtt{Mod}]\!]$: $[\![\mathtt{Mod_S}]\!]$) is not necessary, but facilitates reading.

(25) $[_{\overline{\mathtt{X}}_1} \mathtt{Mod}\ \overline{\mathtt{X}}_2] \quad \overset{(SSS)}{\Rightarrow} \quad \begin{array}{l} [\![\overline{\mathtt{X}}_{1\mathtt{S}}]\!] : [\![\mathtt{Mod}]\!](\ \boxed{\cdot}\ ) \\ \qquad\qquad\qquad\quad \vdots \\ \qquad\qquad\qquad\quad [\![\overline{\mathtt{X}}_{2\mathtt{S}}]\!] \end{array}$

$[\![\mathtt{Mod}]\!]$: $[\![\mathtt{Mod_S}]\!]$ $\quad$ $[\![\overline{\mathtt{X}}_1]\!]$: $[\![\overline{\mathtt{X}}_2]\!]$

Finally, the rule that constructs the upper half of the dominance diamond corresponds to the syntax rule that $\overline{\mathtt{X}}$ constituents may by themselves constitute $\mathtt{XP}$s of their own. The main fragment of $\mathtt{XP}$ is only a hole that dominates both fragments of the $\overline{\mathtt{X}}$ constituent:

(26) $[_{\mathtt{XP}}\ \overline{\mathtt{X}}] \quad \overset{(SSS)}{\Rightarrow} \quad \begin{array}{ccc} & [\![\mathtt{XP}]\!] : \boxed{\cdot} & \\ \swarrow & & \searrow \\ [\![\mathtt{XP_S}]\!] : [\![\overline{\mathtt{X}}]\!] & & [\![\overline{\mathtt{X}}_\mathtt{S}]\!] \end{array}$

5.2 Analyses of the syntax-semantics mismatches

Semantic construction for *potentially controversial* now uses the lexical entries for *controversial* (22) and *potentially* (27) and the rules (24)-(26) to derive the diamond in (20) on the basis of (21).

(27) $[\![\mathtt{Adv}]\!]$, $[\![\mathtt{Adv_S}]\!]$: $\quad \lambda P \lambda x. \diamond (^\wedge P(x))$

In the lexical entry for *potentially*, both fragments are identical; according to (24), this carries over to *potentially* as $\overline{\mathtt{Adv}}$ constituent. Following (26), the constraint for the $\mathtt{AdvP}$ *potentially* is (28):

(28) $\begin{array}{l} [\![\mathtt{AdvP}]\!] : \boxed{\cdot} \\ \qquad\qquad\ \ \vdots \\ [\![\mathtt{AdvP_S}]\!] : \lambda P \lambda x. \diamond (^\wedge P(x)) \end{array}$

Next, (25) combines (22) and (28) into (29), the bottom half of a diamond for the meaning of the $\bar{\mathtt{A}}$ constituent *potentially controversial*, before (26) transforms (29) into the full diamond (20).

(29) $[\![\bar{\mathtt{A}}]\!] : \lambda P \lambda x.\, \boxdot(x) \wedge P(x)$ $\qquad$ $[\![\bar{\mathtt{A}}_{\mathtt{S}}]\!] : \lambda x.\, \diamond({}^\wedge \boxdot(x))$

$$\mathbf{controversial}'$$

The semantics of *beautiful dancer* is derived analogously. It is based on the lexical entry for the semantics of *dancer* (30)[7] and a simple lexical entry for *beautiful*, which is given in (31):[8]

(30) $[\![\mathtt{N}]\!] : \lambda y.\mathrm{GEN}[e,x](x \textbf{ in } e \wedge y = x,\ \boxdot(e))$

$$[\![\mathtt{N}_{\mathtt{S}}]\!] : \ \mathbf{dance}'(x)$$

(31) $[\![\mathtt{A}]\!]$, $[\![\mathtt{A}_{\mathtt{S}}]\!]$: $\lambda P \lambda x. P(x) \wedge \mathbf{beautiful}'(x)$

The resulting dominance diamond (32) has *two solutions*, viz., (8b) and (8c).

(32)

$$[\![\mathtt{NP}]\!] : \boxdot$$

$[\![\mathtt{NP}_{\mathtt{S}}]\!]: \lambda y.\mathrm{GEN}[e,x](x \textbf{ in } e \wedge y = x,\quad \boxdot(e))$ $\qquad$ $\lambda y.\, \boxdot(y) \wedge \mathbf{beautiful}'(y)$

$$\mathbf{dance}'(x)$$

Finally, the dominance diamond for the indefinite pronoun cases emerges from lexical entries for these pronouns where the restriction of the quantification constitutes the secondary fragment of the determiner, e.g., for *something*:

(33) $[\![\mathtt{D}]\!] : \lambda P \exists x.\ \boxdot\ (x) \wedge P(x)$

$$[\![\mathtt{D}_{\mathtt{S}}]\!] : \ \mathbf{thing}'$$

With the rules (24)-(26) and a simple lexical entry for *blue* (in analogy to (31)) we can derive the semantic representation (34) for *something blue*:

---

[7]This twopartite semantic structure can be derived by a rule of the morphology-semantics interface which combines the stem and the affix semantics. This rule is described as (41) in section 6 below.

[8]Here and in the following the distinction between the combinatorial semantics and the inherent content of the adjective is of no avail, hence, neglected.

(34)

$$[\![\mathtt{DP}]\!] : \boxdot$$

$$[\![\mathtt{DP_S}]\!] : \lambda P \exists x. \boxdot (x) \wedge P(x) \qquad \lambda y. \boxdot (y) \wedge \mathbf{blue'}(y)$$

$$\mathbf{thing'}$$

Just like for the case of the modification of modifiers, the scope ambiguity as expressed in the dominance diamond is only a potential one, because the fragments can only be put together in one specific way. In (34) the right fragment can be identified with the hole in the left fragment but not the other way round, which yields as the sole solution the desired λ-term (9b). I.e., once again the analysis does not lead to unwanted overgeneration.

This concludes the presentation of the proposed analysis, whose goal was a uniform semantic construction for mismatches at the syntax-semantics interface on the basis of a surface-oriented syntactic structure.

6 Conclusion and outlook

Syntax-semantics mismatches in modification structures that involve agentive nouns, indefinite pronouns, or modifiers that are modified themselves, have been analysed in terms of *potential scope ambiguities*. This analysis can be extended to capture additional, seemingly unrelated phenomena. In the remainder of the paper I will show that the morphosemantic mismatches noted by Lüdeling (2001) and discussed by Müller (2003) under the heading of 'bracketing paradoxes' can be analysed as one more instance of the mismatch, though, this time, the mismatch affects the morphology-semantics and not the syntax-semantics interface.

Consider e.g. separable prefix verbs like *losrennen*:

(35)	los-	renn	-en
	start	*run*	*infinitive*
	'to start running'		

In nominalisations of these verbs by the *Ge... e* circumfix, which expresses iteration semantically, only the verb stem shows up within the circumfix (thus, for *losrennen* the nominalisation is (36). In the gloss, the two parts of the circumfix are distinguished by subscripts:

(36)	Los-	ge-	renn	-e
	start	*iter_nom*$_1$	*run*	*iter_nom*$_2$
	'iteration of events of starting to run'			

This suggests a morphological structure in which the verb stem combines with the circumfix *before* the prefix is attached: In the other option (combining the circumfix with the prefixed verb stem) the prefixation would have to be undone again in order to get the position of the circumfix around the verb stem only right.

But if we assume that the order of morphological combination fixes the semantic scope of the operators, the prefix should have scope over the circumfix. However, this prediction is not bourne out, the scope of the affixes is exactly the other way round, which constitutes a morphology-semantics mismatch. I.e., in the case of *Losgerenne* the prefix is in the scope of the circumfix, thus, the nominalisation refers to iterations of eventualities of starting to run (and not the start of an iteration of running eventualities).

This problem is yet another instance of the sort of mismatch discussed in this paper. To see this, consider the following reformulation of the problem: The semantics of *Gerenne* is (37a), in prose, the set of eventualities e such that e is an iteration of eventualies where some x runs. From this semantic representation we can obtain the semantics of *Losgerenne* by pertaining the prefix meaning (mostly, the change-of-state operator BECOME) not to the semantics of the base (37a) as a whole, but only to that part of it that is contributed by the verb stem (plus argument binding), which is underlined in (37a). The resulting (37b) stands for the set of iterations of eventualities where some x starts to run:

(37) (a) $\lambda e.\mathrm{ITER}(\underline{\lambda e' \exists x.\mathbf{run'}(x)(e')})(e)$
(b) $\lambda e.\mathrm{ITER}(\mathrm{BECOME}(\lambda e' \exists x.\mathbf{run'}(x)(e')))(e)$

The two operators ITER and BECOME in (37) are defined in the following way. ITER relates properties of eventualities P to eventualities e if e is the convex union (i.e., including anything in between) of a set of eventualies E, each of whose elements is a P-eventuality. In addition, e itself may not be a P-eventuality (38a). The definition of BECOME in (38b) is basically the one of Dowty (1979):

(38) (a) $\forall P \forall e.\mathrm{ITER}(P)(e) \leftrightarrow \exists E.\forall e'.e' \in E \rightarrow P(e') \wedge \bigcup E = e \wedge \neg P(e)$
(b) $\mathrm{BECOME}(P)(e)$ iff e is preceded by an eventuality for which $\neg P$ holds and is succeeded by a P-eventuality and there is no smaller eventuality e' that also fulfills the first two conditions

Müller's solution analyses prefixes like *los-* as *subcategorised modifiers*. First, a lexical rule maps an ordinary verb stem like *run*$_1$ (the suffix is used for expository reasons) onto a stem *run*$_2$, which subcategorises for a separable prefix as a modifier. The prefix semantics becomes the semantics of the resulting stem *run*$_2$. It specifies how the semantic contributions of the prefix and the stem *run*$_1$ are combined into the semantics of the stem *run*$_2$. Thus, the semantics of the stem *run*$_2$ can be paraphrased as 'prefix semantics (whatever that may be) applied to the semantics of *run*$_1$'. The semantics of *run*$_1$ is lexically given.

Next *run*$_2$ undergoes nominalisation by circumfixing *Ge...e*, which yields *Gerenne*. But in this noun, the subcategorisation for the prefix remains. The paraphrase of the semantics of *Gerenne* is 'ITER applied to *run*$_2$ semantics' (i.e., 'ITER

applied to the prefix semantics (whatever that may be) applied to run_1 semantics').
The final step then is the determination of the prefix semantics to the operator BECOME after the subcategorisation for a prefix has been saturated by *los-*.

However, as soon as one would try to generalise this solution to modification in general (something which Müller doesn't do, but which might be one way of capturing the common ground between his examples and the data discussed in the main part of this paper), the result would be massive ambiguity in the lexicon. E.g., *dancer* would have to be ambiguous between the standard reading and another reading that subcategorises for a modifier. (This subcategorisation would be inherited from a reading of *dance* that is derived from Müller's lexical rule.) This second reading of *dancer* would have the following semantics, where the λ-abstracted property P is eventually identified with the modifier semantics:

(39) $\lambda P \lambda y.\mathrm{GEN}[e,x](x\ \mathbf{in}\ e \wedge y = x, \mathbf{dance}'(x)(e) \wedge P(e))$

But instead of trying to generalise Müller's solution to the other data presented in this paper, I will implement the insight that this morphology-semantics mismatch can be analysed in analogy to the account of the syntax-semantics mismatches advocated in this paper.

The implementation follows the crucial observation sketched in (37), viz., that the semantic effect of prefixation resembles the effect of modification in examples like (3) and (5). This suggests handling prefixation at the morphology-semantics interface in a fashion close to the (syntax-semantics) interface rule (25).

The rule that builds the semantic representations for affixed nouns, e.g., (40) [= (30)] for *dancer*, is given as (41):

(40)
$$\begin{array}{l} [\![\mathtt{N}]\!] : \lambda y.\mathrm{GEN}[e,x](x\ \mathbf{in}\ e \wedge y = x, \boxdot(e)) \\ \qquad\qquad\qquad\qquad [\![\mathtt{N_S}]\!] : \mathbf{dance}'(x) \end{array}$$

(41)
$$[_{\mathtt{X}}\ \mathtt{Bs}\ \mathtt{Aff}] \overset{\text{(morph)}}{\Rightarrow} \begin{array}{l} [\![\mathtt{X}]\!] : [\![\mathtt{Aff}]\!](\lambda \vec{y}.\boxdot) \\ \qquad\quad [\![\mathtt{X_S}]\!] : [\![\mathtt{Bs_S}]\!](\vec{y}) \end{array}$$

In close analogy to the modification rule (25), (41) assigns affixed expressions a structured semantic representation where the main fragment of the affix dominates the secondary fragment of its base. Scope between the main fragments of base and affix is in principle open; for bases that are roots it is fixed, however, when the main and secondary fragments coincide for these roots. (40) is constructed by (41) from the semantic contribution (7a) of the affix and the semantics of *dance* (**dance**′, which relates eventualities and individuals).

However, the analogy between (25) and (41) is not complete in that (41) defines the main fragment of the affix as the main fragment of the resulting word and the secondary fragment of the base as the resulting word's secondary fragment.

What is more, interface rules for affixation must take into account *argument binding*. The fact that affixes may bind arguments of their base is anticipated in rule (41) in that the individual arguments of the stem are λ-abstracted in the main fragment, which allows binding by the affix. It is then the task of the affix to determine how many arguments are bound; while *-er* binds everything but the agentive argument and *Ge*. . . *e*, every argument of its base, semantically transparent prefixes like *los-* inherit all individual arguments from their bases. (See the corresponding semantic representations of the affixes (7a), (42), and (45).)

Note that in (41) the category of the base ('Bs') and of the resulting expression ('X') are left open. In addition, the rule does not predict the ordering of affix and base. This kind of information must be supplied by the affixes themselves, it is not part of the interface rule. E.g., *Ge*. . . *e* and *-er* map verbal bases to nouns, while *los-* maps nominal or verbal bases to expressions of the same category.

I will now outline the derivation of the semantics of *Losgerenne*. First, the semantics of the circumfix *Ge*. . . *e* maps n-ary relations P between an eventuality and $n-1$ individuals to the property of being an iteration of P-eventualities (with possibly different participants):

(42) $\lambda P \lambda e.\mathrm{ITER}(\lambda e' \exists \vec{x}.P(\vec{x})(e'))(e)$

Semantic construction for *Gerenne* builds on (42) and a simple lexical entry for the verbal root *renn-* 'run':

(43) $[\![\mathtt{V}]\!]$, $[\![\mathtt{V_S}]\!]$: $\lambda x \lambda e.\mathbf{run}'(x)(e)$

(42) and (43) are combined into the semantic representation (44) for *Gerenne* by rule (41):[9]

(44) $[\![\mathtt{N}]\!] : \lambda e.\mathrm{ITER}(\lambda e' \exists x.\ \boxed{\cdot}\ (e'))(e)$

$[\![\mathtt{N_S}]\!] : \lambda e.\mathbf{run}'(x)(e)$

Another application of rule (41) builds the semantics of *Losgerenne* from the semantics of *los-* (45) and (44). (45) maps n-ary relations P onto the n-ary relation which involves the same individual arguments and the begin of a P-eventuality.

(45) $\lambda P \lambda \vec{x} \lambda e.\mathrm{BECOME}(P(\vec{x}))(e)$

(46) $[\![\mathtt{N}]\!] : \lambda e.\mathrm{BECOME}(\boxed{\cdot})(e)$ $\quad$ $\lambda e.\mathrm{ITER}(\lambda e' \exists x.\boxed{\cdot}(e'))(e)$

$[\![\mathtt{N_S}]\!] : \lambda e''.\mathbf{run}'(x)(e'')$

[9]Note that the semantic representation (44) for *Gerenne* is also adequate as the input for the semantic construction of *schnelles Gerenne* in terms of rule (25), which may refer to iterations of fast runnings, i.e., the iteration itself need not be fast. This interpretation, where the modifier pertains only to the stem of its modified expression, is adequately captured by pertaining the modifier *schnell* to the embedded fragment of the semantic of *Gerenne* (which comprises the stem semantics).

Affixation of *Gerenne* by *los-* introduces an additional fragment for *los-* (with the change-of-state operator BECOME) that dominates the verb stem semantics but not the fragment for the circumfix on the right. I.e., narrow scope of BECOME with respect to ITER is possible according to (46).

Finally, we have to explain why narrow scope of BECOME is not only possible but indeed necessary. Here my intuition on the semantics of (productive and semantically transparent) *los-* is that it requires its argument to refer to an eventuality that involves a *maximal axis* in the sense of Lang (1990). For instance, *los-* attaches easily to movement verbs (*loslaufen* 'start walking', *losrollen* 'start rolling' [intransitive]) or even weather verbs that involve movement (*loshageln* 'start hailing', *losregnen* 'start raining) in contrast to other weather verbs (**losfrieren* 'start freezing'). Since an iteration of running eventualities as opposed to these eventualities themselves does not involve such a maximal axis, the sole resolution of (46) is the one where the right fragment receives widest scope, which yields the desired semantic representation (37b) for *Losgerenne*.

In sum, the goal of this paper has been to substantiate my claim that there is considerable common ground between the syntax-semantics mismatches that were presented in this paper. This common ground calls for a unified analysis, which was then presented in the paper within a version of the syntax-semantics interface that is implemented as the CONT feature of HPSG signs. Finally, I motivated and sketched an extension of the analysis to a morphology-semantics mismatch for German separable-prefix verbs.

References

Abney, Steve. 1987. *The English noun phrase in its sentential aspect*. Ph. D.thesis, MIT.

Chomsky, Noam. 1995. *The minimalist program*. Cambridge: MIT Press.

Copestake, Ann, Flickinger, Daniel, Pollard, Carl and Sag, Ivan. 2003. Minimal Recursion Semantics. An introduction, MS (revised version), CSLI Stanford.

Davidson, Donald. 1967. The logical form of action sentences. In Nicholas Rescher (ed.), *The logic of decision and action*, pages 81–95, Pittsburgh: Pittsburgh University Press.

Diesing, Molly. 1992. *Indefinites*. Cambridge: MIT Press.

Dowty, David. 1979. *Word meaning and Montague grammar*. Dordrecht: Reidel.

Egg, Markus, Koller, Alexander and Niehren, Joachim. 2001. The constraint language for lambda-structures. *Journal of Logic, Language, and Information* 10, 457–485.

Kasper, Robert. to appear. The semantics of recursive modification. *Journal of Linguistics* .

Kathol, Andreas. 1999. Restrictive modification and polycategorial NPs in English. In Gousse Bouma, Erhard Hinrichs, Geert-Jan Kruijff and Richard Oehrle (eds.), *Constraints and resources in natural language syntax and semantics*, pages 83–100, Stanford: CSLI Publications.

Kishimoto, Hideki. 2000. Indefinite pronouns and overt N-raising. *Linguistic Inquiry* 31, 557–566.

Kiss, Tibor. 1995. *Merkmale und Repräsentationen*. Westdeutscher Verlag.

Krifka, Manfred, Pelletier, Francis, Carlson, Gergory, ter Meulen, Alice, Chierchia, Gennaro and Link, Godehard. 1995. Genericity: an introduction. In Gregory Carlson and Francis Pelletier (eds.), *The generic book*, pages 1–124, Chicago: University of Chicago Press.

Lang, Ewald. 1990. Primary perceptual space and inherent proportion schema. *Journal of Semantics* 7, 121–143.

Larson, Richard. 1998. Events and modification in nominals. In Devon Strolovitch and Aaron Lawson (eds.), *Proceedings from SALT VIII*, pages 145–168, Cornell University, Ithaca.

Lüdeling, Anke. 2001. *On particle verbs and similar constructions in German*. Stanford: CSLI Publications.

Müller, Stefan. 2003. The morphology of German particle verbs: solving the bracketing paradox. *Journal of Linguistics* 39, 275–325.

Pollard, Carl and Sag, Ivan. 1994. *Head-driven Phrase Structure Grammar*. CSLI and University of Chicago Press.

Reyle, Uwe. 1993. Dealing with ambiguities by underspecification: construction, representation, and deduction. *Journal of Semantics* 10, 123–179.

Sag, Ivan. 1997. English relative clause constructions. *Journal of Linguistics* 33, 431–484.