
A Perspective on PPs

Cornelia M. Verspoor

1	Introduction	230
2	Adjuncts or Complements?	231
2.1	Syntactic Tests for Argument Structure	231
2.2	Semantic Tests for Argument Structure	236
2.3	Conclusions	238
3	Pseudo-Complements	238
3.1	Definition and Relation to adjuncts	238
3.2	Pseudo-complement semantics	241
3.3	Conclusions	243
4	Semantic integration of pseudo-complements/adjuncts	243
4.1	Characteristics of adjuncts to be accounted for	243
4.2	The standard HPSG approach	247
4.3	A “Semantic Obliqueness” hierarchy	247
4.4	The lexical rule approach	249
4.5	Conclusions	250
5	Representation and Methodology	250
5.1	Semantic representation	250
5.2	Implementation of the representation within HPSG	253
5.3	Changes to the Verspoor (1994) implementation	255
5.4	Adjunct semantics	258
5.5	The OP-ADJUNCTS feature	262
5.6	Lexical rules	265
5.7	Dative alternation	267
6	Conclusions	269
	References	271

Abstract

This paper investigates the treatment of the semantic contribution of prepositional phrases in HPSG, with particular reference to dative prepositional phrases (PPs). Using standard syntactic and semantic tests for argument structure, it is shown that certain *for*- and *to*-dative PPs must be construed as entities at a level between pure complements and pure adjuncts. A proposal is made for the semantic integration of PPs in an HPSG framework, based on work by Kasper (1993) and van Noord and Bouma (1994). The proposed approach accommodates various syntactic and semantic properties of adjuncts and provides a way of handling dative PPs which captures generalisations about their semantic contribution across verbal heads.

1 Introduction

This paper investigates the treatment of the semantic contribution of prepositional phrases in HPSG, with particular reference to dative prepositional phrases (PPs). It begins with an investigation of the status of *for*- and *to*-dative PPs in Section 2 – does the syntactic behaviour of these PPs as verbal complements warrant a treatment of their semantic contribution which ignores the consistency of this contribution across uses? It will be shown that certain of these PPs must be construed as entities at a level between pure complements and pure adjuncts. These *pseudo-complements*, as they will be called, have the syntactic properties of complements and the semantic properties of adjuncts. The integration of their semantics with the semantics of the modified entities can be treated in a manner analogous to the treatment for pure adjuncts. However, in Section 3 the pseudo-complements will be shown to have a semantic behaviour differing from the semantic behaviour of pure adjuncts, and this difference will be explicitly accommodated in the framework controlling the semantic integration.

Section 4 will discuss issues related to the treatment of prepositional phrases in HPSG, including general properties of adjuncts which must be accommodated and the existing HPSG treatments of adjuncts. The existing approaches will be shown to fail in adequately handling certain syntactic and semantic properties of adjuncts. In particular, interactions between surface order and semantic precedence are stumbling blocks for those approaches.

Section 5 will propose a framework based on work by Kasper (1994) and van Noord and Bouma (1994) which supports integration of the semantic contribution of all PP types. A semantic representation will be introduced which captures critical properties of verbal semantics and provides the foundation for the treatment of both pseudo-complements and adjuncts within the same system. The treatment of the semantic integration is handled via rules which will be explicitly stated and shown to provide a more satisfactory handling of surface order/semantic precedence interactions as well as other adjunct properties. The framework will also be shown to accommodate a treatment of the phenomenon of the dative alternation.

2 Adjuncts or Complements?

The model of the dative alternation as presented in Verspoor (1994) depends on an analysis of dative PPs¹ as subcategorized-for complements of the relevant verbs. It is not entirely obvious, however, that this is a semantically acceptable analysis.

The approach in Verspoor (1994) forces the semantic contribution of these PPs to be specified explicitly in the lexical entry for each verb which can appear with a dative PP. This ignores generalisations over the contribution of the PPs, in that the PPs seem to add similar information regardless of which specific verb they appear with. Thus in each of (1) and (2), the PP *for Mary* specifies who benefits² from the event described in the remainder of the sentence.

- (1) John baked a cake for Mary.
- (2) John made a drawing for Mary.

Likewise, the contribution of the inner NP in the alternate in (3) of (1) and the alternate in (4) of (2) can be identified as specifying who receives benefit from the outer NP.

- (3) John baked Mary a cake.
- (4) John made Mary a drawing.

A more general question arises from the observation of such generalisations – what is the status of these elements? Should they be treated as subcategorized-for complements or as adjuncts which make an independent, identifiable, semantic contribution across verbal heads? This will be investigated below through a series of standard syntactic and semantic tests for argument structure. The two types of dative PPs, *to*-PPs and *for*-PPs, will be contrasted in this investigation. The analysis will show that *for*-dative PPs and certain *to*-dative PPs behave as complements syntactically while behaving as adjuncts semantically. The remaining *to*-dative PPs behave as complements both syntactically and semantically.

2.1 Syntactic Tests for Argument Structure

2.1.1 The “do so” Test

The standard syntactic (structural) test for argument structure might be called the “do so” test. In X-bar theory terms, a complement is seen as combining with a lexical category to form an intermediate phrasal category while adjuncts combine with an intermediate phrasal category to produce the same category. The claim is that a full V-bar level constituent can be replaced by “do so”. In the case of dative sentences, if the constituent {verb NP} in isolation (i.e. without the PP element) can be replaced by “do so”, this indicates that the prepositional phrase is acting as a V-bar adjunct, because {verb NP} is construed as a V-bar constituent in isolation. If only the full constituent {verb NP PP} can be replaced by “do so”, the PP must be construed as a complement.

¹PPs which participate in the dative alternation, i.e. *to*-datives, as in sentences of the form *John gave a book to Mary* which alternate with those of the form *John gave Mary a book*, and *for*-datives, as shown in (1) and (3).

²in some way – how precisely will be discussed in Section 3.2.1.

***to*-datives**

As noted in Jackendoff (1990), there seem to be two types of verb classes which can appear with *to*-datives. The first type are verbs for which the PP is a complement, while the PP is an adjunct for verbs of the second type. The data in (5)-(12) suggest that *give* and *tell* belong to the first subclass (despite the optionality of the *to*-PP with *tell*), while *send* and *kick* belong to the second.

- (5) a. Adam gave a book to Debbie and Brian also did so.
 b. *Adam gave a book to Debbie and Brian did so to Susan.
- (6) a. Adam told a story to Debbie and Brian also did so.
 b. *Adam told a story to Debbie and Brian did so to Susan.
- (7) a. Adam gave a book to Debbie in the library.
 b. *Adam gave a book in the library.
- (8) a. Adam told a story to the children in the bedroom.
 b. Adam told a story in the bedroom.
- (9) a. Sam sent a letter to Bill and Mark also did so.
 b. Sam sent a letter to Bill and Mark did (so) to Susan.
- (10) a. Sam kicked a ball to Bill and Mark also did so.
 b. Sam kicked a ball to Bill and Mark did (so) to Susan.
- (11) a. Sam sent a letter from the post office.
 b. Sam sent a letter to Bill from the post office.
- (12) a. Sam kicked a ball in the park.
 b. Sam kicked a ball to Bill in the park.

***for*-datives**

The application of this test to *for*-datives, as shown in (13)-(14), provides evidence that these prepositional phrases should be treated as adjuncts.

- (13) a. Adam baked a cake for Debbie and Brian also did so.
 b. Adam baked a cake for Debbie and Brian did so for Susan.
- (14) a. Adam sang a song for Debbie and Brian also did so.
 b. Adam sang a song for Debbie and Brian did so for Susan.

2.1.2 Iterability test

Pollard and Sag (1987) (P&S 1987) discuss the complement vs. adjunct distinction, reviewing several syntactic and semantic tests which generally capture usage distinctions between the two types of constituents.

One of the syntactic tests is the iterability test. In general, several instances of the same adjunct type can combine with the same head, as shown in (15).

- (15) Kim and Sandy met in Baltimore in the Hyatt hotel in the lobby.
[P&S 1987, (257a)]

Complements, on the other hand, cannot be iterated. Thus in (16)-(18) the prepositional phrases seem to be complements rather than adjuncts.

- (16) *Adam gave a book to Debbie to Frank.
(17) *Adam told a story to the kids to the adults.
(18) *Adam sent a letter to Mary to Diane.

By the same logic, however, it would appear that the prepositional phrases in (19)-(21) are complements as well.

- (19) *Sam kicked a ball to Bill to Frank.
(20) *Sam sent a letter to Bill to Frank.
(21) *Adam baked a cake for Debbie for Susan.³

The problem here is that adjuncts can really only be iterated if the semantic (meaning) contribution each makes is in a relation of containment to the previous adjuncts. Thus in (15), the adjuncts can be iterated because each one can be interpreted as being contained within the location specified by the previous adjunct, making more precise the locative information, rather than providing an overriding semantic contribution. In (16)-(21), the prepositional phrase specifies the (intended) recipient of some object. The containment relation does not apply to distinct recipients and therefore these adjuncts are incompatible with iteration. This analysis is confirmed by the data in (22) and (23), which contrast with (15) and (20) respectively. Sentence (22) is ungrammatical because Chicago cannot be contained within Baltimore, while (23) is grammatical because the head office of the Times is contained within New York.⁴

- (22) *Kim and Sandy met in Baltimore in Chicago.
(23) Adam sent a letter to New York to the head office of the Times.

³This sentence is okay, however, on an interpretation in which the entire action of *Adam baking a cake for Debbie* has been performed for Susan's benefit. See Section 3.

⁴Thanks to Janet Hitzeman for the suggestion of this data.

Similarly, temporal adjuncts which are very similar in content and type to locative adjuncts can only be iterated if the information conveyed by a given adjunct is contained in the information conveyed by previous adjuncts. One point in time does not contain another, but a point of time is contained in a span of time. Thus (24a) is ungrammatical, while (24b) is not. The difference here has nothing to do with a difference in status between the PPs, but rather the fact that certain semantic roles can be multiply specified via the containment relation while for other roles this relation does not apply.

- (24) a. *Sam kicked a ball at 10 o'clock at 8 o'clock.
 b. Sam kicked a ball in the morning at 10 o'clock.

Furthermore, some of the examples Pollard and Sag provide of adjunct iteration rely on pragmatic factors and do not seem to be wholly grammatical. For example, (25) can seemingly only be interpreted with the two prepositional phrases as adjuncts if the comma indicates a conjunction such as “and”.

- (25) Heather opened the rusty lock with a key, with a pair of pliers. [P&S 1987, (257e)]

Applying this interpretation requirement to the ungrammatical sentences above improves their acceptability, as shown in (26)-(29). These sentences seem to display ellipsis, rather than providing a sense of the underlying argument structure.

- (26) Adam gave a book to Debbie and to Frank.
 (27) Sam kicked a ball to Bill and to Frank.
 (28) Sam sent a letter to Bill and to Frank.
 (29) Adam baked a cake for Debbie and for Susan.

This test is therefore not a reliable indicator of argument structure, and in fact cannot be viewed as purely syntactic since the phenomenon of iterability seems to interact with semantic factors. The evidence it provides for treating the dative prepositional phrases as complements rather than adjuncts will not be taken as definitive.

2.1.3 Relative Order

Pollard and Sag (1987) point out that in English adjuncts tend to be ordered after complements, suggesting that prepositional phrases which are required to precede other kinds of adjuncts are actually complements.

The data in (30)-(35) suggest that the dative prepositional phrases should be treated as complements according to the relative order diagnostic. These PPs must appear before any other adjunctive phrases.

- (30) a. Adam gave a book to Debbie in the library.

- b. *Adam gave a book in the library to Debbie.
- (31) a. Adam told a story to the children in the bedroom.
b. *Adam told a story in the bedroom to the children.
- (32) a. Adam sent a letter to Mary from the post office.
b. *Adam sent a letter from the post office to Mary.
- (33) a. Adam kicked a ball to Mary in the park.
b. *Adam kicked a ball in the park to Mary.
- (34) a. Adam baked a cake for Mary in the kitchen.
b. ?Adam baked a cake in the kitchen for Mary.
- (35) a. Adam sang a song for Mary in the pub.
b. ?Adam sang a song in the pub for Mary.

2.1.4 Complement-Internal Gaps

Some adjuncts appear to be extraction islands, as shown in (36), while unbounded dependencies into complements are generally possible, as shown in (37). The data in (38)-(40) therefore suggest that the dative prepositional phrases are complements rather than adjuncts.

- (36) *Which endangered species did Sandy meet someone fond of __? [P&S 1987, (260c)]
- (37) Which endangered species did Kim impress you as being most fond of __?
[P&S 1987, (261c)]
- (38) Whom did Adam give a book to __?
- (39) Whom did Adam kick a ball to __?
- (40) Whom did Adam bake the cake for __?

Pollard and Sag acknowledge, however, that certain adjunct types do appear to sanction internal gaps, as shown in (41)-(42).

- (41) This is the blanket that Rebecca refuses to sleep without __. [P&S 1987, (264a)]
- (42) Which symphony did Schubert die without finishing __? [P&S 1987, (264c)]

Furthermore, one of the examples they give of an ungrammatical sentence with an adjunct-internal gap, shown in (43a), seems to become more acceptable with a different adjunct, as in (43b). The change involves replacing the “motivational” adjunct with a *for*-PP, suggesting that this type of adjunct allows internal gaps. It therefore may be incorrect to assume that the data in (38)-(40) necessarily indicate that the dative PPs should be treated as complements.

- (43) a. * Which famous professor did Kim climb K-2 without oxygen in order to impress
 ___? [P&S 1987, (260b)]
- b. Which famous professor did Kim climb K-2 without oxygen for ___?

2.2 Semantic Tests for Argument Structure

2.2.1 Constancy of Semantic Contribution

Pollard and Sag (1987) discuss the semantic basis for the distinction between arguments and adjuncts as follows:

In general, a given adjunct can co-occur with a relatively broad range of heads while seeming to make a more-or-less uniform contribution to semantic content across that range. A given optional complement, by contrast, is typically limited in its distribution to co-occurrence with a small (and often semantically restricted) class of heads (possibly even a single item); in addition, the semantic contribution of the complement is idiosyncratically dependent on the head. (p. 136)

In addition, the contribution of the adjunct to the semantic content of a phrase is not simply the filling of some role in the head's relation. It is this observation which seems to distinguish the two types of *to*-datives. For the "true" *to*-datives, such as *give* and *tell*, the semantic information contributed by the dative PP is directly relevant to the meaning of the verb, fills a particular role (such as that of RECIPIENT in the *give* relation) and is therefore a "true" argument of the verb. For the "adjunct" *to*-datives, the semantics of the dative PP provides additional information about the situation being described by the sentence, but does not fill a particular role in the verb's relation.

Both *to*- and *for*-datives appear with a wide range of heads. More importantly, they seem to have a constant semantic contribution across each use. In general terms, the *to*-datives seem to indicate the intended recipient of some object, and the *for*-datives seem to indicate the intended beneficiary of something.⁵

2.2.2 Functor vs. Argument

Pollard and Sag (1987) remind us that much work suggests that the adjunct/complement distinction reduces to whether the element in question is semantically a functor or an argument. This seems to hinge on the type of semantic contribution the element makes to the sentence in which it appears. The discussion of this with respect to dative PPs is found in the previous section and will not be repeated here. The conclusion is simply that in most contexts dative PPs seem to make a consistent semantic contribution augmenting the semantic relation

⁵Since the semantics of these elements seems to be uniform across heads, there is semantic evidence in support of their treatment as adjuncts. This consistent contribution was observed by Jackendoff (1990) and formalized in terms of "adjunct rules" which identify the semantic contribution of particular elements in certain syntactic constructions and indicate how this contribution is to be integrated into the semantic representation for the overall construction. The contribution can also be observed in the core structures of dative verbs, as presented in Verspoor (1994).

expressed by the verb rather than a contribution specifically dictated by the verb, and that they therefore should be treated as functors which select their verbal heads.

2.2.3 Entailment Tests

A good indicator of a verb's argument structure is the entailments of sentences containing the verb. For example, the optional prepositional phrases in (44a) seem to be optional complements of the verb *complain* rather than adjuncts due to the entailments displayed in (44b). (Examples from Wechsler 1994.)

- (44) a. John complained (to Mary) (about the heat).
 b. John complained.
 $\models \exists x, y \mid \text{John complained to } x \text{ about } y.$

In contrast, adjunctive prepositional phrases do not result in such entailment patterns, as shown in (45). These entailment patterns indicate whether or not particular semantic information is directly relevant to the meaning of the verb. Information which is not directly relevant should be treated as an adjunct rather than an argument.

- (45) a. John sang (to Mary) (about his homeland).
 b. John sang.
 $\not\models \exists x \mid \text{John sang to } x.$
 $\not\models \exists y \mid \text{John sang about } y.$

Considering the application of this test to *to*-datives, we find the entailment patterns in (46). The data supports Jackendoff's assertion that some *to*-datives require the PP as an argument, while for others it is an adjunct. What is interesting, however, is the contrast between (46b) and (46c). The notion of a recipient is more central to the notion of *sending* than to *kicking*, since *send* necessarily involves an (intended) transfer, while *kick* does not. Thus there are semantic differences in the relationship these verbs have to the *to*-PP which are not reflected in the syntactic tests for argument structure.

- (46) a. Adam told a story.
 $\models \exists x \mid \text{Adam told a story to } x.$
 b. Sam sent a letter.
 $\models \exists x \mid \text{Sam sent a letter to } x.$
 c. Sam kicked a ball.
 $\not\models \exists x \mid \text{Sam kicked a ball to } x.$

Applying the test to *for*-datives, we have the entailment patterns in (47). The information added by the PPs thus seems to be adjunctive.

- (47) a. Adam baked a cake.
 $\not\models \exists x \mid \text{Adam baked a cake for } x.$

- b. Adam sang a song.
 $\not\models \exists x \mid$ Adam sang a song for x .

However, the semantic intuitions about the adjunctive nature of *for*-datives become a bit confused when we consider the data in (48) (Haegeman 1991).

- (48) a. Hercule bought a detective story for Jane.
 b. Hercule bought Jane a detective story.
 c. Hercule bought a detective story.

In an unmarked context, (48c) is taken to mean that Hercule bought the story for himself. This suggests that the semantic relation of *buying* includes the person for whom the bought object is intended. Thus, (48c) $\models \exists x \mid$ Hercule bought a detective story for x . This would seem to argue against the treatment of the *for*-PP as an adjunct for the verb *buy*, but the semantic intuitions about *for*-datives remain valid in the general case.

2.3 Conclusions

The most influential argument for the treatment of certain dative PPs as adjuncts rather than complements is that they seem to have a constant semantic contribution across all applications. The fact that these PPs often appear to behave as complements syntactically is overshadowed by the semantic generalisations which can be made by treating them as adjuncts. It does not seem to make sense to treat these PPs as idiosyncratically contributing semantic information to the heads they modify when this semantic contribution is so consistent. This consistency, however, does not seem to hold as strongly for *to*-dative PPs as for *for*-dative PPs. The syntactic and semantic tests raise much contradictory evidence for the argument status of the *to*-dative PPs.

The *send* and *kick* type *to*-datives and the *for*-dative PPs seem to be instances of something which I will call a *pseudo-complement*. This is an element which often behaves syntactically as a complement but which behaves semantically as an adjunct. The information expressed by the pseudo-complement cannot be logically inferred from the use of the verb, but is somehow “closer” to the meaning expressed by the verb than true adjuncts. This idea will be developed further in the section which follows.

3 Pseudo-Complements

3.1 Definition and Relation to adjuncts

It is possible to define a pseudo-complement precisely in terms of its relationship to the semantics of the verbs it modifies. Specifically, a pseudo-complement is an element with an independent semantic contribution involving a semantic argument of the verb. In contrast, adjuncts are elements with an independent semantic contribution involving the full event described by the verb and its semantic arguments. Thus the semantics of a pseudo-complement

preposition specifies a relation between an element *within* the semantics of the verb it modifies and the object of the preposition, while the semantics of an adjunct specifies some operation on the full event conveyed by the sentence (minus the adjunct).

Consider the sentences in (49)-(51).

- (49) a. John sang a song about his homeland.
 b. John sang a song for Mary.
 c. John sang a song in the park.
 d. John sang a song at noon.
 e. John sang a song $\left\{ \begin{array}{l} \text{about his homeland} \\ \text{for Mary} \end{array} \right\} \left\{ \begin{array}{l} \text{in the park.} \\ \text{at noon.} \end{array} \right\}$
 f. John sang a song $\left\{ \begin{array}{l} \text{in the park} \\ \text{at noon} \end{array} \right\} \left\{ \begin{array}{l} \text{*about his homeland.} \\ \text{?for Mary.} \end{array} \right\}$
- (50) a. Sam sent a letter to Bill.
 b. Sam kicked a ball to Bill.
 c. Sam sent a letter to Bill from the post office.
 d. Sam kicked a ball to Bill in the park.
 e. *Sam sent a letter from the post office to Bill.
 f. *Sam kicked a ball in the park to Bill.
- (51) a. *John ran a marathon about his homeland.
 b. John ran a marathon for Mary.
 c. John ran a marathon in the park.
 d. John ran a marathon at noon.
 e. John ran a marathon for Mary $\left\{ \begin{array}{l} \text{in the park.} \\ \text{at noon.} \end{array} \right\}$
 f. John ran a marathon $\left\{ \begin{array}{l} \text{in the park} \\ \text{at noon} \end{array} \right\}$ for Mary.

None of the PPs in the above sentences contains information which is entailed by the verb's semantics. However, in (49) and (51) there is a clear difference between the PPs in the (a,b) sentences and the (c,d) sentences. The PP in (49a) expresses a property of the *song* which is sung by John, while the PPs in the (c,d) sentences provide information about the situation described by the sentence (minus the PP). Likewise, in (50) the PP *to Bill* specifies

a particular goal relation between *Bill* and *the ball/the letter*,⁶ rather than a relation between *Bill* and the full situation expressed by the sentence (minus the PP).

It could be argued that the PP in (49a) is a structural modifier of the NP rather than the VP, such that *a song about his homeland* forms a single constituent. This would explain the grammaticality of (52). It seems, however, that the analysis in which the PP modifies the VP constituent must also be available, as shown by the grammaticality of the sentences in (53)–(54). These sentences appear to be licensed semantically – there is an argument of *sing* which is embedded into the semantics of the verb (singing entails singing *something*, even if that something is an unnamed tune; that is, it involves producing sound which is normally called a song) and this argument is available as the element within the verbal semantic representation which can be picked out for the relation contributed by a pseudo-complement. Furthermore, the existence of sentences such as (55), in which there is no explicit NP to which the PP could be attached, provides evidence that the PP can be viewed as specifying a relation involving an argument internal to the verb – an argument which is unexpressed in this case but still entailed by the verb and therefore a part of the verbal semantic argument structure.⁷ It is not the event of *singing* which is *about John's homeland*, but rather *what* John was singing.

(52) A song about his homeland was sung by John.

(53) A song was sung by John about his homeland.

(54) A song was sung by the choir about freedom.

(55) John sang about his homeland.

Sentence (49b) is ambiguous between two interpretations – one in which the PP behaves as a pseudo-complement and a second in which it behaves as a true adjunct. On the pseudo-complement interpretation, the PP expresses that the song itself is for Mary's benefit, while on the adjunct interpretation it expresses that the entire activity of singing is for Mary's benefit.

The availability of both of these interpretations implies that both a pseudo-complement and an adjunct can appear in the same sentence. Not only is this evidenced by (49e), but more interestingly by (56), which can only be interpreted as indicating that the song was for Mary's benefit and that the entire activity was done for Bill's benefit.⁸

(56) John sang a song for Mary for Bill.

⁶In terms of the representation of Verspoor (1994), this relation is namely: $\text{GO} \left(\left\{ \begin{array}{c} \text{ball} \\ \text{letter} \end{array} \right\}, \text{to (Bill)} \right)$

⁷Note that this sentence differs from sentences which superficially resemble it, e.g. *John worried about his homeland*, in which no verb-internal argument to be modified by a pseudo-complement clearly exists. The difference is that an act of worrying entails a topic about which one worries, while an act of singing does not entail a song topic. That is, *John worried* $\models \exists x | \text{John worried about } x$, while *John sang* $\not\models \exists x | \text{John sang about } x$. Thus the fact that the object of the event in the *worry* sentence is not clear does not discredit a pseudo-complement analysis of verbs like *sing* which do have a semantically entailed product.

⁸If this sentence is difficult to interpret, imagine a context, for example, in which Bill and Mary are unable to celebrate their anniversary together because they are living in different places, so Bill asks John to go to where Mary is and sing.

There is a syntactic ordering preference for the pseudo-complement PPs to precede the adjunctive PPs, as shown by the contrast between (49e) and (49f), and between (50c,d) and (50e,f). The interpretation of the *for Mary* version of the sentences in (49f) is questionable – it is unclear whether the pseudo-complement interpretation of the PP is available when preceded by another adjunct. It could be postulated on the basis of the contrast in (49f) and the sentences in (50) that the pseudo-complement interpretation of a PP is only available in immediately post-verbal-complement position, and that therefore *for Mary* in (49f) must be interpreted as specifying a relation involving the entire event expressed by the verb. This constraint can be captured in terms of obliqueness – pseudo-complements are semantically less oblique than adjuncts and less oblique elements precede more oblique elements in English.

This analysis leads to an explanation for the ungrammaticality of (51a). The PP *about his homeland* can only behave as a pseudo-complement with respect to a verb phrase; it does not provide information which could apply to a full situation. Thus there are certain PPs which can only behave as pseudo-complements and other PPs which can only behave as adjuncts. Similarly, certain verbs are not ‘open’ to pseudo-complementation. Although the semantic basis for the ‘openness’ criteria will not be explored in this paper, one factor influencing a verb’s ability to allow pseudo-complementation may be whether the activity expressed by the verb can be construed as “creating” its NP object in some sense.⁹ *Run* therefore must be closed to pseudo-complementation in its transitive form.¹⁰ This means that the PP in (51b) can only be interpreted as a true adjunct, that is that the whole activity of *John running a marathon* was done for Mary. The marathon itself cannot be interpreted as benefitting Mary. This also explains the contrast in acceptability between (49f) and (51f). There is an obliqueness difference between the PPs in the former on the pseudo-complement interpretation, which prevents the PPs from freely alternating in syntactic order. In contrast, there is no obliqueness difference between the adjuncts in the latter, enabling the PPs to appear in any order.

3.2 Pseudo-complement semantics

3.2.1 The *for*-dative pseudo-complement

In the analysis in Verspoor (1994), *for*-dative prepositional phrases are treated as arguments of the verbs with which they appear. Their semantic contribution is therefore directly integrated into the semantics of the verb at the lexical level. The semantic analysis is based on the discussion of Pinker (1989). The core semantic content of each of the *for*-dative verbs for sentences of the form NP_1 *gimbles* NP_2 *for* NP_3 ¹¹ can be paraphrased as, “ NP_1 acts on NP_2 in order for NP_3 to have NP_2 ”. The contribution of the *for*-PP can be identified as the “in order for NP_3 to have NP_2 ” portion of the paraphrase. In the notation of Verspoor (1994),

⁹Thus “singing” involves the physical creation of a song, “baking” involves bringing into existence baked goods, etc. This constraint corresponds to the constraint suggested by Jackendoff (1990, p. 196) on the double object form of *for*-beneficiary sentences, but in this case applies to the available interpretations for the **dative** forms of different types of verbs.

¹⁰Intransitives are not open to pseudo-complementation, nor are ditransitives. In the former, no semantic argument within the verb semantics is available to be modified and in the latter the element being modified would be unclear. ‘Openness’ criteria may then also depend on the semantic “base” argument structure of the verb – that is, *run* may not be open to pseudo-complementation because its base form is intransitive.

¹¹*Gimbles* is a marker for verbs which can appear in this construction.

this is represented as a HAVE event related by a *for*_{to} subordinating relation to the main event expressed by the semantics of *gimble*.

Jackendoff (1990) argues that this HAVE event doesn't properly capture the semantics contributed by the *for*-PP. He claims that the event is rather forced when applied to certain verbs. For example, when *John sings a song for Mary*, in what sense does Mary *have* the song? Jackendoff therefore suggests that the contribution of the *for*-PP is better described as indicating that the object of the preposition (NP₃) is intended to benefit from the action of the subject (NP₁). The event embedded by the *for*_{to} relation would more appropriately be as in (57b) rather than Pinker's proposal of (57a). This event represents "NP₁ affects NP₃ positively", or in other words, "NP₃ is intended to benefit from the actions of NP₁".

- (57) a. (HAVE (THING₃, THING₂)) [Pinker's proposal]
 b. (AFF⁺ (THING₁, THING₃)) [Jackendoff's proposal]

However, Jackendoff's proposal also does not seem to accurately capture the interpretation associated with the PP in this form. The benefit represented in his form is indirect – since NP₁ does not act upon NP₃ directly, what actually is intended to benefit NP₃ remains unclear. In fact, it seems that what is intended to benefit NP₃ directly is NP₂, the object upon which NP₁ acts in order to benefit NP₃. Thus it seems more accurate to represent the semantics of the *for*-dative as indicated in (58).

- (58) *for*_{to} (AFF⁺ (THING₂, THING₃))

This will be the semantics associated with the *for*-dative preposition throughout the remainder of this paper. It is clear that this representation involves a pseudo-complement interpretation since one of the arguments of the AFF⁺ predicate is a semantic argument of the verb. In addition, the treatment of the pseudo-complement modification will include tying the subordinated *for*_{to} relation directly to the semantics expressed by the verb rather than to the situation captured in the sentence.

In contrast, the *for*-adjunct preposition (as in *John ran a marathon for Mary*) adds the semantic content in (59) to the representation of the full situation. Its definition specifies that the AFFECTING argument of the AFF⁺ predicate corresponds to the entire event expressed in the sentence. The object of the preposition is therefore affected positively by the event, rather than by a particular semantic element within the event representation.

- (59) *for*_{to} (AFF⁺ (EVENT, THING₃))

Note that although Jackendoff (1990, p.195) suggests that the *for*-PP can be given precisely such an event interpretation, he provides no formal mechanism for doing so, or for distinguishing between the two possible interpretations of the *for*-PP. In Jackendoff's approach, the two different readings of the *for*-dative form must fall out of a single representation (that in (57b)), which fails to adequately reflect either reading and does not account for the identity of the interpretation of the double object form with *one* of the dative form readings (that in (58)).

The distinction that pseudo-complements pick out a semantic argument from within the verb semantics while adjuncts incorporate the event expressed in the sentence as an argument in

the relation they express is thus formalized in the semantics of the two forms associated with *for*. The difference in where the semantic contribution is integrated with respect to the verb semantics – that pseudo-complements contribute to the semantics of the verb while adjuncts contribute to the full situation expressed by a sentence – will be discussed in more detail in Section 5 and handled by the lexical rules which will be introduced there.

3.2.2 The *to*-dative pseudo-complement

In Verspoor (1994), the *to*-dative prepositional phrase is also explicitly specified as an argument of each verb with which it appears. The core semantic content for each of the *to*-dative verbs for sentences of the form NP_1 *gimble* NP_2 *to* NP_3 can be paraphrased as, “ NP_1 acts on NP_2 , causing NP_2 to go to NP_3 ”. The contribution of the *to*-PP can thus be identified as the “causing NP_2 to go to NP_3 ” portion of the paraphrase. In the notation of Verspoor (1994), this is represented as a GO event related by an *effect* subordinating relation to the main event expressed by the semantics of *gimble*, as shown in (60). The meaning of this preposition is such that no adjunctive interpretation would make sense – it wouldn’t make sense for an event to GO somewhere, and thus no adjunct interpretation exists for it.

(60) *effect* (GO (THING₂, (to (at (THING₃))))))

3.3 Conclusions

Pseudo-complements are elements very close in nature to true verbal complements. They specify a particular relation between a semantic argument of the verb and the object of the preposition. Their semantics can, however, be treated by the same mechanisms as true adjuncts. Pseudo-complements and adjuncts share the property of specifying a consistent, contentful, and identifiable relation which can be applied across modified heads.

Specification of the type of modification which an individual PP may provide with respect to a head must occur lexically. Three types of PPs will be allowed for in the treatment of PPs to be introduced in Section 5 (in particular, in the sort hierarchy) – PPs which can only behave as pseudo-complements, PPs which can only behave as adjuncts, and PPs which are ambiguous between the two. The type of a particular use of a preposition must then be specified in the lexical entry of the preposition. This type will be used as a criteria for determining how semantic integration between the semantics of the PP containing the preposition and the semantics of the modified verb is to occur.¹²

4 Semantic integration of pseudo-complements/adjuncts

4.1 Characteristics of adjuncts to be accounted for

There are certain characteristics which pseudo-complements and adjuncts share which must be taken into consideration in any treatment of the semantic contribution of these elements.

¹²i.e. which lexical rule will apply – see Section 5; 5.6 in particular.

4.1.1 Adjuncts have a consistent semantic contribution

As was discussed in Section 2.2.1, adjuncts have an identifiable, consistent semantic contribution across heads. The implication of this for any treatment of adjuncts is that there should be a single lexical entry which specifies the meaning of the adjunct with respect to a particular type of head. That is, the content of the adjunct combines in a certain general way with the content of the element it modifies (a verb or noun phrase, for example) and this must be specified only once. Since this combination does not change with every type of head, a single specification is much more efficient than incorporation into the lexical entry, into the subcat list, of each verbal head with which an adjunct can appear.

In particular, a single lexical entry can only be realized if adjuncts select the types of heads they modify. Were individual heads to idiosyncratically specify the adjuncts with which they can appear, the semantics of the adjunct could conceivably be incorporated with the content of the head in a different way for each head, and in effect the adjunct need not have any independent meaning. Furthermore, this approach requires that the set of adjuncts which could appear with a particular head be specified in advance, at the level of the lexicon, for every individual element in the lexicon which could potentially be modified by an adjunct. This is clearly not a desirable consequence.

An additional semantic argument for the selection of a head by an adjunct is observed by Kasper (1994): “The semantic contribution of a modifier generally must incorporate the semantic contribution of the element that it modifies, whereas the semantic content of the modified element (the syntactic head) does not depend crucially on any of its potential modifiers”.

4.1.2 Restrictive, Operator, and Thematic adjuncts

Adjuncts have traditionally been analysed as being of one of two types:¹³ *restrictive* adjuncts and *operator* adjuncts. Restrictive adjuncts are adjuncts which “restrict” the value of a particular index representing an object, event, or situation, such as the index for location or time of an event. These adjuncts specify properties to be associated with the indices. Operator adjuncts are adjuncts which take the content of what they modify as an argument in a semantic operation, predicating something of that content. Examples of this type of adjunct include negatives, frequentatives, and causatives.

The distinction between these adjunct types provides an explanation of the differences in the semantics of (61a) and (61b), containing operator adjuncts, as compared to the lack of semantic difference between (62a) and (62b), containing restrictive adjuncts. In (61a), the twenty minute duration is a property of the event whose frequency is described, while in (61b), the ‘twice-dailiness’ is a property of the event whose duration is described (Pollard and Sag 1987). In both (62a) and (62b), *in the park* specifies the location of the jogging, and *yesterday* specifies the time of the jogging, regardless of their surface order. They each specify (or *restrict*) properties of the main event described in the sentence, rather than predicating something of an event they receive as an argument, as in (61). (Sentences from P&S 1987, (252))

¹³This discussion of adjunct types is mainly derived from the discussion in Kasper (1994).

- (61) a. John jogged for twenty minutes twice a day.
 b. John jogged twice a day for twenty years.
- (62) a. John jogged in the park yesterday.
 b. John jogged yesterday in the park.

In essence, restrictive adjuncts seem to add new information about an index for which the event was previously underspecified (e.g. location) while operator adjuncts take the event as an argument, thereby building up a more complexly structured semantic representation for the sentence.

There is a group of adjuncts which semantically do not clearly fit either of these two types. These adjuncts, like all other adjuncts, add information to the basic event expressed by the verb plus its semantic arguments. However, they do not simply restrict an index specifying something about the situation in which the event occurs or predicate something of that situation. The function they perform with respect to the basic event expressed by the verb is to relate information via one of a predetermined, limited, set of subordinating relations. They can be viewed as adding a theme to the verb semantics, and thus will be called *thematic* adjuncts. Examples of thematic adjuncts can be found in (63)-(65). In (63), the *because_of*-PP adds information which explains the cause of the situation expressed in the remainder of the sentence. In (64), the *with*-PP expresses the means by which the situation expressed in the sentence minus the PP occurred. In (65), the *to*-PP expresses a motivation for the situation in the remainder of the sentence.

- (63) Peter reads well because of the tutoring. [Kasper 1994, (10a)]
- (64) Peter opened the door with the key.
- (65) Peter read the book to learn about World War II.

4.1.3 Surface order vs. Semantic precedence

The relative surface order of multiple restrictive adjuncts generally has no effect on their interpretation. The relative semantic scope of multiple operator adjuncts, on the other hand, sometimes does and sometimes does not depend on their relative surface order.¹⁴ Since the order of interpretation of operator adjuncts can affect the overall interpretation of a sentence, it is important to account for interpretation orders which vary from straight surface order, in addition to accounting for interpretation orders which are dependent on surface order.

An example of the inconsequence of surface order for restrictive adjuncts was shown in (62) above. The sentences in (61) showed that relative surface order can influence the interpretation of the sentence. Contrasting (61) with (66) indicates that the content of the multiple adverbials can also influence their relative interpretation. Sentences (61a) and (66a) have the same semantics despite their differences in surface order. Sentence (66b) is ungrammatical because the combination dictated by the surface order is temporally impossible – it is not possible to repeat an event which itself lasts twenty years twice within one day.

¹⁴See Kasper (1994) for a good overview of the cases of interaction among multiple adjuncts.

- (66) a. John jogged twice a day for twenty minutes.
 b. *John jogged for twenty years twice a day.

Clearly there are very complex constraints governing both the semantic composition and the relative surface order of multiple adverbials. A treatment of adjuncts must therefore provide a mechanism for the application of these constraints.

4.1.4 Redundancy constraints

It is important in any treatment of adjuncts to prevent multiple adjuncts from providing information which fills the same role. Sentences such as those presented in (67)-(69) must be prohibited. For thematic adjuncts, the constraint seems to be that only one thematic adjunct corresponding to a particular subordinating relation is allowed, while for restrictive adjuncts the constraint is that multiple restrictive adjuncts relating to the same index must have values which are related via containment (as discussed in Section 2.1.2).

- (67) a. Peter reads well because of the tutorials and because of the homework exercises.
 b. *Peter reads well because of the tutorials because of the homework exercises.
- (68) a. Heather opened the rusty lock by oiling it and by applying force. [cf. (25)]
 b. *Heather opened the rusty lock by oiling it by applying force.
- (69) a. Sam kicked a ball at 10 o'clock and at 8 o'clock. [cf. (24)]
 b. *Sam kicked a ball at 10 o'clock at 8 o'clock.

If information is explicitly coordinated through a conjunction or disjunction, it is possible for multiple PPs of the same type to appear in a sentence. Since coordination in effect builds a complex element of the same category as its components, this data can be interpreted as evidence that exactly one PP making a particular type of semantic contribution can appear in a sentence. Although this does not hold for PPs which supply information related by containment, it does hold for most PP types.

4.1.5 Interspersal of adjuncts with complements

Kasper (1994) presents a detailed analysis of word-order phenomena in the German *Mittelfeld*: “the part of the German clause between the finite verb (or the beginning of verb final clauses) and the clause final verb or verb cluster, if any.” In particular, he observes that the linear order of verb complements and adjuncts within the *Mittelfeld* is relatively free. Any treatment of adjuncts must therefore be able to account for this interspersal.

4.2 The standard HPSG approach

The treatment of adjuncts in Pollard and Sag (1994) centres on the selection of a head by an adjunct. The adjunct specifies the type of head which it modifies via the MOD feature of its SYNSEM:LOC:CATEGORY:HEAD field. Semantic integration is specified in the lexical entry of the adjunct, via structure sharing between a substructure of the head's content and the content of the adjunct. Adjuncts differ from complements in that they have a non-null MOD value, that they are not subcategorized-for by the element with which they combine, and that they are joined with that element via a different mechanism.

Immediate dominance (ID) schemata govern the permissible configurations of immediate constituency (akin to phrase-structure trees) in HPSG. One such schema creates a *head-adjunct-structure*, combining a head and an adjunct into one structure, and ensuring that the head of the constituent is an element allowed by the MOD feature of the adjunct. The content of the mother in a head-adjunct-structure is required to be token-identical with the content of the adjunct via the Semantics Principle. This guarantees that the appropriately integrated semantics is associated with the phrase as a whole.

The specification of the ID schemata in standard HPSG does not allow for Mittelfeld phenomena. The schemata handling complements require that all complements other than the subject must be combined at once into a phrase. The adjunct attachment schema allows the adjunct to appear immediately before or after the head it selects,¹⁵ or before or after the phrase containing the head and all of its complements, but does not license the appearance of the adjunct within a group of complements.

Other characteristics of adjuncts are handled in this approach, however. A single lexical entry specifies the integration of an adjunct's semantics with the element it modifies. The difference between restrictive and operator adjuncts can be accommodated by variances in the definitions in the CONTEXT field of the adjunct's SYNSEM feature. Redundancy constraints are not explicitly accommodated, but could conceivably be implemented within the MOD feature of an adjunct in terms of restrictions on the modified head. It is not entirely clear, however, how this implementation would be accomplished.

Surface order and semantic precedence issues remain a stumbling block for the standard HPSG approach. Since linear precedence constraints (constraints defined in terms of obliqueness which control the surface order of elements relative to one another) apply at the level of individual phrases built by the ID schemata, and only one adjunct at a time can be attached to a head via an ID schema, the order of modification is constrained to surface order.

4.3 A “Semantic Obliqueness” hierarchy

Kasper (1994) proposes a treatment of adjuncts aimed specifically at handling Mittelfeld phenomena. He adopts the standard HPSG representation of adjuncts, in that the adjuncts specify the heads they modify via the MOD field and semantic integration occurs through

¹⁵Note that this in fact does not constrain adjunctive placement enough, improperly allowing lexical heads rather than phrasal heads to be modified by an adjunct. This would therefore not rule out phrases such as **The king in the bath of France* or sentences like **John kicked in the park the ball*. These sentences must be ruled out via the lexical entries of the prepositions which select for nominal/verbal heads: a head with an empty SUBCAT list must be explicitly selected for in the MOD field of the preposition.

coindexing between parts of the CONTEXTS of the selected head and of the adjuncts themselves.

Kasper makes several relevant semantic assumptions. First, states of affairs (*soas*) come in two basic kinds: those that are spatio-temporally located (*located-qfsoa*) and those that are not (*unlocated-qfsoa*). Second, the NUCLEUS of a state of affairs is split into a primary quantifier-free *soa* (*qfsoa*) and a set of restrictions. Multiple semantic restrictions with respect to the same state of affairs can thereby be specified in the restrictions set. This set plays a role analogous to the RESTRICTIONS feature on referential indices in the semantic content of nominal objects. Thus adverbials and adnominals can be treated in a parallel manner.

The *head-complement* structure of standard HPSG is extended by Kasper to include an ADJUNCT-DAUGHTERS attribute. This is a list of adjunct signs ordered in terms of a “semantic obliqueness” hierarchy, i.e. from widest to narrowest semantic scope.

To handle the syntax and semantics of adjunction, Kasper splits the MOD field of the adjuncts into two parts: a SYN attribute which indicates the syntactic category of the head with which the adjunct must combine and a SEM attribute specifying the semantic value to which the adjunct is applied. Kasper then specifies an *Adjunct Syntax Principle* requiring the MOD:SYN attribute of all signs on the ADJUNCT-DAUGHTERS list of a *head-complement* structure to be token-identical with the CAT value of the head daughter. Furthermore, his *Adjunct Semantics Principle* forces semantic composition to occur in terms of “semantic obliqueness” order: the element with narrowest scope is applied to the head’s semantics, then the element with second-narrowest scope is applied to the resulting semantics, and so on down the list.

The relative surface order of complements and adjuncts would then have to be constrained by separate principles of constituent order which constrain the possible combinations of elements from the ADJUNCT-DAUGHTERS and COMP-DAUGHTERS attributes.

An issue which Kasper remains vague about is how elements are put onto the ADJUNCT-DAUGHTERS list. Apparently the HEAD-COMPLEMENT and HEAD-SUBJECT-COMPLEMENT schemata must be redefined to allow for arbitrary insertion of adjuncts into the ADJUNCT-DAUGHTERS list of the *head-complement* structure. What drives this insertion, however, remains unclear. Some mechanism must exist to identify all adjunctive sentence constituents, evaluate their relative “semantic obliqueness”, and insert them into the list.

Since Kasper opts for a semantic obliqueness order on the ADJUNCT-DAUGHTERS list rather than an order reflecting surface order, semantic differences which depend on syntactic order may not be appropriately handled. The adjunct insertion mechanism discussed above must be defined in such a way as to take order effects into account. Furthermore, the mechanism must also provide for adjuncts which are not hierarchically related semantically (as in the case of restrictive adjuncts) so as to avoid analysis redundancies deriving from differences in order on the list.

It is observed by van Noord and Bouma (1994) that Kasper’s approach cannot account for interpretation ambiguities in Germanic verb cluster constructions. These ambiguities occur because adjuncts are able to modify any verb within a verb cluster. Thus in the Dutch sentences in (70) (from van Noord and Bouma 1994) the adjuncts (*today, with the telescope*) can either be interpreted as having narrow scope and modifying the event introduced by the main verb or as having wide scope and modifying the event introduced by the auxiliary.

- (70) a. dat Arie vandaag Bob wil slaan
 that Arie today Bob wants to hit
 that Arie wants to hit Bob today
- b. dat Arie Bob de vrouwen met een verrekijker zag bekijken
 that Arie Bob the women with a telescope saw look at
 that Arie saw Bob looking at the women with a telescope

Under the standard treatment of such clusters within a flat structure, the first auxiliary verb is treated as the head of the structure. Kasper's solution thus dictates that any adjuncts must modify this head rather than an embedded verb, not allowing for any narrow-scope readings.

4.4 The lexical rule approach

To solve the problem of accounting for the ambiguity of adjunctive modification in Germanic verb clusters, van Noord and Bouma (1994) propose a solution treating adjunction via a lexical rule. The lexical rule specifies the addition of a single adjunct to the SUBCAT list of a verb. The ambiguity in the verb cluster modification then derives from the possibility of the lexical rule applying to any verb in the cluster. In the narrow scope case the lexical rule applies to the embedded verb, placing the adjuncts on its subcat list. The subcat requirement will then be inherited by the head verb, but the semantics of the adjunct will be incorporated into the semantics of the embedded verb. In the wide scope case the adjunct is simply on the list of the head verb and its semantics applies to the head.

Use of standard lexical rule mechanisms, i.e. application of the lexical rules upon the lexicon in a 'precomputation' phase, would result in an infinite lexicon. Nothing could prevent the lexical rule from continuing to add additional adjuncts to a SUBCAT list ad infinitum. To avoid this problem, van Noord and Bouma propose instead to treat lexical rules as constraints on lexical categories and to use delayed evaluation techniques.¹⁶

These lexical category constraints are implemented as rules which must be satisfied by the lexical entry of a word in a particular category. The constraints are evaluated with respect to the base (or "stem") form of a word in the lexicon. The true lexical entry for the word used in an attempted parse results from evaluation of constraints with respect to the base form.

The delayed evaluation techniques prevent constraints from being evaluated until enough information is available to do so. This means that constraints may actually only be partially evaluated at any step in the application of multiple constraints to a single lexical entry. The benefit of these techniques is that parsing mechanisms can interact with lexical information, allowing constraints from both structural and lexical levels to apply simultaneously as input is processed.

The van Noord and Bouma approach accommodates most of the characteristics of adjuncts well. A single lexical entry is necessary for each adjunct, and they allow for both restrictive and operator adjuncts by requiring the appropriate semantic combinations to be specified in the MOD field of the adjunct, following Kasper's (1994) approach. Mittelfeld phenomena are handled by allowing for the insertion of the adjuncts at any point in the verbal subcat list.

¹⁶These topics will only be discussed briefly in this paper. See van Noord and Bouma (1994).

It is noted by van Noord and Bouma that their approach is flexible enough to accommodate various approaches to the ordering of adverbials on the subcat list. Although the lexical constraint controlling the addition of adjuncts as defined in their paper assumes that the adjuncts are inserted into the subcat list in order of semantic obliqueness (adopting Kasper's idea of semantic combination from narrow to wide scope), there is nothing in their methodology which restricts the definition of the constraint. It is difficult to see precisely how syntactic ordering effects could be accommodated in an approach that relies entirely on semantic obliqueness. Changes in the ordering on the subcat list, however, would require radical changes in the existing definition of the constraint. In particular, if the ordering on the subcat list were changed to reflect the surface order of the adverbials, their recursive approach to semantic composition would no longer suffice. Other mechanisms, analogous to the linear precedence (LP) constraints which are required to handle word order restrictions in their existing approach, would be necessary to control semantic composition. These mechanisms could only be applied to a fully expanded subcat list and thus would prevent semantic content from being truly recursively computed.

Redundancy constraints are a problem in the van Noord and Bouma (1994) approach, as in all other approaches discussed here. They could conceivably be defined in the requirements in the MOD field specifications, but again it is not clear how to do this in a straightforward manner.

4.5 Conclusions

None of the existing approaches to the treatment of adjuncts provides a satisfactory framework for explaining surface order and semantic precedence effects. The standard HPSG approach makes no attempt to accommodate these effects whatsoever; the Kasper (1994) and van Noord and Bouma (1994) approaches both rely on unspecified principles for determining semantic precedence, and principles of constituent order to control the surface order of adjuncts. None of the approaches satisfactorily allows for interactions between these various principles. In the section that follows, I will attempt to develop a more satisfactory framework.

5 Representation and Methodology

The van Noord and Bouma (1994) treatment of adjuncts adopts the positive aspects of Kasper's (1994) treatment, integrating them into a framework which solves several problems with Kasper's original treatment. They accomplish this via a delayed-evaluation lexical rule approach to the incorporation of adjuncts. I will adopt this general approach, but will refine the semantic representation to show how it can be used to handle the phenomena of redundancy restrictions and adjunct combination restrictions. Additionally, a more explicit methodology for handling word order and semantic precedence constraints will be introduced.

5.1 Semantic representation

The semantic representation of a verb can essentially be divided into two components: *internal* and *external* semantics. The internal semantics of a verb reflects the meaning expressed

by the verb itself. This includes specification of the verb’s semantic arguments and all of the relations involving these arguments: the roles they play, and any events/subevents which can be logically inferred from a use of the verb in a sentence. The external semantics reflects meaning particular to a particular situation expressed by the verb on a particular use. Examples of elements of external semantics include location, time, and thematic information (contributed to a situation by thematic adjuncts).

In Verspoor (1994), a representation for verb semantics based on work by Pinker (1989) and Jackendoff (1990) was presented. The purpose of the representation is provide a formal way of describing the semantic role verbal arguments play with respect to one another, the main event the verb expresses and any subevents which are also expressed by the verb. The traditional HPSG representation of semantics as predicate names plus semantic roles particular to the predicate is overridden by this more general semantic description. Predicate names do not explicitly appear at all within the representation.

The essential elements of the representation include a set of conceptual primitives corresponding to ontological categories, predicates which denote particular relations, and subordinating relations used to relate subevents (Table 1). Valid predicate–argument structures, built up with the representational elements, are defined in formation rules (Table 2).¹⁷ A grammar for

¹⁷The *time* marker allows for vague specifications of temporal relations among subevents, indicating the relative order in which the subevents occur rather than locating them at a specific point or interval in time.

Conceptual Constituents	
EVENT, STATE, THING, PLACE, PATH, PROPERTY, MANNER	
Predicate Definitions	
GO	an Event-function which denotes a Thing traversing a Path.
STAY	an Event-function which denotes stasis over a period of time; two arguments: the Thing standing still and its location (Place).
MOVE	an Event-function which specifies that a Thing moves.
ORIENT	a State-function specifying the orientation of a Thing with respect to a Path.
BE	a State-function for specifying the location (Place) of a Thing.
HAVE	a State-function which specifies a Thing which has (possesses) a Thing.
AFF	a State-function which specifies that an actor “affects” a patient.
Place Functions	
at, on, in, under ...	functions expressing location.
Path Functions	
to, from, via, away-from, toward	functions expressing direction.
Subordinating Relations	
<i>effect, cause, despite, but, let, prevent, means, for _ to, obligates, fulfills</i>	

Table 1: Representational Elements

the structure of the representation of verb semantics within the lexicon is specified (Table 3, where *SubordFunc* refers to an element of the set of subordinating relations and where the allowed STATES and EVENTS are defined in the formation rules in Table 2). The action tier in a description expresses the actor/patient relationship, while the thematic tier expresses the causal relationships between the relation in the action tier and other occurrences (events or states) encompassed by a verb's semantics. The semantic descriptions allowed by the grammar correspond to the structure of the internal semantics.

The representational elements can also be used for external semantics with the addition of a formation rule to accommodate predicates with more complex arguments, such that an entire situation can be related to something in a particular way and subordinated events can be associated with a situation as a whole. Thus we might add the formation rule in (71).

$$(71) \quad [\text{STATE}] \rightarrow [\text{AFF} (\text{DESCRIPTION}, \text{THING}, \textit{time}, \textit{manner})]$$

Manner indicates how an actor acts or a theme changes during a particular state or event. This field is used, for example, to indicate the difference between walking and running: the GO-event which is a part of both will be specified for MANNER:walking in the case of *walk* and MANNER:running in the case of *run*.

[EVENT]	→	$\left\{ \begin{array}{l} \left[\text{EVENT GO} \left(\text{THING}, \text{PATH}, \textit{time}, \textit{manner} \right) \right] \\ \left[\text{EVENT STAY} \left(\text{THING}, \text{PLACE}, \textit{time} \right) \right] \\ \left[\text{EVENT MOVE} \left(\text{THING}, \textit{time}, \textit{manner} \right) \right] \end{array} \right\}$
[STATE]	→	$\left\{ \begin{array}{l} \left[\text{STATE BE} \left(\text{THING}, \text{PLACE}, \textit{time} \right) \right] \\ \left[\text{STATE HAVE} \left(\text{THING}, \text{THING}, \textit{time} \right) \right] \\ \left[\text{STATE ORIENT} \left(\text{THING}, \text{PATH}, \textit{time} \right) \right] \\ \left[\text{STATE AFF} \left(\text{THING}, \text{THING}, \textit{time}, \textit{manner} \right) \right] \end{array} \right\}$
[PLACE]	→	$\left[\text{PLACE } \textit{place function} \left(\text{THING} \right) \right]$
[PATH]	→	$\left[\text{PATH} \left\{ \begin{array}{l} \text{to} \\ \text{from} \\ \text{toward} \\ \text{away - from} \\ \text{via} \end{array} \right\} \left(\left(\begin{array}{l} \text{THING} \\ \text{PLACE} \end{array} \right) \right) \right]$

Table 2: Formation Rules

[DESCRIPTION]	→	$\left\{ \begin{array}{c} \text{STATE} \\ \text{EVENT} \\ \text{COMPLEX_DESCRIPTION} \end{array} \right\}$
[COMPLEX_DESCRIPTION]	→	$\left[\begin{array}{c} \text{ACTION_TIER} \\ \text{THEMATIC_TIER} \end{array} \right]$
[ACTION_TIER]	→	$\left[\text{STATE AFF} \left(\text{THING, THING, } \textit{time}, \textit{manner} \right) \right]$
[THEMATIC_TIER]	→	$\left[\left[\begin{array}{c} \textit{SubordFunc}_1 \left(\left\{ \begin{array}{c} \text{EVENT} \\ \text{STATE} \end{array} \right\} \right), \\ \textit{SubordFunc}_2 \left(\left\{ \begin{array}{c} \text{EVENT} \\ \text{STATE} \end{array} \right\} \right), \\ \vdots \end{array} \right] \right]$

Table 3: Semantic Description Grammar

5.2 Implementation of the representation within HPSG

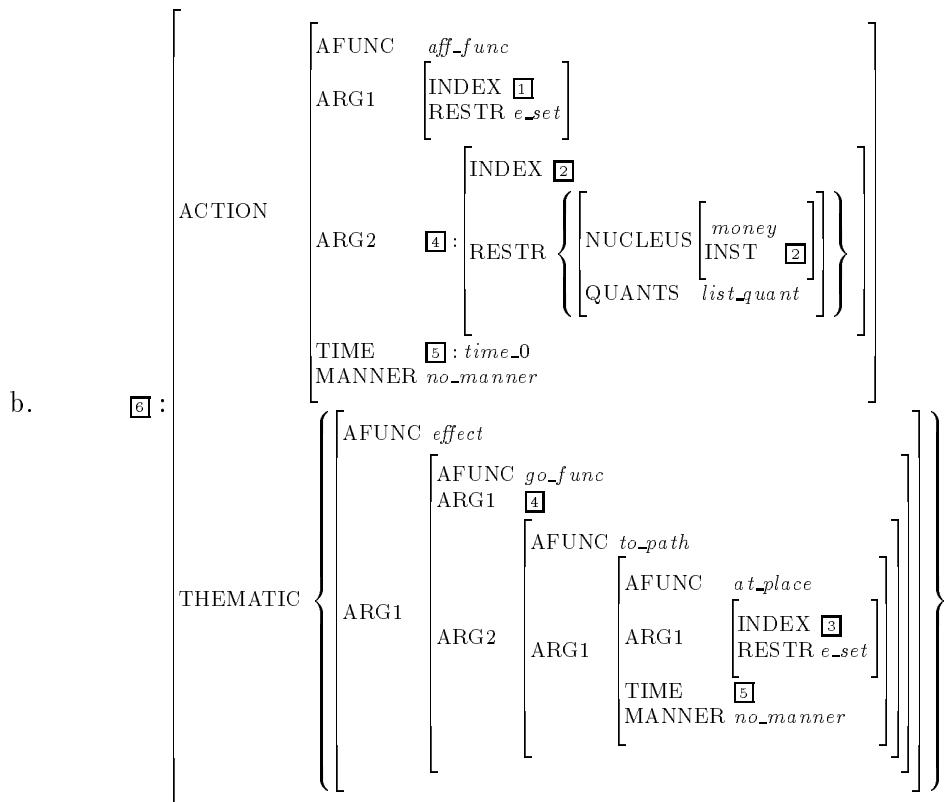
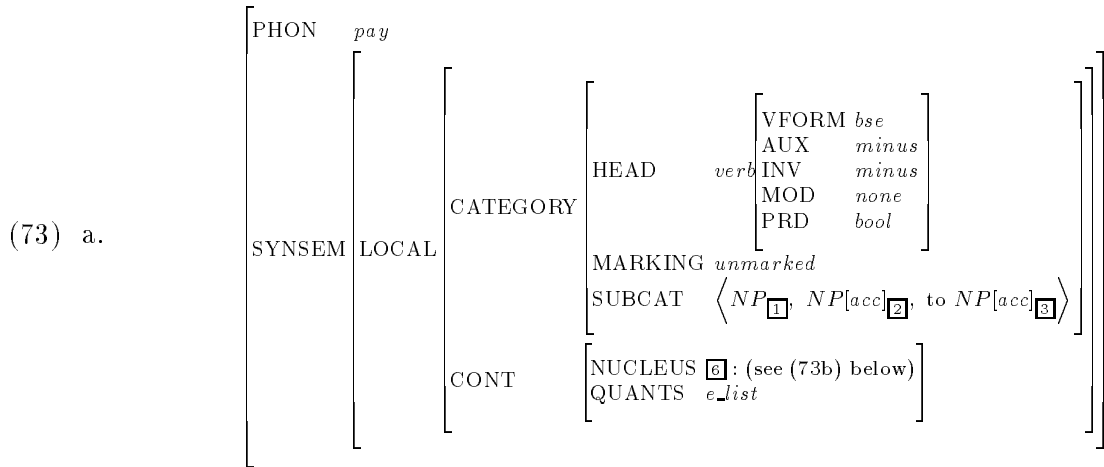
To accommodate a modified semantic representation within an HPSG grammar, a new subtype of the type *qfproa, sem-desc*, is introduced, as described in detail in Verspoor (1994).¹⁸ This type corresponds to DESCRIPTION in the semantic description grammar in Table 3 above. The definitions in the sort hierarchy for the subtypes of *sem-desc*, the features for which they are defined, and the values of these features follow the semantic description grammar. The subtypes of this type are therefore *state* and *event*, which in turn have subtypes defined according to the possible states and events as introduced in the formation rules in Table 2 above, and *complex-desc*. The latter is defined for an ACTION feature with value of type *aff-state* (affecting state, a subtype of *state*), and a THEMATIC feature which is a set of thematic elements. Thematic elements are in turn defined as having features for the subordinating relation and a subordinated *description*.

A sample HPSG lexical entry, for the verb *pay* in the sense of (72), can be found in (73) on page 254. The semantics expressed in this entry, as applied to (72), can be paraphrased as *John affects \$100 at some time_o in no particular manner with the effect that \$100 goes to Mary, also at time_o.*

The phonological (PHON) feature has as its value the written word to which the entry corresponds, for lack of a more precise phonological transcription. The SYNSEM feature contains the syntactic and semantic information associated with the word being represented. Only the LOCAL information is relevant, specifically the CATEGORY and CONT (content) information. CATEGORY includes the HEAD features of the verb, all of the features defining the form of the verb and how it can be used (AUX specifies whether the verb is an auxiliary verb, INV

¹⁸Note that the description here has been slightly simplified from the actual implementation, for purposes of clarity. See Verspoor (1994) for all details.

(72) John paid \$100 to Mary.



specifies whether the verb can appear in inverted form, MOD contains verb modifier information, PRD specifies whether the verb is predicative). The CATEGORY also contains a MARKING feature which indicates whether the verb is being used within a complementized clause (see Pollard and Sag 1994, pp. 45-47), and the SUBCAT feature which has a list of synsem objects, corresponding to the SYNSEM values of the signs with which the verb must combine to become “saturated”.

The CONT (content) field has two features: the NUCLEUS, containing the core of the semantic information, and QUANTS, used in the HPSG treatment of quantification (see Pollard and Sag 1994, ch. 8). The value of the nucleus field in this work differs dramatically from what appears in Pollard and Sag’s original HPSG work. It is where the semantic representation described in the previous paragraphs is integrated into HPSG.

The value of the NUCLEUS feature reflects the semantic structure of the verb. The example shown above shows a complex semantic structure, consisting of both an action and a thematic tier. The value of the ACTION feature is an *aff-state* entity, which specifies the AFF function as the main function, and restricts the two arguments of this function to be of type *thing*. Additionally, the features MANNER, and TIME are specified for this function. In the example, there is only one subordinated event in the thematic tier, and it is a *go-event* entity, specified for MANNER:*no_manner*, subordinated by the *effect* subordinating function. Other verbs with more subordinated occurrences simply will have more elements specified in the THEMATIC set.

5.3 Changes to the Verspoor (1994) implementation

5.3.1 The sort hierarchy

In the Verspoor (1994) implementation, there was no distinction between internal and external semantics. The semantics represented in the NUCLEUS of a verbal lexical entry was purely its internal semantics. For the purposes of the treatment of adjuncts, however, it is necessary to introduce this distinction.

In order to represent both internal and external semantics, the sort hierarchy must be rearranged. *Qfpsoa* is divided into *restricted-soa* (*rsoa*) and (unrestricted) *soa*. The former will be defined for an attribute RESTRICTION, whose value is a set of restrictions of type *psoa*. *Situated-description* (*sit-desc*) is then made a subtype of *rsoa*, while operator adverbials become subtypes of *soa* (*cause-soa*, etc). A *sit-desc* is defined for attributes INTERNAL, with value of type *desc*, and EXTERNAL, with value of type *ext-desc*. It is a *sit-desc* structure which is associated with each verb in the lexicon, and in which the verb’s internal semantics is held distinct from other kinds of semantics.

A basic type *sem-objs* is introduced. The two semantic objects – *desc*, corresponding to DESCRIPTION in the semantic description grammar in Table 3 as introduced above, and a new type *external-descriptions* (*ext-desc*) – are made to be subtypes of this type. Objects of type *ext-desc* are defined for attributes reflecting external elements of a situation. Following Kasper (1994), *ext-desc* is divided into two subtypes: *loc-desc*, defined for attributes LOCATION and TIME,¹⁹ and *unloc-desc*, not defined for either attribute.

¹⁹I have not explored the representation of temporal information and will leave the precise definition of the TIME attribute unspecified.

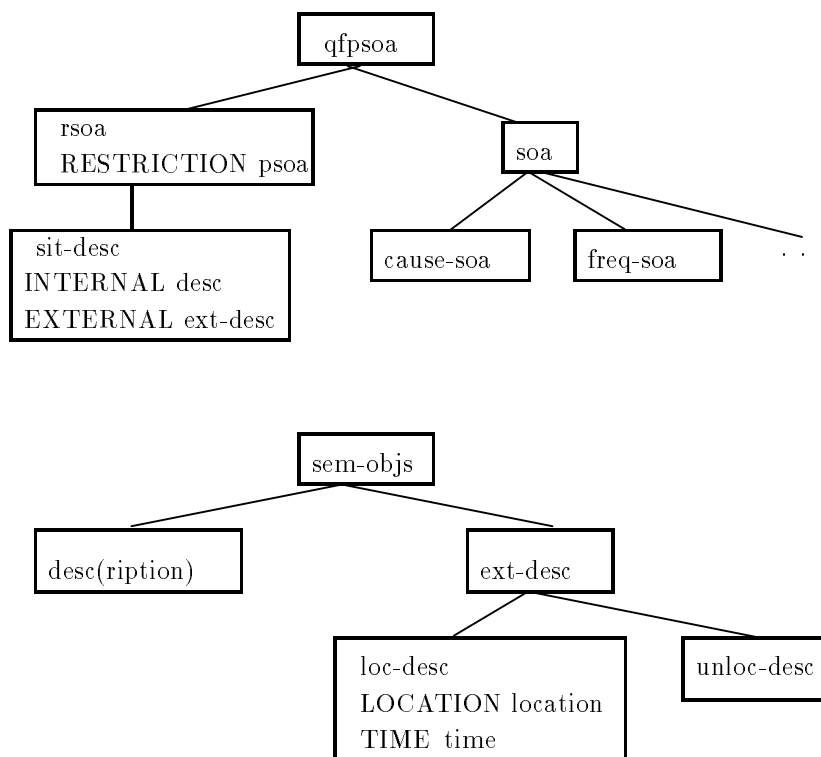


Figure 1: Type hierarchy for some semantic elements

The types as described above are summarized in Figure 1.

5.3.2 PP types

Thematic prepositional phrases add information to a situation which can be related to the situation via subordinating relations. In general only one thematic PP adding a given type of information can appear in a sentence, as is clear from the discussion in Sections 2.1.2 and 4.1.4. This redundancy restriction can be handled by defining objects of type *ext-desc* to have no more than one attribute corresponding to a particular thematic PP type.

In addition, it is important to track exactly which types of PPs have already appeared in the sentence in order to rule out sentences such as (74) in which the semantic content of the PPs is token-identical.

(74) *Peter reads well because of the tutoring because of the tutoring. [cf. (63)]

In a lexical rule approach using a sort hierarchy in which objects of type *ext-desc* are defined to have a single attribute per thematic adjunct type (that is, *ext-desc* objects are defined to have one feature for each of the possible subordinating relations), the lexical rule would simply require the content of an adjunct PP to be token-identical with the value of the corresponding thematic attribute in the verb's external semantic content. This approach is incapable of ruling out sentences like (74).

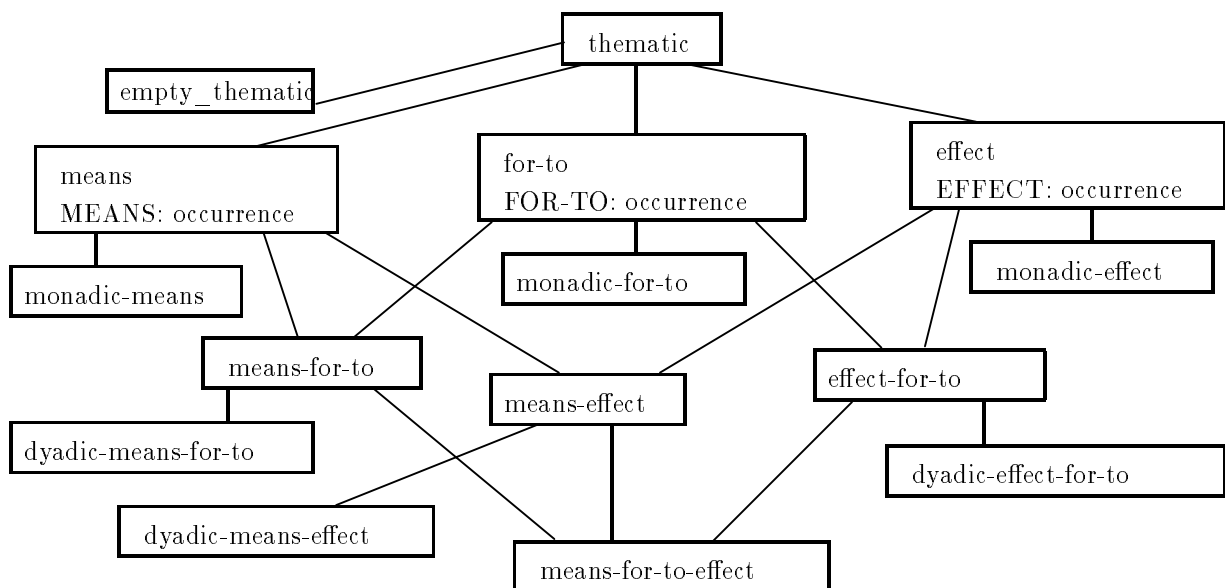


Figure 2: Segment of the sort hierarchy

The approach that will be taken here is inspired by the subsumption hierarchy defined in Wechsler (1994) for sorting *psaos* according to valency. First, a type *thematic* will be defined as a subsort of *qfpsoa*. All objects of type *ext-desc* will be defined for an attribute `THEMATIC` with *thematic* value. The most general *thematic* object is not defined for any PP types. Each subtype of this object will be defined for one or more modifying PP type. Part of the sort hierarchy appears in Figure 2.

The advantage of such a hierarchical type structure is that the type of the `THEMATIC` element associated with the external semantics of a situation reflects precisely which PPs have already been added. As each PP is added to the verb's subcat list via a lexical rule, the semantics associated with the PP – a thematic object of type *means*, *for-to*, *effect*, etc. – will be unified with the `THEMATIC` attribute of the external semantics associated with the verb, thereby making the type of this attribute more specific. The lexical rule can enforce that the type is not already a subtype of the thematic type of the PP to be added, thereby preventing redundant thematic PPs.

The approach presented here also would allow any restrictions on the combinations of thematic PPs which can occur (not investigated in this context, but a possibility) to be simply implemented via missing links in the *thematic* type hierarchy. This avoids the use of mechanisms such as searching down the `SUBCAT` list for preceding elements in lexical rules which would be responsible for the enforcement of such combination restrictions.

The sort hierarchy introduced above will be utilized not only for the `EXTERNAL:THEMATIC` attribute, but will also replace the definition of `INTERNAL:THEMATIC` (corresponding to the `THEMATIC_TIER` in the semantic description grammar in Table 3). Thus the latter will no longer be a set of subordinating relations and the corresponding subordinated occurrence; it will simply be an object of type *thematic*. This allows for a general treatment of thematic elements, regardless of whether they appear at the internal semantics or the external semantics level.

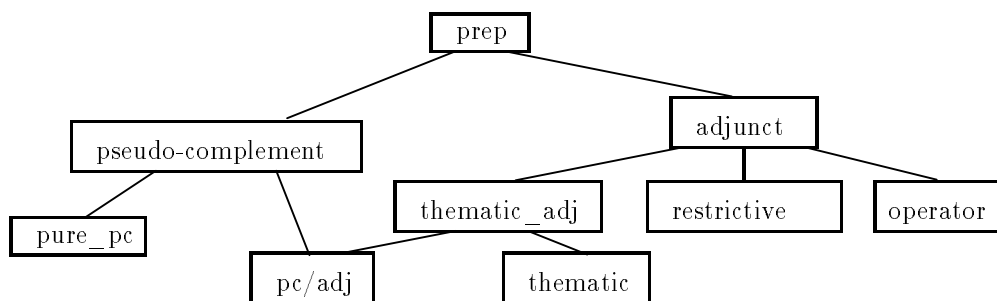


Figure 3: Preposition types in sort hierarchy

5.4 Adjunct semantics

The form of the lexical entries for adjuncts used in this approach relies on the semantic representation introduced in Section 5.1. The MOD field of an adjunct is used as the main vehicle for identification of the type of object which the adjunct can modify. Specification of the type of the adjunct is, however, also crucial. The definition of the lexical rules depends upon this specification.

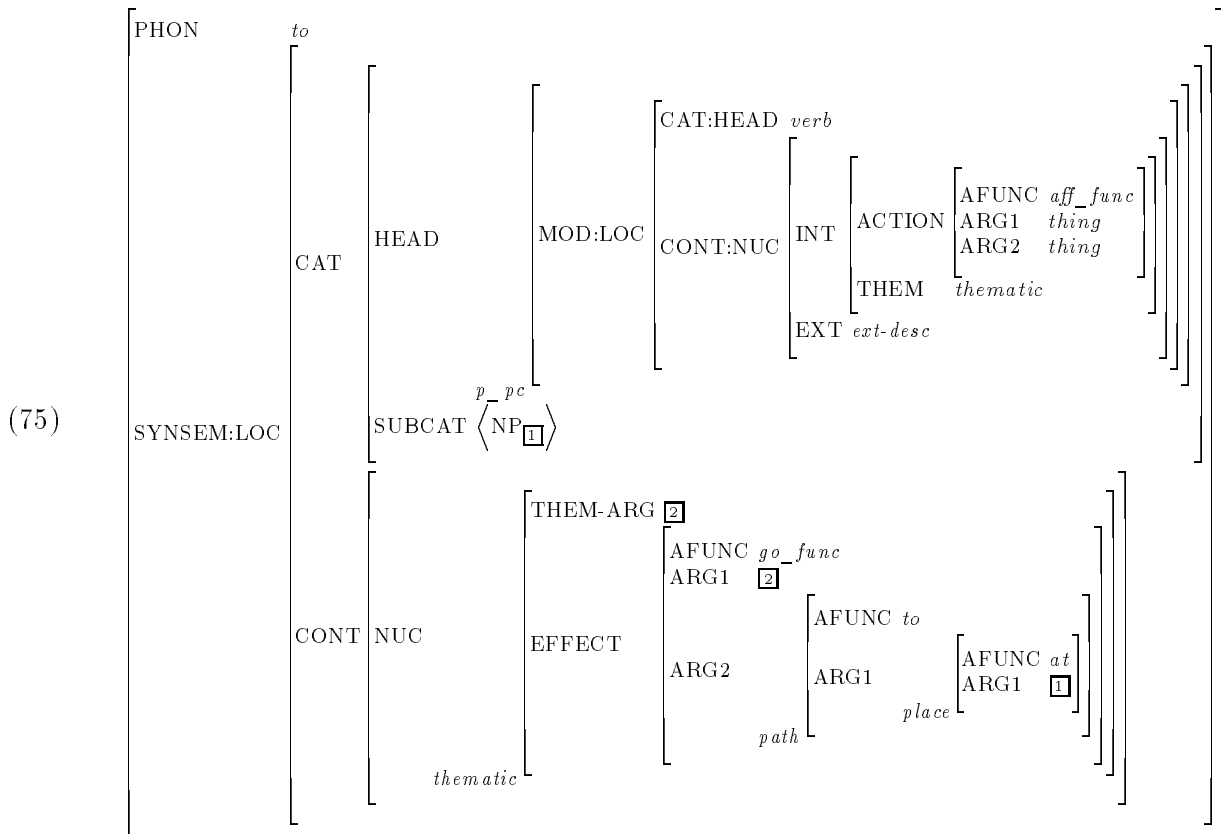
Kasper’s (1994) splitting of the MOD field into syntactic and semantic parts is unnecessary in a lexical rule approach. Since the adjuncts are added directly to the SUBCAT list of the element they modify, the lexical rules account for the appropriate structure sharing between the SYNSEM specified in every adjunct’s MOD field and the modified “head”.²⁰ In fact, the lexical rule approach to adjunct modification even eliminates the need for HPSG’s *Head-Adjunct Schema* (schema 5) and the complex definition of a semantic head (Pollard and Sag 1994, p. 322) – adjunctive elements are essentially given the status of subcategorized elements and the differences in how the semantics of the different types of adjuncts interacts with the semantics of the modified phrase are handled directly in the rules. The verb therefore remains the semantic head of the sentence, and all phrases with complements and (possibly) adjuncts are licensed by the *Head-Complement Schema*.

In Section 3.3 it was proposed to divide prepositions into three types, reflecting their behaviour as strictly a pseudo-complement, strictly a true adjunct, or a preposition which can behave as both. In fact, more types are necessary, to capture the difference between restrictive, operator, and thematic adjuncts. The relevant piece of the type hierarchy appears in Figure 3.

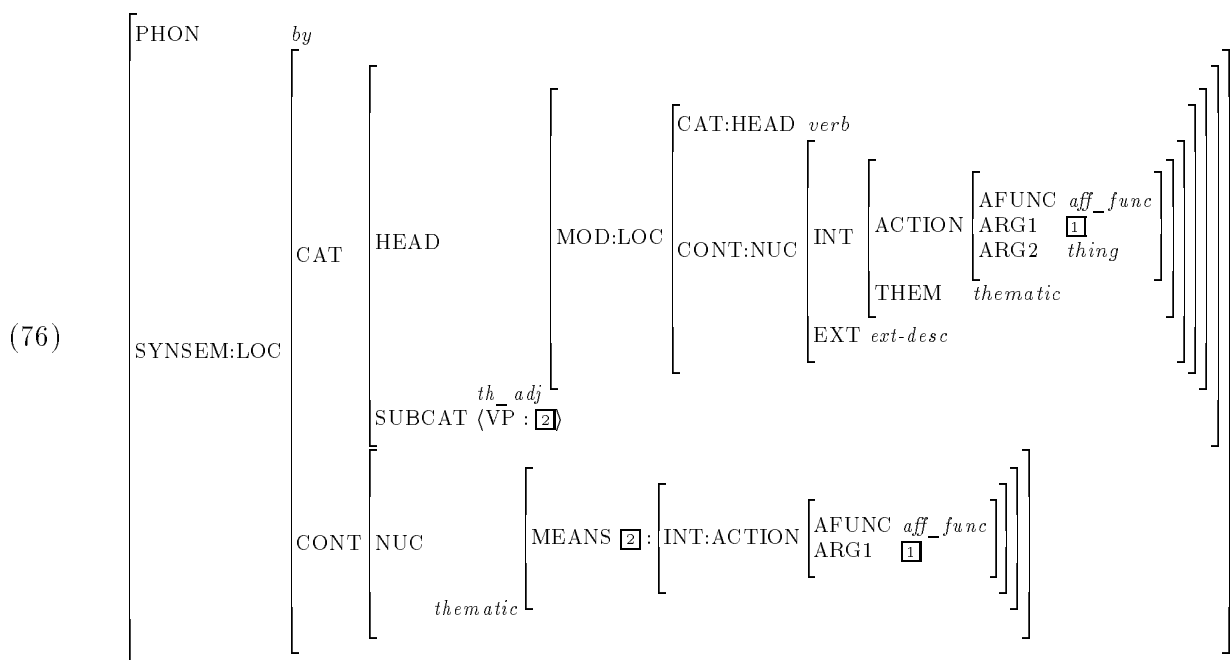
I will provide representative lexical entries for each of these types. The pure pseudo-complement *to* is shown in (75). This type of preposition adds an *effect* thematic element to the internal semantics associated with a situation (see Section 3.2.2). The lexical entry need only specify this thematic element and the basic semantic structure of the modified verb. Structure sharing between the semantics of the prepositional phrase and the INTERNAL:THEMATIC attribute of the situation is specified in the lexical rule bringing about the modification. This is because

²⁰Note that it is necessary to interpret the MOD field as specifying a particular type of element with which an adjunct can combine, rather than necessitating that the adjunct modify a phrasal head. This is because the head of a phrase may not be the element in the phrase which the adjuncts actually modifies, as was evidenced by the verb cluster data in Section 4.3.

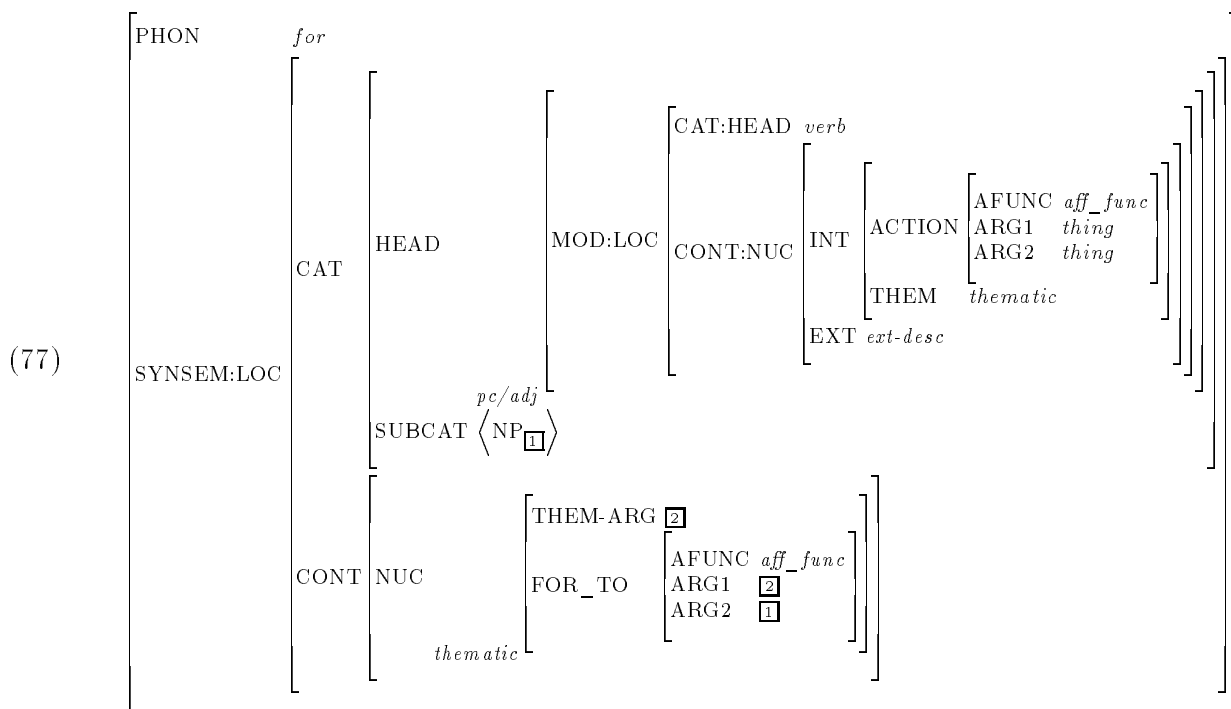
this aspect of modification remains constant across prepositions of this type.



The lexical entry for *by*, a thematic adjunct, is shown in (76). The sense of *by* expressed here is that in *John broke the lock by hitting it with a hammer*. This type of preposition adds a thematic element to the external semantics associated with a situation. As above, the lexical entry need only specify this thematic element and the basic semantic structure of the modified verb, as the appropriate structure sharing between the semantics of the modified verb and the semantics of the preposition is accomplished in the lexical rule. In this case, the thematic element expresses the particular means through which the situation is accomplished. It also expresses an additional constraint that the actor of the embedded VP be token-identical with the actor in the main situation.



The lexical entry for *for*, which can behave as both a pseudo-complement and an adjunct, is shown in (77).



This type of preposition adds a thematic element to either the internal or the external semantics associated with a situation, depending on how it is used in a particular utterance (see Section 3.2.1). Again, the lexical entry need only specify the thematic element and the basic semantic structure of the modified verb. Either the lexical rule for pseudo-complements

or the lexical rule for thematic adjuncts will be applied to incorporate this adjunct into a sentence. Which rule is used determines where the thematic element is attached.

The lexical entries in (75)-(77) make use of a semantic element, `THEMATIC-ARG`, defined for all objects of type *thematic*, which has not yet been explained. This element is a result of the distinctions between pseudo-complements and adjuncts as introduced in Section 3.2. Both types of prepositions express a relation which subordinates a state or event. The relation expressed may contain an argument which in the case of pseudo-complements is also a verbal semantic argument, and in the case of true adjuncts is tied to the internal semantics as a whole. In order to allow prepositions which can behave as both pseudo-complements and as adjuncts to be represented by a single lexical entry, it is necessary to come up with a way to allow this argument position to be structure-shared with the appropriate semantic element regardless of which particular type of modification occurs on a particular use of the preposition.

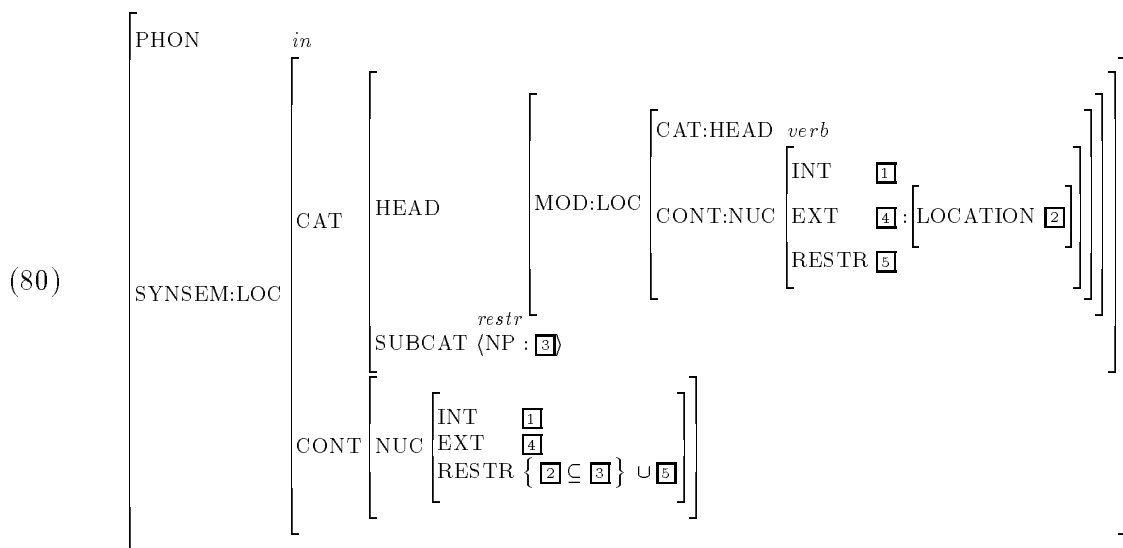
This is accomplished by specifying structure-sharing between the variable argument position in the subordinated event and the `THEMATIC-ARG` attribute in the `SYNSEM:LOC:CONT:NUC` field of the lexical entry, and through definition of constraints on objects controlling structure-sharing between the `THEMATIC-ARG` element and other semantic elements, shown in (78)-(79). It obviously also relies on the treatment of both the internal and external thematic components as objects of type *thematic*. If a whole `THEMATIC` structure is unified with an `INTERNAL:THEMATIC` element, the `THEMATIC-ARG` is forced to be structure-shared with the second argument in the `ACTION` tier, as controlled by a constraint defined for an object of type *complex-sem*, shown in (78). Similarly, a constraint is defined for objects of type *sit-desc* as shown in (79). This constraint ensures that if a `THEMATIC` structure is unified with a `EXTERNAL:THEMATIC` element, the `THEMATIC-ARG` is forced to be structure-shared with the full internal semantics.

$$(78) \quad \left[\begin{array}{l} \text{INTERNAL} \left[\begin{array}{l} \text{ACTION} \left[\begin{array}{l} \text{AFUNC } aff_func \\ \text{ARG1 } thing \\ \text{ARG2 } \boxed{1} \end{array} \right] \\ \text{THEM} \left[\begin{array}{l} \text{THEM-ARG } \boxed{1} \end{array} \right] \end{array} \right] \end{array} \right]$$

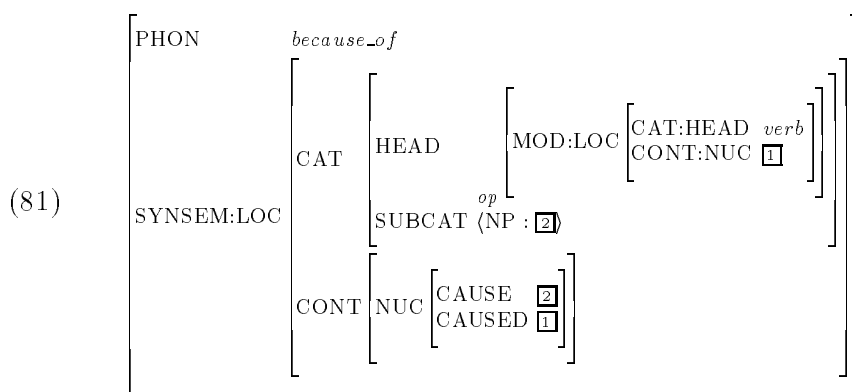
$$(79) \quad \left[\begin{array}{l} \text{INTERNAL } \boxed{1} \\ \text{EXTERNAL} \left[\begin{array}{l} \text{THEM:THEM-ARG } \boxed{1} \end{array} \right] \end{array} \right]$$

The lexical entry for the restrictive preposition *in*, as in *John ran in the park* is shown in (80). This definition follows that of Kasper (1994), specifying the restriction of an index picked out from the verb semantics. The semantic effect of a simple locative adverbial such as *in* is only to add a restriction on the `LOCATION` index associated with the situation – in this case, the location of the situation must be spatially included within (\subseteq) *the park*. The union of this restriction with any existing restrictions allows for the possibility of multiple restrictive PPs within a single sentence. Note also that this lexical entry utilizes the standard HPSG approach to semantic specification, as the `SYNSEM:LOC:CONT:NUC` attribute of the entry specifies the full *sit-desc* to be associated with the sentence. Thus the lexical rule will

specify the replacement of the semantics associated with the sentence by this *sit-desc*, in effect allowing this PP to become the semantic head of the sentence. Since this aspect of the semantics is controlled by the lexical rules, however, it does not need to be addressed in the schemata controlling phrase structure (see Section 5.4).



An approximated representation for the operator preposition *because_of*, as in *Peter reads well because of the lessons*, is shown in (81). This also follows Kasper's (1994) treatment of operator adverbials. Here the semantic content of the modified VP appears as an argument of the *cause-soa*, reflecting the behaviour of operator adjuncts as adjuncts which predicate something of the content they modify.



5.5 The OP-ADJUNCTS feature

Both the Kasper (1994) and the van Noord and Bouma (1994) approaches generate a list on which adjuncts theoretically appear in order of their semantic obliqueness. Surface order of these adjuncts is then controlled by separate principles of constituent order. The motivation behind building these lists in terms of semantic obliqueness lies in the compositional approach to semantic interpretation in the two approaches.

The problem with these approaches is that they cannot easily account for the interaction between semantic scope of modification and surface order. Furthermore, it is not clear in either approach how or when the relative semantic obliqueness of adjuncts on these lists is determined. In the Kasper (1994) approach, a mechanism must exist which drives the insertion of elements into the ADJ-DTRS list, although it is not explicitly specified. This mechanism must also be responsible for evaluating the relative semantic obliqueness of inserted elements. It is not at all obvious how the surface order of the elements would be taken into account in this evaluation.

The van Noord and Bouma (1994) approach assumes that the parser hypothesizes a structure for the SUBCAT list of the head of a phrase which is evaluated against the constraints captured in the lexical rules. The hypothesized SUBCAT list must therefore reflect consultation of linear precedence rules imposed upon the parser. These linear precedence rules must be able to generate a SUBCAT list arranged in terms of semantic obliqueness from the surface order of the elements. Once the SUBCAT list is hypothesized to be a list of elements in a certain order, the lexical rules adding adjuncts to the subcat list act to perform the appropriate semantic integration of the adjuncts into the overall representation of the verb semantics. Because the system treats these rules as constraints to be verified, no mechanisms controlling the relative order of adjuncts on the SUBCAT list need be applied at the level of the rules. These mechanisms would be redundant.

This general approach is quite interesting, and effectively handles the word-order effects on the adjunct semantics if the linear precedence constraints are defined correctly. However, it is difficult to imagine how these constraints would be defined given that they would have to accommodate all variances in surface order among all adjunct types.

The approach presented here will restrict the domain of the constraints controlling semantic obliqueness to operator adjuncts. The constraints only need to take into account the relative semantic order of operator adjuncts, and will thus be easier to define. This restriction is possible since all other types of adjuncts provide information which actually modifies only the main *sit-desc* object associated with a verb. For example, in the sentences in (82), the “John-jogged” event is what is located in the park, regardless of the position of the restrictive PP relative to the operator adjuncts. It is not the “twenty-minutes-duration (John-jogged)” event which is located in the park, as would be suggested by (82b), or the “twice-daily (twenty-minutes-duration (John-jogged))” event which is located in the park, as suggested by (82c). All three of these sentences should have the interpretation “twice-daily (twenty-minutes-duration (in-park (John-jogged)))”. Thus the semantic contribution of the restrictive adjunct must be incorporated before the operations specified by the operator adjuncts are processed.

- (82) a. John jogged in the park for twenty minutes twice a day.
 b. John jogged for twenty minutes in the park twice a day.
 c. John jogged for twenty minutes twice a day in the park.

Neither of the van Noord and Bouma (1994) and Kasper (1994) approaches handles this phenomena appropriately. Both approaches will give rise to errors in the semantic representation associated with a sentence containing interspersed operator and other adjuncts – namely that

the restrictive or thematic adjuncts will be seen as modifying complex operator SOAs rather than the main SOA expressed by a sentence – because they do not postpone evaluation of operator adjuncts until after the other types.

Because all adjuncts other than operator adjuncts provide information relevant to the main *sit-desc* associated with a verb, the semantic contribution made by these adjuncts can be incorporated into the structure representing the semantics of the situation being modified as soon as they are encountered (i.e. as soon as the adjuncts are inserted into the SUBCAT list of the modified word by a lexical rule). On the other hand, operator adjuncts must always be processed after all other adjuncts, as evidenced by the example above.

To accommodate this difference between operator adjuncts and other adjuncts, a distinction is made in the current approach between the treatment of operator adjuncts and the treatment of other adjuncts. In the lexical rules controlling the treatment of all types of adjuncts other than operator adjuncts, the semantic contribution of these adjuncts is incorporated into the representation of the semantics of the situation immediately. For operator adjuncts, however, incorporation of their semantic contribution is postponed until after all adjuncts have been inserted into the SUBCAT list.

As operator adjuncts are added to the SUBCAT list in a lexical rule, they are also added to an OPERATOR-ADJUNCTS (OP-ADJ) list associated with the SYNSEM:CAT of the lexical element whose SUBCAT list is being manipulated. This is used in the handling of semantic status and surface order interactions.

The approach involves keeping track of both surface order and relative semantic obliqueness of operator adjuncts. Following van Noord and Bouma (1994), the application of the lexical rules will be driven by a structure for the SUBCAT list as proposed by the parser. However, this structure will reflect the natural surface order of the adjuncts rather than incorporating any evaluation of their semantic obliqueness. Thus linear precedence constraints on the parser will simply require that all adjuncts appear after the complements on the subcat list, with the adjuncts in surface order. The evaluation of semantic obliqueness will occur when an operator adjunct is added to the subcat list in a lexical rule. The evaluation function will be given the existing OP-ADJ list and the new element, and then must determine the placement of the new element onto the list. This function will be able to take into consideration the relative surface order of the operator adjuncts, as any adjunct which it is attempting to insert into the OP-ADJ list must appear later in the surface order than any elements already on the list.

After all operator adjuncts have been inserted into the OP-ADJ list, and the semantic contribution of all other adjuncts has been integrated into the semantic representation for the situation as a whole, the semantics of the operator adjuncts can be processed. The OP-ADJ list will contain all of the operator adjuncts, listed from narrowest to widest scope. The function *process_op_adj*s will essentially accomplish what Kasper's (1994) *Adjunct Semantics Principle* does, but then only for operator adjuncts: the MOD:LOC:CONT:NUC value of the adjunct of narrowest scope will be made token identical to the *sit-desc* object representing the situation. Then, if there are $n > 1$ elements on the OP-ADJ list, the MOD:LOC:CONT:NUC value of OP-ADJ_{*i*} is token-identical with the SYNSEM:LOC:CONT:NUC value of OP-ADJ_{*i-1*} for all *i* between 2 and *n*. The result of this processing is a semantic value which then becomes the semantics associated with the sentence as a whole.

In sum, the approach proposed here differentiates between operator and other adjunct types, integrating the semantics of other adjunct types immediately and postponing the semantic integration of operator adjuncts. This results in an appropriate representation of the semantics of sentences in which adjunct types are interspersed, and reflects the fact that only the semantic obliqueness of operator adjuncts relative to one another (but not to other adjunct types) plays a role in interpretation. The approach also allows the surface order of adjuncts to influence the evaluation of semantic obliqueness in a more straightforward manner by allowing the SUBCAT list to reflect their surface order.

5.6 Lexical rules

The approach presented here requires there to be different lexical rules for different types of adjunction. Each rule allows for the integration of semantics and structure-sharing between modifier and modified appropriate to the relevant type of adjunction. The design of the rules essentially follows that of van Noord and Bouma (1994), in that the *add_adj_control* rule builds an output structure based on the input structure it receives, by relying on other rules to modify elements of the structure in appropriate ways. The rules are described and presented below. Note that the subsort check needed to prevent redundant thematic PPs is not explicitly represented.

- Controlling rule: allows for the addition of all adjuncts to the element's SUBCAT list, and the processing of all operator adjuncts. The first argument is the original *synsem* object input, the second argument is the *synsem* object which results after all adjuncts have been added and processed. This rule calls *process_op_adj*, which is responsible for processing the semantic contribution of the operator adjuncts.

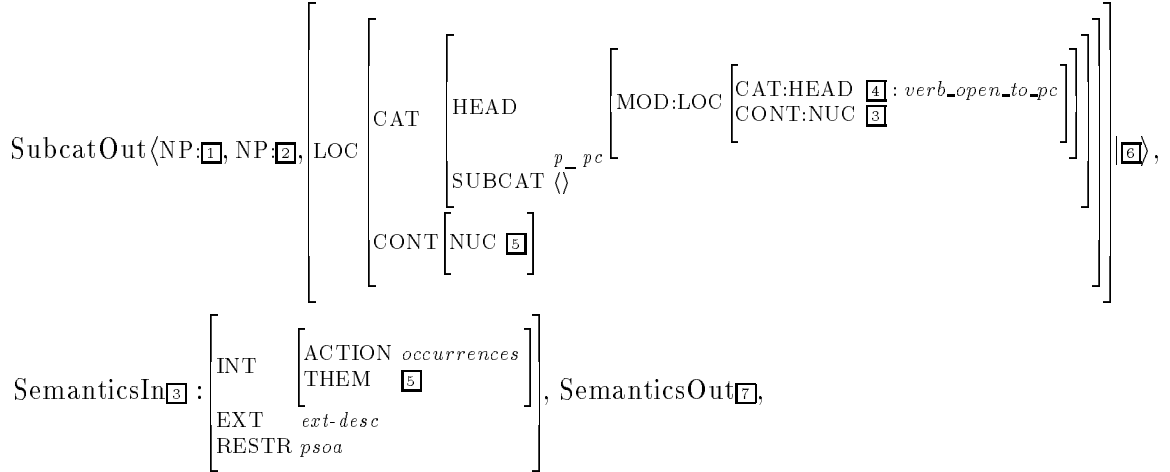
$$\text{add_adj_control} \left(\text{LOC} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{HEAD } \text{Head}_{[1]} \\ \text{SUBCAT } \text{SubcatIn}_{[2]} \\ \text{OP-ADJ } \langle \rangle \end{array} \right] \\ \text{CONT} \left[\begin{array}{l} \text{NUC } \text{SemanticsIn}_{[3]} \end{array} \right] \end{array} \right], \text{LOC} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{HEAD } \text{Head}_{[1]} \\ \text{SUBCAT } \text{SubcatOut}_{[4]} \\ \text{OP-ADJ } \text{Operator-adjOut}_{[5]} \end{array} \right] \\ \text{CONT} \left[\begin{array}{l} \text{NUC } \text{SemanticsOut}_{[6]} \end{array} \right] \end{array} \right] \right) \\ \text{:-} \\ \text{add_adj_top}(\text{Head}_{[1]}, \text{SubcatIn}_{[2]}, \text{SubcatOut}_{[4]}, \text{SemanticsIn}_{[3]}, \\ \text{SemanticsMid}_{[7]}, \langle \rangle, \text{Operator-adjMid}_{[8]}), \\ \text{process_op_adjs}(\text{SemanticsMid}_{[7]}, \text{SemanticsOut}_{[6]}, \text{Operator-adjMid}_{[8]}, \text{Operator-} \\ \text{adjOut}_{[5]}).$$

- Top level rule used in the addition of adjuncts: forces all adjuncts to be added to the SUBCAT list after all complements.

$$\text{add_adj_top}(\text{Head}_{[1]}, \text{SubcatIn}_{[2]}, \text{SubcatOut}_{[3]}, \text{SemanticsIn}_{[4]}, \text{SemanticsOut}_{[5]}, \\ \text{Operator-adjIn}_{[6]}, \text{Operator-adjOut}_{[8]}) \text{:-} \\ \text{add_adj}(\text{Head}_{[1]}, \text{AdjunctList}_{[7]}, \text{SemanticsIn}_{[4]}, \text{SemanticsOut}_{[5]}, \\ \text{Operator-adjIn}_{[6]}, \text{Operator-adjOut}_{[8]}), \\ \text{append}(\text{SubcatIn}_{[2]}, \text{AdjunctList}_{[7]}, \text{SubcatOut}_{[3]}).$$

- Top level rule which specifies that pseudo-complements can only be added to the SUBCAT list of verbs open to pseudo-complementation with a subject and an object complement; further specifies the unification of the *thematic* information added by the pseudo-complement with the verb's internal thematic element. This adds the information into the existing representation of the verb's semantics.

add_adj_top(Head₄, SubcatIn⟨NP:₁, NP:₂⟩,

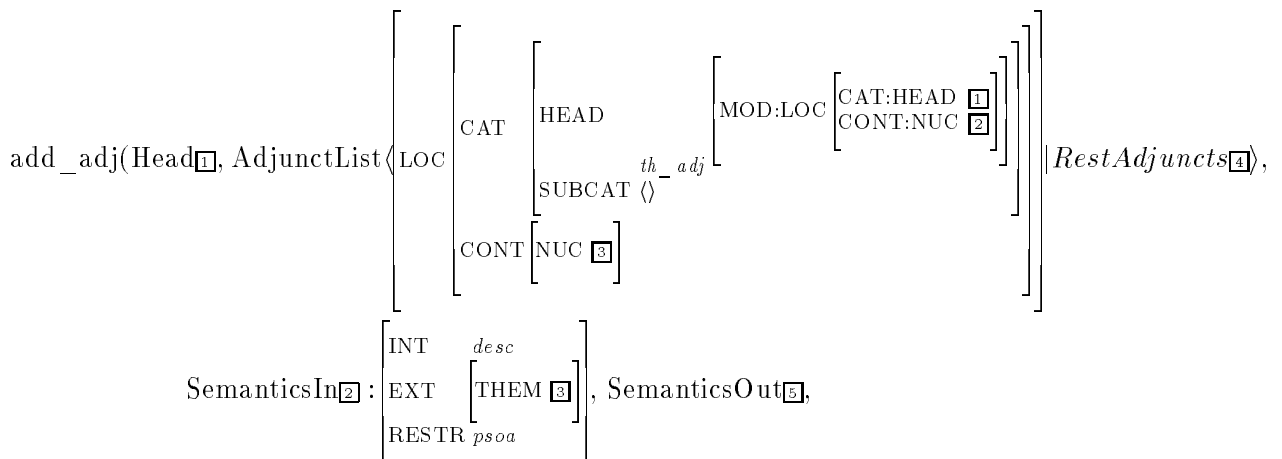


add_adj(Head₄, AdjunctList₆, SemanticsIn₃, SemanticsOut₇,
Operator-adsIn₈, Operator-adsOut₉).

- Base case for adding adjuncts – adds no adjunct, and the output semantics is unified with the input semantics. The argument structure for this function is add_adj(Head, Adjuncts, SemanticsIn, SemanticsOut, Operator-adsIn, Operator-adsOut).

add_adj(⟦, ⟨⟩, Semantics₁, Semantics₁, Operator-ads₂, Operator-ads₂).

- Adds a thematic adjunct; specifies the unification of the *thematic* information added by the adjunct with the situational (external) thematic elements. This adds the information into the existing representation of the situation as a whole.



add_adj(Head₁, RestAdjuncts₄, SemanticsIn₂, SemanticsOut₅,
Operator-adsIn₆, Operator-adsOut₇).

- Adds a restrictive adjunct; specifies that the *sit-desc* object found in the SYNSEM:LOC:CONT:NUC field of the adjunct definition becomes the semantics associated with the current situation.

$$\text{add_adj}(\text{Head}_{[1]}, \text{AdjunctList} \left\langle \text{LOC} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{HEAD} \left[\text{MOD:LOC} \left[\begin{array}{l} \text{CAT:HEAD} [1] \\ \text{CONT:NUC} [2] \end{array} \right] \right. \\ \text{SUBCAT} \langle \rangle \\ \text{NUC} [3] \end{array} \right] \end{array} \right] \right. \left. \right] \text{RestAdjuncts}_{[4]} \rangle, \\ \text{SemanticsIn}_{[2]}, \text{SemanticsOut}_{[5]}, \text{Operator-ajdsIn}_{[6]}, \text{Operator-ajdsOut}_{[7]} \text{ :-} \\ \text{add_adj}(\text{Head}_{[1]}, \text{RestAdjuncts}_{[4]}, \text{Semantics-of-Adjunct}_{[3]}, \text{SemanticsOut}_{[5]}, \\ \text{Operator-ajdsIn}_{[6]}, \text{Operator-ajdsOut}_{[7]}).$$

- Adds an operator adjunct to both the adjuncts list and the operator-adjuncts list. Function *eval_sem_oblique* evaluates the semantic obliqueness of this adjunct with respect to other elements of the operator-adjuncts list and inserts it in the appropriate place ([2] is the *synsem* value associated with the adjunct, [6] is the original OP-ADJ list and [7] is the modified OP-ADJ list). Does not change the semantics associated with the current situation.

$$\text{add_adj}(\text{Head}_{[1]}, \text{AdjunctList} \langle [2] : \left[\begin{array}{l} \text{LOC:CAT} \left[\begin{array}{l} \text{HEAD} \left[\text{MOD:LOC:CAT:HEAD} [1] \right] \\ \text{SUBCAT} \langle \rangle \end{array} \right] \end{array} \right] \text{RestAdjuncts}_{[3]} \rangle, \\ \text{SemanticsIn}_{[4]}, \text{SemanticsOut}_{[5]}, \text{Operator-ajdsIn}_{[6]}, \text{Operator-ajdsOut}_{[8]} \text{ :-} \\ \text{eval_sem_obliq}(\text{AddedAdjSynsem}_{[2]}, \text{Operator-ajdsIn}_{[6]}, \text{Operator-ajdsNew}_{[7]}), \\ \text{add_adj}(\text{Head}_{[1]}, \text{RestAdjuncts}_{[3]}, \text{SemanticsIn}_{[4]}, \text{SemanticsOut}_{[5]}, \\ \text{Operator-ajdsNew}_{[7]}, \text{Operator-ajdsOut}_{[8]}).$$

5.7 Dative alternation

Within the framework developed in this paper, dative alternation must be seen as an alternation between two forms of pseudo-complementation. The phenomenon can therefore be captured in terms of lexical rules. The dative form is accounted for straightforwardly by the pseudo-complementation lexical rule introduced in Section 5.6. The double object form must be allowed by another rule, such as the one specified in (83). This rule identifies a pseudo-complement preposition which supplies the semantics associated with the NP inserted into the SUBCAT list. This NP can be seen as the object of the missing preposition. The lexical rule induces a “focus shift”, raising the inserted NP in obliqueness to the level of direct object and pushing the original direct object down to the level of indirect object.

$$(83) \quad \text{add_adj_top}(\text{Head}_{[4]}, \text{SubcatIn}\langle \text{NP}_{[1]}, \text{NP}_{[2]} \rangle, \text{SubcatOut}\langle \text{NP}_{[1]}, \text{NP}_{[3]}, \text{NP}_{[2]} | \text{AdjunctList}_{[6]} \rangle,$$

$$\text{SemanticsIn}_{[10]} : \left[\begin{array}{l} \text{INT} \quad \left[\begin{array}{l} \text{ACTION } \textit{action} \\ \text{THEM } [5] \end{array} \right] \\ \text{EXT} \quad \textit{ext-desc} \\ \text{RESTR } \textit{psoa} \end{array} \right],$$

$$\text{SemanticsOut}_{[7]}, \text{Operator-adsIn}_{[8]}, \text{Operator-adsOut}_{[9]} :-$$

$$\left[\begin{array}{l} \text{LOC} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{HEAD} \left[\begin{array}{l} \text{MOD:LOC} \left[\begin{array}{l} \text{CAT:HEAD } [4]: \textit{verb_open_to_pc} \\ \text{CONT:NUC } [10] \end{array} \right] \\ \text{SUBCAT } \langle \text{NP}_{[3]} \rangle \end{array} \right] \\ \text{CONT:NUC } \textit{thematic}_{[5]} \end{array} \right] \end{array} \right] \end{array} \right],$$

$$\text{add_adj}(\text{Head}_{[4]}, \text{AdjunctList}_{[6]}, \text{SemanticsIn}_{[10]}, \text{SemanticsOut}_{[7]},$$

$$\text{Operator-adsIn}_{[8]}, \text{Operator-adsOut}_{[9]}).$$

This approach to the dative alternation links the alternate forms through the semantics associated with the dative (pseudo-complement) preposition – the semantics provided in one case by the preposition is in the other case indicated by the obliqueness of one NP relative to the other. Thus the approach makes a generalisation about the relationship between dative PPs and inner double object NPs. Furthermore, the approach ensures that there is only one available interpretation of the double object form – the pseudocomplement interpretation – even if the “missing” preposition can be interpreted as either a pseudo-complement or an adjunct type preposition. It is also in line with Jackendoff’s (1990) analysis in which the double object form only allows an interpretation in which the object of the preposition benefits from the object of the verb, but differs from that work in that here the double object form has an interpretation identical to one of the interpretations of the dative form (see Section 3.2.1).

The rule in (83) above is only an example of how the double-object form lexical rule could be defined. In actuality, this rule would likely have to define more complicated modifications of the internal semantic structure expressed by the verb in the alternate form. Several lexical rules of this type may also be necessary, probably involving a more precise definition of the initial internal semantics associated with the verb, to capture different types of semantic alternation between the dative and double object forms.²¹ The form of the rules is not critical for the current discussion; the fact that such rules can be defined to account for the dative alternation is important.

The lexical rule approach to the treatment of the semantics of the two forms involved in the dative alternation provides a means of accounting for alternation contrasts previously difficult to explain. Consider the sentences in (84)-(89). (From Jackendoff 1990, who attributes (84)-(85) and (88)-(89) to Jane Grimshaw.)

- (84) a. John fixed the roof for Mary.
 b. *John fixed Mary the roof.

²¹See Verspoor (1994) and Pinker (1989) for a fuller discussion of lexical rules used to capture syntactic alternations with corresponding semantic consequences which depend on a verb’s semantics.

- (85) a. John fixed a sandwich for Mary.
 b. John fixed Mary a sandwich.
- (86) a. Bill removed the garbage for Harold.
 b. *Bill removed Harold the garbage.
- (87) a. John chose a dress for Mary.
 b. *John chose Mary a dress.
- (88) a. Sue poured some cement for Dick.
 b. *Sue poured Dick some cement.
- (89) a. Sue poured some coffee for Dick.
 b. Sue poured Dick some coffee.

The contrast between (84) and (85) stems from differences in the meaning expressed by the verb *fix*. In (84), *fix* means *repair*, and is apparently not open to pseudo-complementation on this interpretation. The only lexical rule which can be used to interpret (84a) is the thematic adjunction lexical rule, resulting in an interpretation in which the entire fixing event is done for Mary. No interpretation of (84b) is possible because the lexical rule licensing the double object form requires the modified verb to be open to pseudo-complementation. In (85), on the other hand, *fix* is being used to mean *make*, which is open to pseudo-complementation, and therefore the double object form lexical rule can apply to provide an interpretation for (85b). Likewise, the verbs in (86) and (87) are not open to pseudo-complementation and thus the double object forms involving these verbs are not permitted. Only the thematic adjunct interpretation of the PPs is available.

The contrast between (88) and (89) must be a result of consultation of world knowledge in the application of the lexical rules. There is no difference in the senses of *pour* expressed in these sentences. On the pseudo-complementation interpretation of these sentences (that is, when the pseudo-complement lexical rule introduces the *for*-phrase), what is being poured is interpreted as affecting Dick directly. While there are clearly several senses in which coffee can benefit Dick (e.g. because it is liquid and humans need liquid to survive; because it is warm; etc.), there is no sense in which the cement in (88) can affect Dick directly, likely because Dick is not intended to receive the cement. Thus the pseudo-complement interpretation of these sentences is ruled out on the grounds of limitations in the world.

6 Conclusions

The proposals made in this paper concerning the treatment of adjuncts go a long way towards appropriately handling the characteristics of adjuncts:

- **Consistent semantic contribution:** There is only one lexical entry required in this approach for each meaning associated with an adjunct, even if the adjunct is involved in different types of adjunction.

- ***Restrictive and operator adjuncts:*** Both of these types of adjuncts are accounted for and treated in a way which reflects precisely the type of modification which must be associated with them; namely that restrictive adjuncts directly modify the situation expressed by the verb and that operator adjuncts take a full situation as an argument. A third type of adjunct, *thematic adjuncts*, has also been identified as a type of adjunct which adds information about a situation as a whole.
- ***Surface order vs. semantic obliqueness:*** The interaction between surface order and semantic obliqueness for operator adjuncts is accounted for by maintaining lists which reflect both of these types of information – surface order in the SUBCAT list and semantic obliqueness in the OP-ADJS list.
- ***Redundancy constraints:*** Redundant PPs are avoided through use of a type system which keeps track of modifying information associated with a sentence. The lexical rules would then simply need to include a subsort check to prevent two modifiers of the same type in a sentence.
- ***Mittelfeld phenomena:*** Complements and adjuncts both appear on the SUBCAT list of a head. There is thus nothing structural which prevents these elements from being interspersed. The linear precedence rules must be responsible for determining their allowed relative order.

The advantages of the approach presented in this paper over the previous approaches from which it is derived can be summarized as the following:

- The redundancy constraint problem is solved in a clear way via the type system.
- The division between external and internal semantics allows various types of modification, including types not handled in the previous approaches (thematic adjuncts and pseudo-complements), to be accommodated within the same framework. In particular, the use of a semantic object of type *thematic* common to external and internal semantics provides for a general treatment of prepositions which can behave both as a thematic adjunct and as a pseudo-complement. This treatment can even account for the ambiguity of interpretation found in sentences involving such prepositions.
- Dative alternation can be easily accounted for by defining variants of the basic pseudo-complementation lexical rule. The approach leaves open the possibility of an explanation of the “openness” of verbs to this alternation.
- The interspersal of operator adjuncts with other types of adjuncts does not lead to interpretation errors.
- There is a more straightforward framework in which to account for the interaction between surface order and semantic precedence. The use of delayed evaluation and linear precedence rules which follow surface order allows the context to drive adjunct interpretation.

It must also be pointed out that the precise inventory of representational elements introduced in this paper is not critical. Only general aspects of the semantic representation are crucial:

the distinction between internal and external semantics and the commonality of the THEMATIC attribute to these components. It is these elements which allow for the general treatment of various adjunct types.

Acknowledgments

Thanks to Gosse Bouma, Claire Grover, Janet Hitzeman, Joost Zwarts, and an anonymous reviewer for insightful comments on this work. Thanks also to the Research Institute for Language and Speech at Utrecht University where I was a guest at the time this paper was written.

References

- Haegeman, L. (1991). *Introduction to Government and Binding Theory*. Basil Blackwell, Oxford.
- Jackendoff, R. (1990). *Semantic Structures*. MIT Press, Cambridge, Mass.
- Kasper, R. (1994). Adjuncts in the mittelfeld. In J. Nerbonne, K. Netter, and C. Pollard, editors, *German in Head-Driven Phrase Structure Grammar*, number 46 in CSLI Lecture Notes. Center for the Study of Language and Information, Stanford, Ca.
- Pinker, S. (1989). *Learnability and Cognition: The Acquisition of Argument Structure*. MIT Press, Cambridge, Mass.
- Pollard, C. and Sag, I. A. (1987). *Information-Based Syntax and Semantics: Fundamentals*. Number 13 in CSLI Lecture Notes. Center for the Study of Language and Information, Stanford, Ca.
- Pollard, C. and Sag, I. A. (1994). *Head-Driven Phrase Structure Grammar*. CSLI and University of Chicago Press, Stanford, Ca. and Chicago, Ill.
- van Noord, G. and Bouma, G. (1994). The scope of adjuncts and the processing of lexical rules. In *Proceedings of the 15th International Conference on Computational Linguistics*, Kyoto, Japan.
- Verspoor, C. M. (1994). *A Cognitively Relevant Lexical Semantics*. Master's thesis.
- Wechsler, S. (1991). *Argument Structure and Linking*. Ph.D. thesis, Stanford University, Stanford, Ca.
- Wechsler, S. (1994). Postscript: some possible improvements. Addendum to "Argument Structure and Linking".