Advanced Topics in HPSG*

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1 Introduction

This chapter is an attempt to survey some of the major areas that have seen significant work from an HPSG perspective in the past decade or so. For most of this work, Pollard & Sag 1987; Pollard & Sag 1994 continues to be an important point of reference, but many of the analyses summarized here go significantly beyond the original theory, both in terms of empirical coverage (of English and other languages) and analytic depth and comprehensiveness. The present survey is necessarily biased both in the selection of topics and the way that the various analyses are presented and compared. But these caveats nothwithstanding we hope that it will give the reader a reasonable idea of the research efforts around the middle of the second decade of HPSG's existence.

In keeping with HPSG's emphasis on lexical information, the first section concentrates on the licensing of phrasal dependents. We begin with the highly influential idea of argument composition as a way to dynamically determine the valence information of certain heads and continue with the conceptual separation between argument structure and valence in much of recent HPSG work. A third major topic involves the argument/adjunct distinction (or the lack thereof). In §2, we concentrate on issues of linear order, first on lexicalist equivalents of configurational analyses and second on departures from the "phrase structure grammar" part of HPSG. The common thread of the topics covered in §3 is the notion of "syntactic abstractness". This pertains to both the issue of whether extraction phenomena involve "traces" and the limits of a radically lexicalist view of syntactic licensing. One of HPSG's design features that distinguish it rather strongly from transformational grammar its integrative view with respect to semantic and pragmatic information. In §5 we discuss a number of recent developments in this area, in particular the treatment of scope and distinctions in illocutionary force as well as information structure and the representation of speaker beliefs and intentions. After reviewing a selection of work dealing with morpho-syntactic issues in §6, we conclude with a summary of recent developments in the logical foundations of the HPSG formalism (§7).

2 Argument structure

One of the most significant conceptual changes that distinguish Generalized Phrase Structure Grammar from HPSG is the treatment of combinatorial properties. While in GPSG, lexical items are linked to the subcategorization frame in which they can occur by means of an numerical index, HPSG folds the combinatorial potential into the lexical description of an item by means of a valence feature. The single list-valued valence feature SUBCAT, proposed by Pollard (1984) and Pollard & Sag (1987) thus can be seen as the equivalent of a type constructor as used in Categorial Grammar. As in Categorial Grammar, the elements of a SUBCAT list directly reflect the combinatorial potential of the word or phrase in question. For that reason, early HPSG exhibits a close similarity to formalisms that combine the combinatorial engine of a categorial grammar with the features of a phrase structure grammar (for instance, Karttunen 1989, Zeevat 1988).

A number of linguistic problems have since been explored in HPSG and solutions have been developed that have significantly refined the original ideas and provided new insights into the nature of valence.

2.1 Argument composition

Since GPSG was designed to be faithful to the formalism of context-free grammars,[1] the kinds of syntactic dependencies that can be expressed in the syntactic rules are very restricted.

Moving subcategorization information into lexical properties at first blush appears to simply redistribute the division of labor between syntax and lexicon. However, it turns out that the HPSG approach affords a much wider perspective on the kind of relationships that are lexically encoded. In particular, the lexicalization of valence makes it possible to consider second-order dependencies, i.e., the valence of valence elements etc. This makes it possible to incorporate a lexicalized version of functional composition into HPSG grammars. Functional composition in categorial grammar is a mode of combination whereby the combinatorial properties of one category (here: `B/C`) are, as it were, "transmitted" to a functor category (here: `A/B`). As a result, we obtain a category that will be of type `A` provided it can combine with an element of type `C`, notated as `A/C`.

(1) $$\frac{\mathrm{A/B} + \mathrm{B/C}}{\mathrm{A/C}}$$

The HPSG analysis of controlled complements can be seen as a variant this basic idea, in that the subject requirement of the selected VP is identified with the subject requirement of a predicate selecting that VP (see Green):

(2) $$\left[\textsc{subcat}\ \left\langle \boxed{1}, \left[\mathrm{V}\left[\textsc{subcat}\ \langle \boxed{1}\ \textit{synsem} \rangle\right]\right]\right\rangle\right]$$

[1]The one notable exception in this regard are proposals for the *liberation* of phrase structure, see §3.2 below.

More generally, since HPSG coreference tags may act as variables over any kind of structure, they can range over the the entire list of valence elements of the subcategorized for predicator. The valence list of that predicator consists of the verbal complement appended to (notated by "$\oplus$") the list of dependents of that very complement. This is illustrated in (3), where "$\boxed{1}$" now acts as a variable over lists.

(3) $\left[\text{SUBCAT}\ \boxed{1} \oplus \left\langle \left[\text{V}\left[\text{SUBCAT}\ \boxed{1}\ \textit{list}(\textit{synsem})\right]\right] \right\rangle\right]$

As a result, the arguments of the higher predicator are composed from those of the selected (typically) verbal complement. Another way of thinking about such cases is in terms of the higher predicator "attracting" the valence requirements of the lower one. Many phenomena for which separate operations of "clause union" have been assumed in other syntactic frameworks can thus be treated in terms of a rather straightforward head-driven extension of HPSG's original valence mechanism.

Among the original applications of argument composition is Hinrichs and Nakazawa's analysis of the German verb cluster, that is the clause-final sequence of verbal forms (Hinrichs & Nakazawa 1989, 1994). Starting with Bech 1955, two modes of verbal complementation have been assumed for German. The first (also referred to as "incoherent" construction) is very similar to English VP-complement constructions, as for instance in (4):

(4) a. Sandy tries [$_{\text{VP}}$ to read the book].

b. daß Otto versucht [$_{\text{VP}}$ das Buch zu lesen].
   that Otto tries the book to read

A plausible analysis of (4) states that *lesen* combines with its NP complement (*das Buch*) and the resulting phrase serves as the (VP) complement to *versucht*.

However, it is highly debatable whether the same should be assumed for the relation between *gelesen* and its notional object *das Buch* in constructions such as (5), where the main verb cooccurs with the tense auxiliaries *haben* and *werden*.

(5) a. daß Peter das Buch **gelesen** **haben** **wird**.
   that Peter the book read-PSP have-INF will-FIN
   'that Peter will have read the book.'

Hinrichs and Nakazawa propose that in "coherent constructions" of this kind, the valence requirements of the main verb (here: *lesen*) are inherited by the governing tense auxiliaries (*haben* and *wird*), so that the satisfaction of the main verb's valence requirements are now mediated by the highest verbal governor (here: *wird*).

Suggestive evidence for such an analysis comes from the fact that the object of the main verb is subject to the same range of order variation as if the main verb itself had been the sole predicator in the clause. Thus, in (6a) the pronominal object *es* occurs before the subject *Peter*, which is precisely parallel to the simple case in (6b):

(6) a. daß **es** Peter gelesen haben wird.
that it Peter read-PSP have-INF will-FIN
'that Peter will have read the book.'

b. daß **es** Peter las.
that it Peter read
'that Peter read it.'

Transformational analyses have usually assumed that such cases are the result of a scrambling transformation that dislocates the object (*es*) from the phrase that it forms with the main verb.[2] From an HPSG perspective, a dislocation analysis is undesirable and instead order variation of this kind has been analyzed in terms of permissive linear precedence conditions within a local syntactic domain (typically, a local phrase structure tree). If both subject and object end up as arguments of the highest predicator *wird* via argument composition, the "scrambled" order in (6a) can be explained in terms of order variations among daughters within the same local tree, just as in (6b).

Further evidence against the constituent status of the main verb together with its notional object comes from the failure to occur as a unit in contexts such as relative clauses:

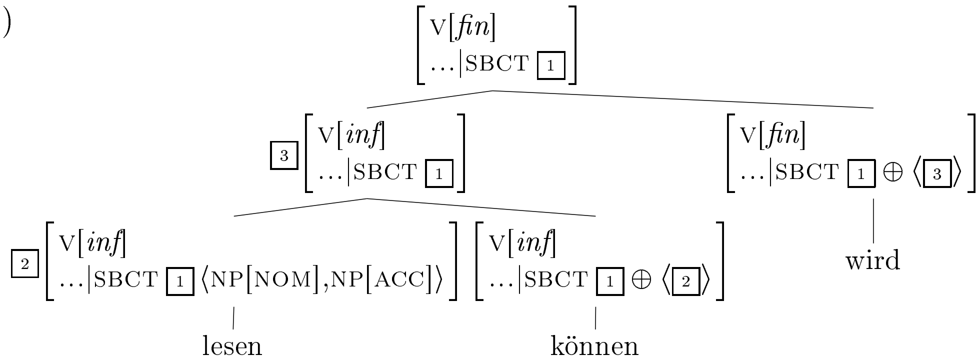
(7) *ein Buch [[das gelesen] Peter haben wird]
a book that read Peter have will

As has been pointed out by Kathol (2000:180–183), linking the valence requirements of verbal material by means of argument composition does not, in fact, determine the phrase structural relations among the participating verbs. Thus, for typical head-final cases as in (5), there have been proposals that assume no subconstituents among the verbal elements at all (Baker 1994, 1999; Bouma & van Noord 1998; van Noord & Bouma 1997), a constituent with right-branching structure (Kiss 1994; 1995), or a constituent

[2] Notable exceptions are the analyses of Haider (1993) and Bierwisch (1990) who assume base-generated verbal complexes similar to the ones proposed by Hinrichs and Nakazawa.

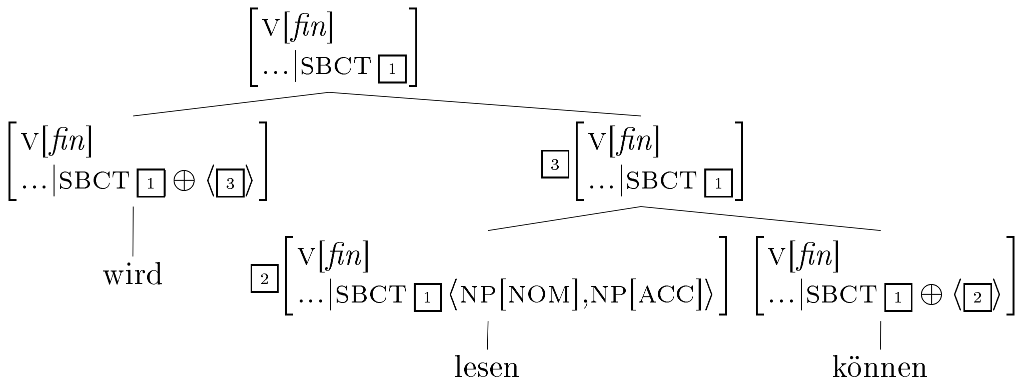
with left-branching structure (Hinrichs & Nakazawa 1989; Kathol 2000) illustrated in (8):[3]

(8)



Empirical evidence in favor of structures of this kind is presented by Hinrichs & Nakazawa (1989), who point out, among other things, that the order variation known as *Oberfeldumstellung* (or "aux-flip") receives an elegant account in terms of reordering of constituents under their left-branching analysis:

(9)



In §3, we will return to evidence presented by Kathol (2000) that a purely phrase structure-based view fails to cover the full range of order variation among verb cluster elements seen in German and Dutch.

Argument composition analyses in effect establish "extended" valence relations between governing verbs and the phrasal argument of more deeply embedded verbs. This property has been the basis for novel proposals for the treatment of passives suggested by Kathol (1994) and Pollard (1994b). Instead

[3]Chung (1993) argues that similar constructions in Korean should be handled by means of a valence feature distinct from SUBCAT that is exclusively responsible for combining verbal material. Rentier (1994) makes a closely related proposal for Dutch verb clusters, which is extended and further motivated empirically by Kathol (2000).

of just passing the valence requirements of the embedded verb, a passive auxiliary can be thought of as actively manipulating the set of valence elements that they inherit from the governed dependents. As a result, passives on the clausal level can be analyzed as a form of object-to-subject raising. Such an approach has a number of desirable consequences over the more standard manipulation of the verb's valence in terms of lexical rules, such as the fact that the morphologically spurious distinction between passive and past participles is no longer needed.

Other areas of German grammar for which argument composition analyses have been proposed include derivational morphology (Gerdemann 1994) and the problem of preposed complements of nouns (De Kuthy & Meurers 1998). In addition, Abeillé & Godard (1994) have argued that tense auxiliaries in French should be analyzed as inheriting the arguments of their main verbs via argument composition, albeit with a flat constituent structure. Abeillé *et al.* (1998) show how this idea can be extended to certain causative constructions with *faire*. Another language for which argument composition has yielded insightful analysis is Korean, both for auxiliaries (Chung 1993) and control verb constructions (Chung 1998a, cf. also Bratt 1996). Finally, Grover (1995) proposes to analyze English *tough*-constructions by means of argument composition, as an alternative to the more standard approach that attributes missing objects inside the VP complements of *tough*-adjectives to an extraction effect.

2.2 Valence and argument structure

Another development that has generated considerable work in recent years is the separation of valence and argument structure.

The previous section assumes that a single uniform valence attribute (SUBCAT) is responsible for defining the combinatorial potential of lexical and phrasal heads. This reflects a view of complementation assumed in early HPSG ("HPSG1", Pollard & Sag 1987) through the state of the theory represented in the first eight chapters of Pollard & Sag 1994 ("HPSG2"). The crucial assumption underlying this approach to valence is that grammatical relations are derivative of valence. For instance, the notion of subject, as it plays a role in agreement, binding theory, and other phenomena, can be recovered as the least oblique ("leftmost") among the valence elements of some predicator. Despite its conceptual simplicity, later versions of HPSG ("HPSG3"), beginning with chapter 9 of Pollard & Sag 1994, have adopted an approach that singles out subjects from other syntactic arguments by means of a separate valence feature SUBJ (as opposed to COMPS, see also Green forthcoming). This idea was first proposed by Borsley (1987), who points out a number of inadequacies with the unified valence list approach. For instance, consider prepositions in English. Since typical prepositions only require one NP argument for phrasal well-formedness, we obtain a singleton SUBCAT-list, as in (10a). As the least oblique element on the preposition's SUBCAT list, this NP would be expected to have the status of a subject; yet in terms of case marking and post-head occurrence, it is clearly on a par with nonsubject arguments of verbs. This is not apparent from the valence representations in (10a) vs. (10b).

(10) a. $\begin{bmatrix} \text{HEAD } \textit{prep} \\ \text{SUBCAT } \langle \text{NP} \rangle \end{bmatrix}$

b. $\begin{bmatrix} \text{HEAD } \textit{verb} \\ \text{SUBCAT } \langle \text{NP} \rangle \end{bmatrix}$

Thus, least oblique elements on SUBCAT lists have to do double duty as subjects of verbs and objects of prepositions.

In contrast, with Borsley's divided valence proposal, the different status of the NP argument in these two cases can be accounted for quite straightforwardly:[4]

(11) a. $\begin{bmatrix} \text{HEAD } \textit{prep} \\ \text{VAL} \begin{bmatrix} \text{SUBJ } \langle\rangle \\ \text{COMPS } \langle \text{NP} \rangle \end{bmatrix} \end{bmatrix}$

b. $\begin{bmatrix} \text{HEAD } \textit{verb} \\ \text{VAL} \begin{bmatrix} \text{SUBJ } \langle \text{NP} \rangle \\ \text{COMPS } \langle\rangle \end{bmatrix} \end{bmatrix}$

The idea of a single representation of all the dependents of some predicator has recently been revived in the form of the ARG-ST feature on lexical elements. However, while SUBCAT as a valence feature records the level of syntactic

[4] Somewhat ironically, the SUBJ/COMPS distinction has been obliterated in much of the HPSG-based literature on German which assumes a nonempty SUBJ list only for nonfinite forms (cf. Kiss 1995). Subjects of finite verbs are instead members of the COMPS list. Assuming that SUBJ elements cannot be directly discharged in German phrases, this proposal is intended to account for the fact that nonfinite verbs do not take subjects. However, this seems like a spurious generalization in light of well-known counterexamples such as in (i), in which the subject *eine Concorde* combines with the nonfinite predicate *gelandet* in the preverbal phrase:

(i) [Eine Concorde gelandet] ist hier noch nie.
a concorde landed is here yet not
'A concorde has not yet landed here.'

saturation for each higher phrase in the tree, ARG-ST is a static representation of the dependents of the lexical head that does not project to higher nodes in the structure. By default, the elements of the ARG-ST list are identical with the concatenation of SUBJ and COMPS at the lexical level, i.e., if no valence requirement has been saturated yet. However, the lists in question do not always line up in this fashion and the possiblity of mismatches has given rise to a number of analyses of otherwise puzzling phenomena. We will briefly discuss two here, *pro*-drop and argument realignments in Austronesian languages.

The standard approach to missing subjects in finite environments has been to posit a null pronoun (*pro*) that instantiates the syntactic subject position. In keeping with HPSG's general avoidance of unpronounced syntactic material, we can instead analyze the unexpressed subject as an ARG-ST element that does not have a corresponding valence expression. The following example from Italian (12a) and the corresponding lexical description of the verb *mangia* illustrate this idea:

(12) a. Mangia un gelato.
eat.3SG a icecream
'S/he is eating an icecream.'

b. $\begin{bmatrix} \text{ARG-ST } \langle \text{NP[3SG], NP} \rangle \\ \text{SUBJ } \langle\ \rangle \\ \text{COMPS } \langle \text{NP} \rangle \end{bmatrix}$

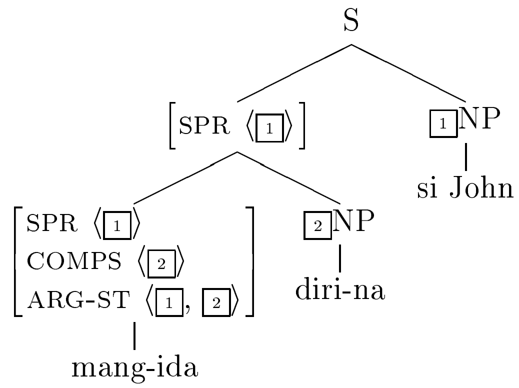
Dependencies in which the subject participates, such as binding or agreement, can be accommodated straightforwardly if we assume that their description references the least oblique ARG-ST element, rather than the value of SUBJ.

A more radical mismatch between valence and argument structure has been proposed by Manning & Sag (1999) for the realization of arguments in Western Austronesian languages such as Toba Batak. In this language clause-initial verbs form a VP with the immediately following argument NP. In the case of active voice (AV) morphology, that NP has the status of nonsubject as evidenced by the fact that a reflexive in that position has to be bound by a later ("higher") NP. Thus, in these cases, valence and argument structure are aligned along the lines familiar from English, despite the difference in word order, cf. (13c):

(13) a. [Mang-ida diri-na] si John.
AV-saw self-his PM John
'John saw himself$_i$.'

b.*[Mang-ida si John] diri-na.
AV-saw PM John self-his

c.

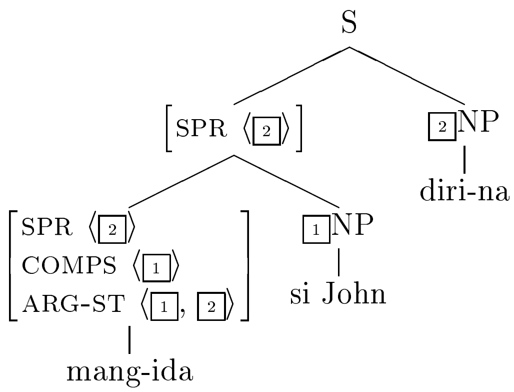


Compare this now with objective voice (OV) verbs. Taking again the distribution of reflexives as a diagnostic, we now have to assume that the VP-internal NP has the status of a subject. But this means that in the OV case, valence and argument structure are aligned in a way that is precisely opposite from the AV cases.

(14) a.*[Di-ida diri-na] si John.
OV-saw self-his PM John

b. [Di-ida si John] diri-na.
OV-saw PM John self-his
'John saw himself$_i$.'

c.



Separating information about valence (i.e., syntactic combinatorial potential) from argument structure (i.e., for the most part, semantic roles with syntactic relevance) it becomes possible to treat a number of phenomena as lexical in nature which otherwise would have to be handled in syntactic terms. In turn this keeps at a minimun the structural complexity in terms of genuine syntactic elements. The issue of structual complexity will also be of concern in the next subsection as well as in §4.

2.3 Dependents and Lexical Amalgamation

The following subsections deal with two issues in the area of argument structure which at first appear to be independent of each other but turn out to be closely linked in recent HPSG work. First, is there a fundamental distinction between complements and adjucts and, second, what is the role of the syntactic head in licensing information about missing dependents?

2.3.1 Complements and Adjuncts

It is a common and generally unquestioned assumption in much of contemporary linguistics that there is a syntactic distinction between complements and adjuncts, and that these two classes of dependents occupy different tree-configurational positions. This was also the position of early HPSG work.

However, the evidence for this syntactically understood complement/adjunct dichotomy has recently been re-examined within HPSG. For example, Hukari & Levine (1994, 1995) show that there are no clear differences between complement extraction and adjunct extraction, and Bouma *et al.* (2000) build on these observations and propose a unified theory of extraction based on the assumption that there is no tree-configurational distinction between complements and (at least a class of) adjuncts. Earlier, eliminating the configurational distinction was proposed in Miller 1992 (on the basis of French agreement facts, *inter alia*), van Noord & Bouma 1994 (on the basis of semantic ambiguities in Dutch clusters), and Manning *et al.* 1999 (on the basis of the behavior of Japanese causative constructions). This 'adjuncts-as-complements' approach is further defended on the basis of case assignment facts in Finnish and other languages (Przepiórkowski 1999c, 1999a), and on the basis of diachronic considerations (Bender & Flickinger 1999).

The central idea of all these analyses is that (at least a class of) adjuncts are added to the verb's subcategorization frame already in the lexicon and, hence, are indistinguishable from complements in syntax. For example, in the analysis of Bouma *et al.* 2000, words are specified for the attribute DEPS (dependents), in addition to attributes ARG-ST and VALENCE discussed above. ARG-ST encodes the 'narrow' argument structure, i.e., information about dependents which are more or less idiosyncratically required by the word. This information is eventually mapped into the word's VALENCE attributes, which are responsible for syntactic realization of these dependents. However, on Bouma *et al.*'s (2000) account there is an intermediary level between ARG-ST and VALENCE, namely, DEPS, which encodes all dependents of a verb, both subcategorized (elements of ARG-ST) and non-subcategorized (adjuncts). In other words, DEPS extends ARG-ST to adjuncts, as schematically illustrated in (15).

(15) Argument Structure Extension

$$\begin{bmatrix} \textit{word} \\ \ldots|\text{HEAD} \;\; \textit{verb} \end{bmatrix} \rightarrow \begin{bmatrix} \ldots|\text{CAT} & \begin{bmatrix} \textit{category} \\ \text{DEPS} \;\; \boxed{1} \oplus \textit{list(adjunct)} \\ \text{ARG-ST} \;\; \boxed{1} \end{bmatrix} \end{bmatrix}$$

The DEPS list is, in turn, mapped into the VALENCE attributes, according to the following schematic constraint.

(16) Argument Realization

$$\textit{word} \rightarrow \begin{bmatrix} \ldots|\text{CAT} & \begin{bmatrix} \textit{category} & \\ \text{VALENCE} & \begin{bmatrix} \text{SUBJ} \;\; \boxed{1} \\ \text{COMPS} \;\; \boxed{2} \ominus \textit{list(gap)} \end{bmatrix} \\ \text{DEPS} \;\; \boxed{1} \oplus \boxed{2} & \end{bmatrix} \end{bmatrix}$$

According to this principle that all elements of ARG-ST, except *gaps*, must be present on VALENCE attributes. There are two things to note about (16). First, *gaps*, i.e., **(***AK)** information associated with extracted elements, are AK
present on the list value of the attribute DEPS, but they disappear from the

VALENCE attributes, which are responsible for syntactic realization of constituents. This means that, according to this approach, there are no *wh*-traces (and, more generally, no empty elements) anywhere in the constituent tree.

Second, and perhaps more importantly, the configurational distinction between complements and adjuncts (sister of X^0 vs. X') is lost here: all elements of the extended argument structure DEPS are uniformly mapped into VALENCE attributes, regardless of their complement/adjunct status.

As we will in the next section, various grammatical processes are assumed to operate at the level of such an extended argument structure.

2.3.2 Extended Argument Structure

Bouma *et al.* (2000) propose a theory of extraction which makes crucial use of the extended argument structure encoded as the value of DEPS. They argue that extraction does not distinguish between various kinds of dependents and propose the following principle of SLASH amalgamation which encodes this observation.

(17) SLASH Amalgamation:

$$\textit{word} \rightarrow \left[\begin{array}{ll} \text{SYNSEM} & \left[\begin{array}{ll} \text{LOC}|\text{CAT} & \left[\begin{array}{ll} \text{DEPS} & \langle[\text{SLASH } \boxed{1}],\ldots,[\text{SLASH } \boxed{n}]\rangle \\ \text{BIND} & \boxed{0} \end{array}\right] \\ \text{SLASH} & (\boxed{1} \cup \ldots \cup \boxed{n}) - \boxed{0} \end{array}\right] \end{array}\right]$$

This principle is responsible for collecting SLASH values from all dependents of a *word*, perhaps lexically binding some of them (this happens in case of words such as *tough* or *easy*, which are lexical SLASH-binders), and collecting all other elements of these SLASH sets into its own SLASH value. This SLASH value is then shared along the head projection of the *word*, in accordance with the principle of SLASH inheritance:

(18) SLASH Inheritance (schematic):

$$\textit{hd-val-ph} \rightarrow \left[\begin{array}{ll} \text{SLASH} & \boxed{1} \\ \text{HD-DTR}|\text{SLASH} & \boxed{1} \end{array}\right]$$

This approach differs from earlier HPSG approaches to extraction not only in treating dependent extraction on part with argument extraction, but also in different division of labor between different parts of the grammar. On the analysis sketched above, the amalgamation of SLASH values takes place at the level of *word*s, never at the level of *phrase*s — *phrase*s only pass SLASH values to the head-filler phrase, where extracted elements are overtly realized.

Similar lexical amalgamation is also assumed for the purposes of the lexical analysis of quantifier scoping in Manning *et al.* 1999 and Przepiórkowski 1997, 1998, and for the flow of pragmatic information in Wilcock 1999.

3 Phrase structure and linear order

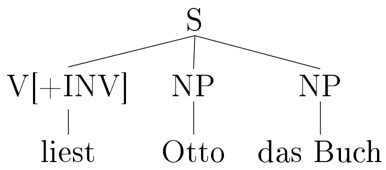
3.1 Configurationality

A theme running through much of the HPSG literature has been the lexicalization of relationships that have been treated in tree-configurational terms in other theories. HPSG's binding theory is a prime example of how certain asymmetries among coarguments can be reinterpreted in terms of obliqueness on valence/argument structure. As a result, there is no longer a need for expressing such asymmetries in tree-structure terms such as c-command.

Similarly, variation in phrase order of the kind seen in Japanese or German has typically been seen in terms of liberal linear precedence constraints over flat clausal tree structure rather than the result of manipulating highly articulate phrase structure via scrambling movements (cf., for instance, Uszkoreit 1987 and Pollard 1996 for German and Chung 1998a for Korean).[5] HPSG analyses of this kind thus are similar to recent LFG proposals to nonconfigurational languages in terms of flat clause structures (cf. for instance Austin & Bresnan 1996).

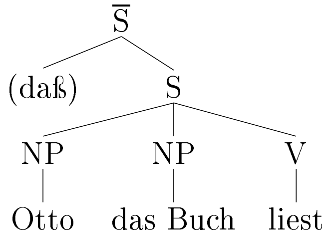
A issue closely related to order variation among phrasal dependent is that of the placement of verbal heads in the Germanic languages (and elsewhere). Given a flat structure analysis for the phrasal constituents of the clause, the different positionings of the finite verb in verb-first and verb-last clauses then reduce to clause-initial vs. clause-final placement of that verb (typically mediated by a binary-valued feature such as INV, familiar from HPSG analyses of English subject-auxiliary inversion), cf. Pollard 1996:

(19) a.



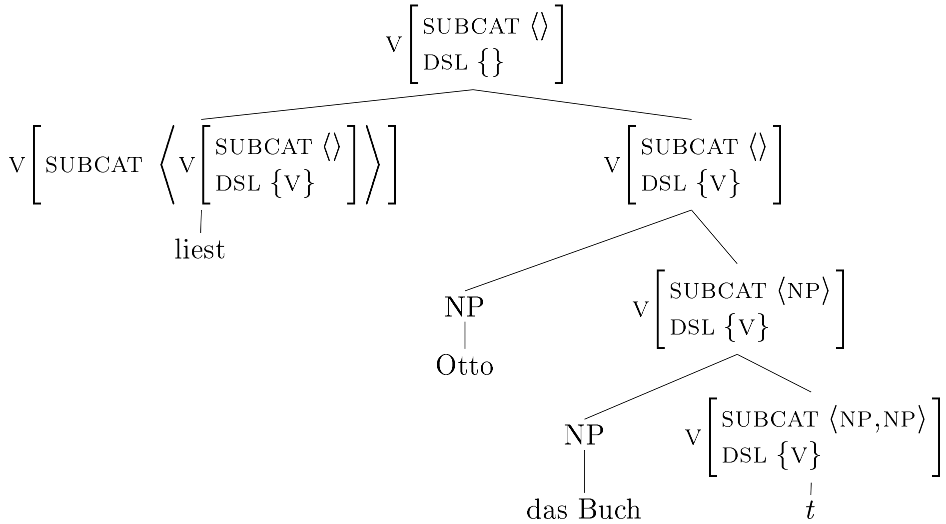
[5]Note however, that this correlation does not follow by necessity. For instance, Kiss 1995 and related works assumes a strictly binary branching clause structure for German of the kind familiar from transformational analyses.

b.



Analyses of this kind clearly differ sharply from the standard transformational approach in terms of movement of the finite verb from its clause-final base position to a clause-initial position (Comp) via head-movement. The underlying intuition that verb placement is dependent on constituent structure is in fact shared by various HPSG-based proposals that offer a number of different ways in which verb movement may be implemented in HPSG, cf. Kiss & Wesche 1991, Kiss 1995, Netter 1992, Frank 1994. The representation given in (20) illustrates how to capture the dependency between the finite verb (*liest*) and its putative base position in terms of the additional nonlocal feature DSL (for "double slash"):[6]

(20)



Accounts of verb placement in terms of nonlocal dependencies of this kind are discussed by Kathol (1998) and Kathol (2000), who points out that none of the putative evidence for a dislocation-based analysis in fact holds up under closer scrutiny.[7] In addition, he notes a number of technical and conceptual

[6]A feature with this name and function was first suggested by Jacobson (1987).

[7]Cf. also Wechsler 1986 for an earlier critique of movement-type analyses of verb placement in Swedish.

problems involving the locality of the dependency and the existence of dislocated heads. One area in which verb dislocation approaches appear to provide better analyses than those based on ordering variation within local trees is the interaction between finite verbs and complementizers. German and other Germanic languages exhibit a characteristic complementarity of distribution between initial finite verbs and complementizers in root and subordinate clauses, respectively. If verbs and complementizers are not subconstituents of the same local tree, it is not clear how they can be made to interact positionally. In contrast, verb movement analyses are able to express a direct functional analogy between those two categories, which can account for those distributional facts. However, like their transformational counterparts, such analyses fail to generalize to phraal clause-initial categories—that is, *wh*-phrases in subordinate interrogative and relative clauses—which possess basic distributional and functional properties of complementizers (cf. Kathol & Pollard 1995 and Kathol 2000, for extensive discussion on this point). In fact, one of the major motivating factors behind the linearization-based approach to Germanic clausal syntax pursued in Kathol 2000 is precisely to allow for this basic parallelism to be expressed in a comprehensive account of the linear underpinnings of Germanic clause structure. As we will see in the next section, the required extensions of the phrase structure substrate of the HPSG linguistic theory affords a rather flexible and elegant approach to problems of discontinuous constituency within the formalism of HPSG.

3.2 Nonconcatenative approaches to linear order

In much of contemporary syntactic theory, the correlation between hierarchical organization and linear order in terms of a left-to-right concatenation of the terminal leaves ("terminal yield") is taken for granted. However, an interesting consequence of the sign-based approach that the very ingredient that gave HPSG its name ("phrase structure grammar") turns out to be a nonessential part of the formalism. While concatenation is one mode of computing the phonology of a sign from the the phonology of its constituent parts, other relations are perfectly compatible with the sign-based approach. There is now a significant literature that explores such alternatives.

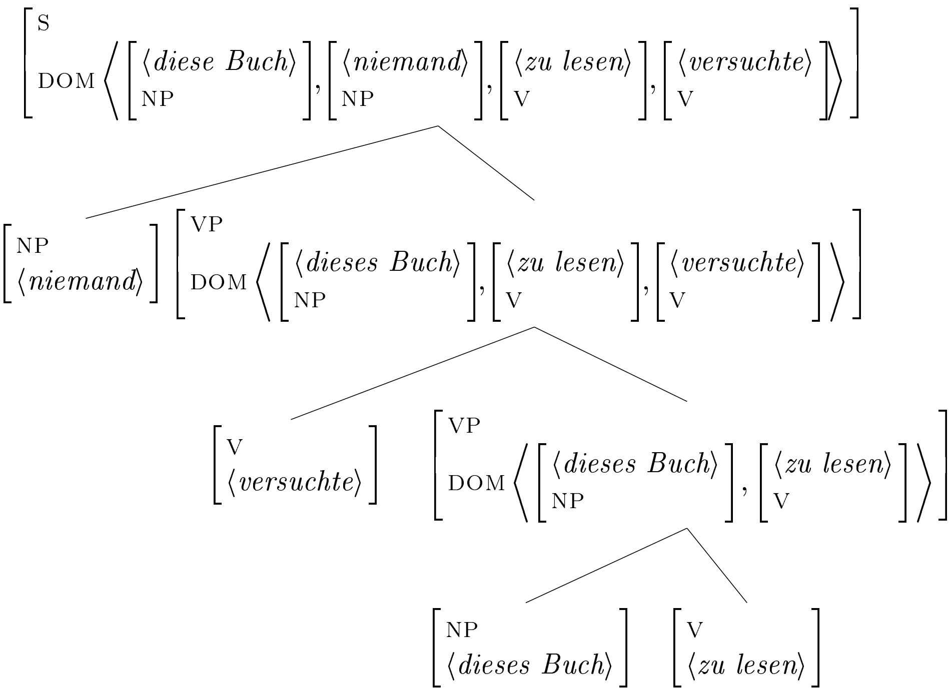
Concatenative approaches lends themselves rather straightforwardly to the description of the relation between constituency and order in a language like English. However, it is far less clear whether this also holds of languages such as German. For instance, Reape (1993,1994, 1996) observes that in German nonfinite complementation construction of the kind illustrated in (21a), the verb *zu lesen* occurs separated from its notional object *dieses Buch*—unlike in the English counterpart (21b).

(21) a. daß **dieses Buch** niemand **zu lesen** versuchte.
that this book.ACC no one.NOM to read tried
'that no one tried to read this book.'

b. No one tried to **read this book**.

The argument composition approach sketched above in §2 attributes this discontinuity to the formation of a complex predicate (*zu lesen versuchte*). Reape instead proposes to analyze the German and English constructions in terms of the same basic constituent types (in particular VPs), yet realized in a discontinuous fashion in the case of German. This is illustrated in (22), where each sign now is augmented with a list-valued feature representing that sign's (WORD) ORDER DOMAIN. Linear order is determined by mapping the phonology of the domain elements onto the phonology of the phrase, rather as the terminal yield of the constituent structure. While in standard phrase structure grammar, the region of (potential) order variation is the local tree, order domains expand that region to include elements that are not immediate constituents of the sign in question. For instance, in (22), the NP *dieses Buch* as a complement of *zu lesen* is not an immediate constituent of the clause; nevertheless it occurs together with the verbal head *versuchte* within the clause's order domain.

(22)



Reape's proposal bears a strong resemblance to previous, approaches to discontinuous constituents, in particular Pullum and Zwicky's notion of "liberation" (Pullum 1982, Zwicky 1986). Thus, the the VP in (22) can be thought of as being "liberated" in the sense that its immediate constituents may intermingle with elements from outside that VP. Unlike Pullum and Zwicky's proposals, HPSG order domains provide a level of syntactic representation from which the range of possible intrusion effects can be read off directly. Thus, while the VP *dieses Buch zu lesen* gives rise to two list elements in the clausal domain, the NP *dieses Buch* contributes only one element. Since domain elements cannot themselves be broken apart, it is predicted that discontinuities are allowed only in the former case, but not in the latter. Finally, if order domains take the place of local trees as the range of potential order flexibility, it is natural to interpret linear precedence constraints as well-formedness conditions over order domains.

3.2.1 Linearization-based vs. valence-based approaches

The initial appeal of structures such as (22) is that they allow an analysis of German which—notwithstanding the differences in linear order—is remarkably similar to the constituency commonly proposed for the equivalent English sentences in nontransformational approaches.

Therefore, it appears that argument composition and order domains constitute two alternative ways of allowing for embedded verbs and their notional objects to occur separated in a "middle distance dependency" construction. This has occasionally been perceived to be an embarrassment of riches with no obvious way of telling which analysis is to be preferred. However, as is discussed in detail in Kathol 1998, Reape's analysis can be shown to ultimately unsatisfactory in that it fails to link the argument structure of more deeply embedded predicates to that of the governing verbs—which is precisely the leading intuition behind the argument composition approach. Evidence that such linkage is in fact necessary comes from a phenomenon known as 'distant' or 'long' passive (cf. Höhle 1978). In (23), the NP *der Wagen* is the direct object of the embedded verb *zu reparieren*, yet its nominative case marks it as the subject of the passivized predicate *wurde versucht*.

(23)	?Der Wagen	wurde	zu reparieren	versucht.
	the car-NOM	was	to repair	tried
	'Someone tried to repair the car.'			

If all predicates of the *versuchen*-class invariably embed VPs, as suggested by Reape, the direct object of the embedded verb (*den Wagen* in (23)) would never be 'visible' to the valence change that accompanies the passivization of *versuchen*.[8] Thus, Reape's approach wrongly predicts that such constructions should not exist. In contrast, any argument composition approach can easily accommodate such cases because the syntactic arguments of the most embedded verbal predicate become also the syntactic dependents of the governing predicates.

Even though facts such as these cast doubt on the appropriateness of order domains in description of the particular phenomena that they were originally developed for, there nevertheless appear to be other discontinuous constituency phenomena for which order domains represent an elegant descriptive tool. For instance, Kathol (1998) points out that argument composition of the kind proposed by Hinrichs and Nakazawa fails to correctly account for certain orderings within Dutch verb clusters. In Dutch we typically find head-first ordering between the governing verb and the governed subcomplex. For example, in (24a), *moet* as the highest governing verb precedes *hebben gelezen*. Combinations of tense auxiliaries and their dependent verbs can generally occur in either order; when they occur in head-final order, as in (24b), the preferred occurrence of the governing verb *moet* (in standard Dutch) turns out to be between *gelezen* and *hebben*. This kind of ordering cannot be described assuming only argument composition and binary branching verbal complexes of the kind initially proposed by Hinrichs and Nakazawa.

(24)	a. dat	Jan	dit boek	moet$_1$	hebben$_2$	gelezen$_3$.
	that	Jan	this book	must-FIN	have-INF	read-INF
	'that Jan must have read the book.'					
	b. dat	Jan	dit boek	gelezen$_3$	moet$_1$	hebben$_2$.
	that	Jan	this book	read-PSP	must-FIN	have-INF

Kathol (2000) shows how facts such as these can be given an elegant solution if argument composition is combined with order domains that permit the discontinuous linearization of certain governed subcomplexes such as *gelezen hebben* in (24). Such an analysis goes a long way toward a uniform account of the ordering possibilities in a number of variants of German and Dutch by factoring out dialect-independent constituency and dialect-dependent linearization constraints.

[8]This argument of course pressuposes a lexicalist approach to passives in terms of variation in argument structure or valence rather than manipulation of tree configuration.

3.2.2 Further applications

Another area in which the adoption of order domains has arguably lead to significant progress is in the syntax of left-peripheral elements in German. As was pointed out above, the striking interplay between finite verbs and complementizers (and *wh*-phrases, for that matter) which forms the basis of transformational verb movement accounts has been captured only insufficiently in purely phrase structure-based approaches. However, if order domains are combined with the concept of "topological fields" from traditional German grammar, these facts can be described rather straightforwardly in purely non-derivational terms (cf. Kathol 2000). The basic idea is to allow for elements with different grammatical roles within the clause—verbal head, phrasal complements, filler phrase, complementizer, filler phrase etc.—to all occur within the clause's order domain and assign each of them to a topogical field such as *Vorfeld (vf.)* (roughly equivalent to [Spec,CP]) or *linke Satzklammer (l. S.)* (roughly equivalent to Comp), *Mittelfeld (mf.)*, etc., according to various lexical or constructional constraints. With the further constraint that the left-most topological fields (*Vorfeld, linke Satzklammer*) may be instantiated by at most one element, the positional competition between complementizer and finite verb falls out as a natural consequence. Thus, in (25) the finite verb cannot be associated with the same field as the complementizer and must instead occur clause-finally (*rechte Satzklammer (r. S.)*).

(25)

$$\left[\textsc{dom}\left\langle \begin{bmatrix} \textit{l. s.} \\ \textsc{phon}\langle \textit{daß} \rangle \\ \textsc{compl} \end{bmatrix}, \begin{bmatrix} \textit{mf.} \\ \textsc{p'n}\ \langle \textit{Lisa} \rangle \\ \textsc{np}[\textsc{nom}] \end{bmatrix}, \begin{bmatrix} \textit{mf.} \\ \textsc{p'n}\ \langle \textit{die Blume} \rangle \\ \textsc{np}[\textsc{acc}] \end{bmatrix}, \begin{bmatrix} \textit{r. s.} \\ \textsc{p'n}\ \langle \textit{sieht} \rangle \\ \textsc{v}[\textsc{fin}] \end{bmatrix} \right\rangle\right]$$

(26)
$$\left[\textsc{dom}\left\langle \begin{bmatrix} \textit{l. s.} \\ \textsc{phon}\langle \textit{sieht} \rangle \\ \textsc{v}[\textsc{fin}] \end{bmatrix}, \begin{bmatrix} \textit{mf.} \\ \textsc{phon}\langle \textit{Lisa} \rangle \\ \textsc{np}[\textsc{nom}] \end{bmatrix}, \begin{bmatrix} \textit{mf.} \\ \textsc{phon}\langle \textit{die Blume} \rangle \\ \textsc{np}[\textsc{acc}] \end{bmatrix} \right\rangle\right]$$

Typical verb-second declarative clauses involve the instantiation of *Vorfeld* by a non-*wh*-phrase and *linke Satzklammer* by a finite verb, as shown in (27):

(27)
$$\left[\textsc{dom}\left\langle \begin{bmatrix} \textit{vf.} \\ \textsc{phon}\langle \textit{die Blume} \rangle \\ \textsc{np}[\textsc{acc}] \end{bmatrix}, \begin{bmatrix} \textit{l. s.} \\ \textsc{phon}\langle \textit{sieht} \rangle \\ \textsc{v}[\textsc{fin}] \end{bmatrix}, \begin{bmatrix} \textit{mf.} \\ \textsc{phon}\langle \textit{Lisa} \rangle \\ \textsc{np}[\textsc{nom}] \end{bmatrix} \right\rangle\right]$$

Kathol (1999a; 2000) further describes how clausal domains of this kind can be utilized in a constructional approach (see refcg-turn below) to German sentence types with various kinds of illocutionary force potential.

While much of the work employing order domains has concentrated on German (see also Richter 1997a and Müller 1999:ch. 11), there have been numerous adaptations of Reape's proposals for a variety of other languages as well, including Japanese (Calcagno 1993 and Yatabe 1996) Danish (Hentze 1996 and Jensen & Skadhauge 1998), Breton (Borsley & Kathol 1999), English (Kathol & Levine 1992), Warlpiri (Donahue & Sag 1999), Ojibwe (Kathol & Rhodes 1999), and Serbo–Croatian (Penn 1999b and Penn 1999a). One of the ongoing issues in the literature on nonconcatenative approaches to linearization is the precise informational content of the inhabitants of order domains. Reape's original suggestion consider order domains as populated by HPSG *signs*. This would allow for the formulation of many linear precedence constraints for which there is little or no empirical evidence. As a result, there have been proposals (cf. Kathol 1995) to limit the informational content of domain elements so as to make certain aspects of linguistic information (such as internal phrase structure) inaccessible to linear precedence relations. This can be seen as closely related other proposals to have the feature architecture express linguistically contentful constraints ("geometric prediction").

4 Syntactic abstractness and reductionism

In this section we survey some developments in HPSG that primarily seem to pertain to methodological issues and closer inspection also have empirical remifications. These have to do with the reality of phonologically empty syntactic constituents and the division of labor between the lexicon and the combinatorial apparatus in expressing syntactic generalizations. The overriding concern in both is the question of how abstract we should assume syntactic representations to be.

4.1 The (non-)reality of syntactic traces

With the reduction of the inventory of transformations in the seventies to those that comply with structure preservation, the notion of a "trace" as the residue of movement operations has become a core ingredient of transformational theories of grammar. The presence of inaudible copies of dislocated elements within the syntactic representation has been of crucial importance for the formulation of many principles in theories of the transformational ilk, including binding, scope of quantificational expressions, distribution of case-marked elements, constraints on extraction etc.

The definition of a trace in HPSG is quite straightforward. One can simply see it as a phrasal element of some category (usually nominal or prepositional) which is phonologically empty and contributes its own local information to the set of nonlocal SLASH information:

(28) $$\begin{bmatrix} \text{PHON} \ \langle\ \rangle & \\ \text{SYNSEM} \begin{bmatrix} \text{LOCAL} \ \boxed{1} \\ \text{NONLOCAL} \mid \text{SLASH} \ \{\boxed{1}\} \end{bmatrix} \end{bmatrix}$$

However, the notion of a phonologically empty syntactic element is somwhat antithetical to the spirit of a surface-true theory such as HPSG. Note also that for a variety of constructions the inaudibilia of transformational analyses have already been dispensed with. This is true in particular for PRO in infinitival constructions (simply an nonsaturated valence requirement) and the trace of A-bar movement (passive subject is not linked to a syntactic object position). Eliminating *wh*-traces thus is tantamount to shedding the last vestiges of a derivational view of grammar.

The abolishment of *wh*-traces poses no technical problem, especially if one adopts the distinction between "static" argument structure and "dynamic" valence. From this perpective, an extracted element is nothing but a locally unrealized element of the ARG-ST list. Rather than licensing a sister constituent of that predicator the SLASH element is realized as a filler (or bound some other way, as in the case of *tough*-constructions). Since the argument structure remains unaffected by the specifics of syntactic realization,[9] any evidence for asymmetries among coarguments can be explained as asymmetries among members of ARG-ST, rather than a valence feature. For instance, this easily accounts for the fact that fillers in English topicalization constructions may be reflexives with an antecedent in the following clause—notwithstanding the fact that the reflexive is presumably in a configurationally higher position than its antecedent (Pollard & Sag 1994:265):

(29) a. (John and Mary are stingy with their children.)
But themselves$_i$, they$_i$ pamper.

While many facts related to extraction phenomena allow for both a trace-based and a trace-less account, this does not entail that both styles of analysis are exactly equivalent in their empirical predictions.

As has been argued by Sag & Fodor (1994), the evidence for the existence of traces proposed in the literature is often extremely weak. At the same time

[9] In addition to being realized as a "gap" matched by a filler, another noncanonical argument realization is as a clitic. See §6.1 below.

there are phenomena that can be explained more straightfowardly if no traces are assumed.

As an example of arguments of the first kind, consider *wanna*-contraction, one of the most celebrated pieces of evidence in favor of traces. The basic idea is that *wh*-traces disallow the phonological contraction of *want* and *to*. The relative clause in (30a) is ambiguous between a subject or object control reading for the understood subject of *succeed*. In contrast, the variant in (30b) only permits the subject control reading which is supposedly explained by the lack of contractabily across a *wh*-trace.

(30) a. This is the man I want to succeed.

b. This is the man I wanna succeed.

However, as has been pointed out by Pullum (1997), there are numerous technical and conceptual problems with this assumption. Instead a fully lexical, traceless analysis of the above contrast is available if *wanna* is thought of as a morphosyntactically underived subject-control verb which does not license an object.

Turning to positive evidence against traces, consider the following extraction facts:

(31) a.*Who$_i$ did you see [__$_i$ and a picture of __$_i$]?

b.*Which student$_i$ did you find a picture of [a teacher of __$_i$ and __$_i$]?

c.*Who did you compare [__$_i$ and __$_i$]?

The operative constraint at work here is that no conjunct must itself consist only of an extraction site. However, this fact is not predicted by the constraints on extraction from coordination constructions which only require each conjunct to be affected in an "Across-the-Board" fashion. Thus, additional stipulations are necessary to capture the ungrammaticality of (31). In contrast, if licensing of extracted phrases is handled entirely by lexical amalgamation of gap information the facts in (31) fall out for free. This is because lexical amalgamation only applies to lexical heads. In order to license the extraction of an entire conjunct, there would have to be a lexical head that could serve as the locus for the gap amalgamation. But no such lexical head arguable exists in coordination constructions, hence there is no way to license the ungrammatical examples in (31).

Together with the elimination of such inaudibilia as *pro* (or empty relativizers as discussed in the next subsection), the abolishment of traces from syntactic representations is a further step toward reducing syntactic abstractness and representational complexity. This has been made possible by the fact that a "word" in later versions in HPSG is no longer a monolithic entity but instead corresponds to a network of lexical resources each of which associated with different combinatorial possiblities. A further, and to some extent complementary, way of reducing representational complexity is to assume a more fine-grained inventory of licensing schemata.

4.2 The "constructional" turn

The development from GPSG to HPSG can be seen, to some degree, as a reaction to the great number of ID rules which had been posited in GPSG. Moreover, in GPSG there did not seem to be any natural correspondence between the semantic valence of a verb and its syntactic frame of occurrence. The lexicalization of combinatorial properties that the feature-based encoding of valence in HPSG makes possible also allows for a rather sparse system of combinatorial schemata which describe all the phrase types of a given language. If the combinatorial potential is lexically encoded then the ID schemata only serve to "execute" those combinatorial possibilities. Conversely, each combination of phrases can be reduced to combinatorial features that are grounded in lexical information.

Even though this view is initially attractive, its shortcomings become apparent when one considers constructions whose combinatorial potential is not ostensibly reducible to the properties of particular lexical elements. A case in point are relative clauses. Being modifiers their combination with a modified noun is licensed by means of the MOD head feature. Yet constructions such as *that*-less relative clauses in English do not appear to have a lexical trigger for their modifier status.[10]

(32) This is the woman I love.

The solution proposed in Pollard & Sag 1994 preserves the idea that combinatorial properties are lexically derived, but at the price of violating HPSG's

[10]Another possibility would be to attribute the relative clause behavior entirely to the verbal head. This would mean that finite verbs have to be treated as ambiguous between a "regular" and a relative clause version which licenses a gap and turns the finite clause into a noun-modifier. However, long-distance dependencies of the kind shown in (i) militate against such an approach.

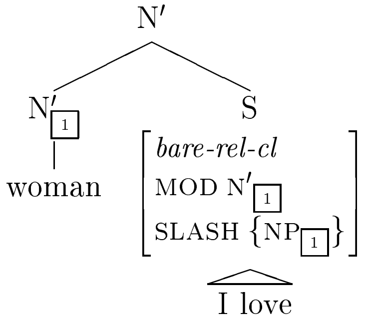
(i) This is the woman that they say I love.

Here the verb that licensing the gap is *love*, yet the verb responsible for the modification of the noun *woman* is *say*.

commitment to avoiding syntactic inaudibilia whenever possible. In particular, Pollard & Sag (1994) propose a functional head analysis in which a phonologically empty relativizer takes a clausal complement with a gap. As the head of the whole relative clause, the relativizer contributes its MOD specification to the entire clause, which in turn licenses the combination with a modified noun.

A rather different approach to relative clauses is pursued by Sag (1997). Instead of reducing the internal and external properties of relative clauses to lexical elements, Sag instead treats relative clauses as grammatical entities in their own right. Thus, relative clauses are considered to be CONSTRUCTIONS in the sense of Construction Grammar (Fillmore *et al.* forthcoming; Zwicky 1994; Goldberg 1995), that is, pairings of meaning and formal syntactic properties that cannot be reduced to any other components of the grammar. From such a construction-based perspective, the example in (32) receives an analysis of the kind sketched in (33):

(33)



Here *bare-rel-cl* is a particular kind of relative clause with properties that set it apart from other kinds of relative clauses, in particular the absence of any initial *wh*-filler.

The constructional perspective has led to a reevaluation of the division of labor between the lexicon and the supra-lexical units recognized by the grammar. Thus, instead of allowing lexical descriptions to become arbitrarily complex by, in effect, incorporating aspects of the constructional context in which the lexical elements are to be embedded, it is now possible to keep the lexicon relatively simple but allow for more complexity in the phrase system. In addition to relative clauses two areas in which a construction-based approach has led to significant advances are English interrogative constructions (Ginzburg & Sag forthcoming, see also §5.1.2) and German clause types (Kathol 1997; Kathol 2000). The latter combines the construction-based perspective with the linearization framework outlined in §3.2. As a result, German clausal constructions can be defined entirely by reference to their topological structure, abstracting away from the combinatorial licensing. In the case of root declarative clauses this makes it possible to have a uniform description of this construction whether the initial element is a filler (as in (27) above) or some other element, such as the positional expletive *es*, illustrated in (34):

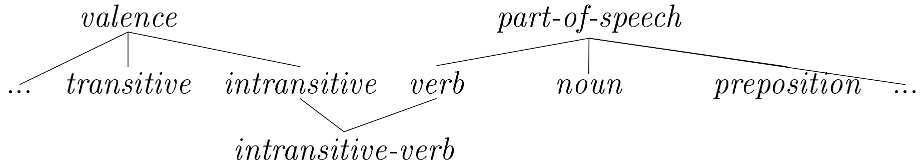
(34)
$$\begin{bmatrix} \textit{root-decl} \\ \textsc{dom} \left\langle \begin{bmatrix} \textit{vf.} \\ \textsc{p'n}\ \langle \textit{es} \rangle \\ \textsc{expl} \end{bmatrix}, \begin{bmatrix} \textit{l. s.} \\ \textsc{p'n}\ \langle \textit{sah} \rangle \\ \textsc{v}[\textsc{fin}] \end{bmatrix}, \begin{bmatrix} \textit{mf.} \\ \textsc{p'n}\ \langle \textit{niemand} \rangle \\ \textsc{np}[\textsc{nom}] \end{bmatrix}, \begin{bmatrix} \textit{vf.} \\ \textsc{p'n}\ \langle \textit{d. Blume} \rangle \\ \textsc{np}[\textsc{acc}] \end{bmatrix} \right\rangle \end{bmatrix}$$

4.3 Type hierarchies for nonlexical generalizations

A complaint often levelled against construction-based approaches is that they are merely descriptive and not explanatory and hence do not try to uncover the underlying factors that are responsible for the patterns observed in the data. Proponents of the constructional perspective tend to consider such criticism as misguided given that the reductionist approach often only succeeds because it relies on an arbitrary selection among the data considered worthy of explanation ("core" vs. "periphery"). In addition, the kind of reductionism seen in many varieties of abstract syntax fails to appreciate the degree to which constructional complexity is often simply hidding within a system of phonologically null elements for which little or no empirical motivation is provided.

Finally, critics of constructional approaches fail to realize that the flipside of describing what is special and irreducible about a given entity in the grammar is an account of all the ways in which a given construction SHARES properties with other elements of the grammar. A particularly powerful device in this respect are multiple inheritance hierarchies. Such hierarchies are well-known from the way that lexical information is organized in HPSG. For instance, a verbal form such as *walks* can intuitively be characterized in terms of at least two parameters of variation. The first is the lexical class or part of speech, which groups *walks* together with such forms as *is*, *proved*, and *singing*. The second is valence, which puts *walks* in the same class as *sleeping*, *house*, or *abroad*, cf. (35).

(35)



Thus once membership in these and other classes has been established for a given lexeme, only the lexically indiosyncratic properties need to be listed for it.

Since HPSG does not assume any ontological distinction between words other linguistic units (all are assumed to be instances of *sign*), it is straightforward to extend multiple inheritance hierarchies to phrasal constructions as well. For instance, the phrasal type *bare-rel-cl* in (33) above is simultaneously an instance of the phrase types *non-wh-rel-cl* and *fin-hd-subj-ph*. The first classifies the construction as a particular subinstance of non-*wh* relative clauses, which in turn are one way in which the "clausality" of a phrase are specified, that is its combinatorial and semantic properties.[11] The second accounts for its internal composition as a subject-predicate construction (and, for instance, not as a filler-head construction as in the case of *wh*-relative clauses). While there is often a residue of properties that cannot be accounted for by stating what larger constructional classes a given entity inherits from, it turns out that bare relative clauses are defined in their entirety by their supertypes. Thus, far from simply providing a list of available constructions, the construction grammatical approach is very much concerned with stating all available generalizations at all applicable levels. As a result, as Kathol (2000:***) points out, the equivalent of the representational complexity inherent in the abstract structures posited in transformational analyses lies in the various inheritance relationships that tie the constructions of a language into a complex web of dependencies of different kinds, sometimes referred to as the "constructicon".

5 Meaning in HPSG

As Halvorsen (1995), Nerbonne (1992, 1995) argue at length, LFG- or HPSG-style constraint-based semantics has several advantages over, e.g., Montagovian kind of semantics in that the latter but not the former assumes a homomorphism between syntax and semantics. In contrast, constraint-based semantics allows for a much greater freedom in stating analyses at the syntax/semantics interface, and also makes it easy to formulate phonological and pragmatic constraints on meanings (cf. §5.2). In addition, constraint-based semantics seems to be particularly well-suited for expressing semantic underspecification (cf. §5.1) and it allows to formulate theories of combinatorial semantics which go beyond compositionality, a notion recently argued to be vacuous at worst and dispensable at best (Zadrożny 1994;

[11] Other ways of instantiating "clausality" include imperative, declarative, or interrogative clauses.

Lappin & Zadrożny 2000).

In the two subsections below, we will look at recent HPSG approaches to semantics and pragmatics, respectively.

5.1 Advances in Semantics

Recent years have witnessed an increase of interest in foundational semantic issues within HPSG. A number of recent works have proposed various novel approaches to HPSG semantics, either building on and further developing the approach of Pollard & Sag (1994) (cf. §5.1.1 and §5.1.2), or replacing their account (cf. §5.1.3).

5.1.1 Scope and Recursive Modification

Pollard & Yoo (1998) and Kasper (1997) deal with two major flaws in the standard (Pollard & Sag 1994) HPSG approach to semantics: wrong interaction of raising and scoping, and no account of recursive modification, respectively.

Raising and Scoping The first problem is recognized in Pollard & Sag 1994, p. 328, who note that the ambiguous sentences in (36) receive only single meanings on their analysis, namely, the wide scope readings in which the quantifiers *a unicorn* and *each painting* outscope the raising verbs.

(36) a. A unicorn appears to be approaching. (ambiguous)

b. Sandy believes each painting to be fraudulent. (ambiguous)

The problem stems from the fact that, in Pollard & Sag 1994, a quantifier starts its life only at the surface position of the phrase to which it corresponds and from there it can only percolate upwards. Thus, in (36a), the quantifier cannot be in the scope of *appears*, even though it corresponds to the raised subject of *approaching*, which is in the scope of *appears*.

The solution Pollard & Yoo (1998) propose is to make the quantifier corresponding to a raised constituent available at the "initial" position, e.g., in (36a), at the level of the embedded verb *approaching*. The quantifier can then percolate up and be retrieved either inside or outside the scope of *appear*.

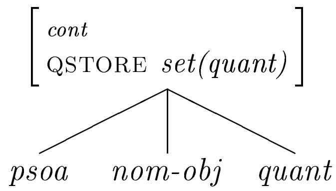
Below, we present a modification of Pollard & Yoo 1998, which is simpler than their analysis, and also avoids spurious ambiguities (i.e., multiple analyses of a sentence with the same syntax and semantics) and some other problems in Pollard & Yoo 1998, namely the analysis proposed in Przepiórkowski 1997, 1998.

This analysis rests on the following assumptions: First, in order to treat raising examples such as (36), QSTORE must be present not at the level of *signs*, as in Pollard & Sag 1994, but at least at the level of *synsem*. For example, once QSTORE is appropriate to *synsem*, the quantifier corresponding to *a unicorn* in (36a) is present on the QSTORE within the *synsem* of *a unicorn*, i.e., within the *synsem* of the subject of *appears*. But since *appears* is a raising verb, this QSTORE value is also present on the subject of *approaching* and may be retrieved within the scope of *appears*. In fact, on the basis of extraction examples such as (37), Pollard & Yoo (1998) argue that QSTORE should be appropriate at least to *local*.

(37) Five books, I believe John read.

Przepiórkowski 1997, 1998 goes further and argues that QSTORE should be part of a sign's *content*:

(38)



Second, there is a new set-valued attribute appropriate to *words* only, namely, NEW-QS. If a word introduces a quantifier, the value of this attribute contains this quntifier; otherwise it is the empty set. For example, a partial specification the indefinite detminer *a*, assumed to be a quantifier, is:

(39)
$$\begin{bmatrix} \textit{word} \\ \text{PHON } \langle\ a\ \rangle \\ \text{SYNSEM}|\text{LOC} \begin{bmatrix} \text{CAT}|\text{HEAD} \begin{bmatrix} \textit{det} \\ \text{SPEC } \text{N}'{:}\boxed{1} \end{bmatrix} \\ \text{CONT } \boxed{2} \begin{bmatrix} \textit{quant} \\ \text{DETERMINER } \textit{exists} \\ \text{RESTIND } \boxed{1} \end{bmatrix} \end{bmatrix} \\ \text{ARG-ST } \langle\ \rangle \\ \text{NEW-QS } \{\boxed{2}\} \end{bmatrix}$$

Third, quantifier retrieval is only allowed at the lexical level, as proposed in Manning *et al.* 1999. The new theory of quantification can schematically be represented as the implicational constraint in (40), where Desc_1 and Desc_2 are given in (41) and (42), respectively.

(40) $\textit{word} \rightarrow \text{Desc}_1 \vee \text{Desc}_2$

(41) $\text{Desc}_1 = \left[\begin{array}{l} \text{SS}|\text{LOC}|\text{CONT} \quad \left[\begin{array}{l} \textit{nom-obj} \vee \textit{quant} \\ \text{QSTORE } \boxed{1} \end{array}\right] \vee \left[\begin{array}{l} \textit{psoa} \\ \text{QSTORE } \boxed{2} \\ \text{QUANTS } \boxed{3} \end{array}\right] \\ \text{NEW-QS } \boxed{5} \end{array}\right]$

where $\boxed{1} = \boxed{5} \uplus$ the union of QSTOREs of selected arguments,
$\boxed{4} =$ the set of elements of $\boxed{3}$,
$\boxed{1} = \boxed{2} \uplus \boxed{4}$.

(42) $\text{Desc}_2 = \left[\begin{array}{l} \text{SS}|\text{LOC}|\text{CONT } \boxed{1} \\ \text{ARG-ST } \langle \ldots, [\text{CONT } \boxed{1}], \ldots \rangle \end{array}\right]$

(I'm still wondering if the preceding could instead be cast in prose) What AK
this constraint says is that, unless a *word* inherits its CONTENT value from one of its arguments (cf. Desc_2), in which case there is no quantifier retrieval, it must satisfy the description Desc_1. In case the *word* has CONTENT value of type *nom-obj* or *quant*, it simply collects elements of QSTOREs of its arguments (and adds any quantifiers it may introduce in NEW-QS). In case of *word*s with CONTENT values of type *psoa*, though, the set of quantifiers collected from arguments (and from NEW-QS) is split between the *word*'s QSTORE (quantifiers to be retrieved higher in the tree) and QUANTS (quantifiers retrieved locally).

Finally, *selected arguments* in (41) is defined in such a way that, e.g., the *synsem* of *a unicorn* in (36a) is a selected argument of the lower verb (*approaching*), but not of the higher verb (*appears*). This way the quantifier is introduced by *a unicorn* at the level of *approaching*.

According to this analysis, (36a) has exactly two readings: *a unicorn* is either retrieved by the word *approaching*, or it is present in the QSTORE value of *approaching* and is retrieved higher, by the word *appears* (note that phrasal retrieval is not allowed by this analysis). See Pollard & Yoo 1998 and Przepiórkowski 1997, 1998 for details.

Recursive Modification Kasper (1997) notices that the original semantic theory of Pollard & Sag 1994 does not account for phrases that contain modifiers of their own as, e.g., in (43).

(43) a. Bob showed us an [[apparently] simple] example.

b. Congress reconsidered the [[[obviously] unintentionally] controversial] plan.

In particular, according to the analysis in Pollard & Sag 1994, such cases of recursive modification would receive iterative modification readings; for example,

(43) would be assigned the meaning in which the simple example is apparent, and not the actual reading in which the example is apparently simple.

On the basis of this and other considerations, Kasper (1997) proposes to distinguish between inherent and combinatorial semantics, with CONTENT values reflecting now only inherent semantics of a sign. For example, the adjective *controversial*, is assumed to always have CONTENT value as indicated in (44), whether it is used attributively or predicatively.

(44) $$\left[\text{CONTENT}\ \left[\begin{array}{ll}\text{RELN} & \textit{controversial}\\ \text{INST} & \boxed{1}\end{array}\right]\right]$$

This differs from the position of Pollard & Sag 1994, where *controversial* has CONTENT of type *nom-obj* when used attributively, and of type *psoa* when used predicatively.

Now, in order to deal with recursive modification, Kasper (1997) enriches values of MOD as in (45) and revises the Semantics Principle as in (46).

(45) $$\left[\begin{array}{ll}\textit{head} & \\ \text{MOD} & \left[\begin{array}{ll}\textit{mod} & \\ \text{ARG} & \textit{synsem}\\ \text{ICONT} & \textit{content}\\ \text{ECONT} & \textit{content}\end{array}\right]\end{array}\right]$$

(46) Semantics Principle (ignoring quantification)

a. For a head-adjunct phrase, the semantic content (CONTENT) is token-identical with the MOD|ECONT value of the adjunct daughter, and the MOD|ICONT value of the adjunct daughter is token-identical withthe adjunct daughter's CONTENT.

b. For all other types of headed phrase the CONTENT is token-identical with the CONTENT of the head daughter.

The value of MOD|ARG corresponds to the value of MOD in Pollard & Sag 1994—it is the *synsem* of the modified element; the value of MOD|ICONT is equal to the CONTENT value of the maximal projection of the modifier (it is different from the modifier's CONTENT if the modifier is itself modified); and the value of MOD|ECONT specifies the combinatorial meaning of the modifier, i.e., the CONTENT value of the phrase resulting from the combination of the modifier phrase with the modified, i.e., ECONT is a function of ICONT and ARG.

Assuming lexical specifications of *potentially* and *controversial* as in (47) and (48), respectively, this analysis leads to the structure of the phrase *potentially controversial plan* schematically described in (49).

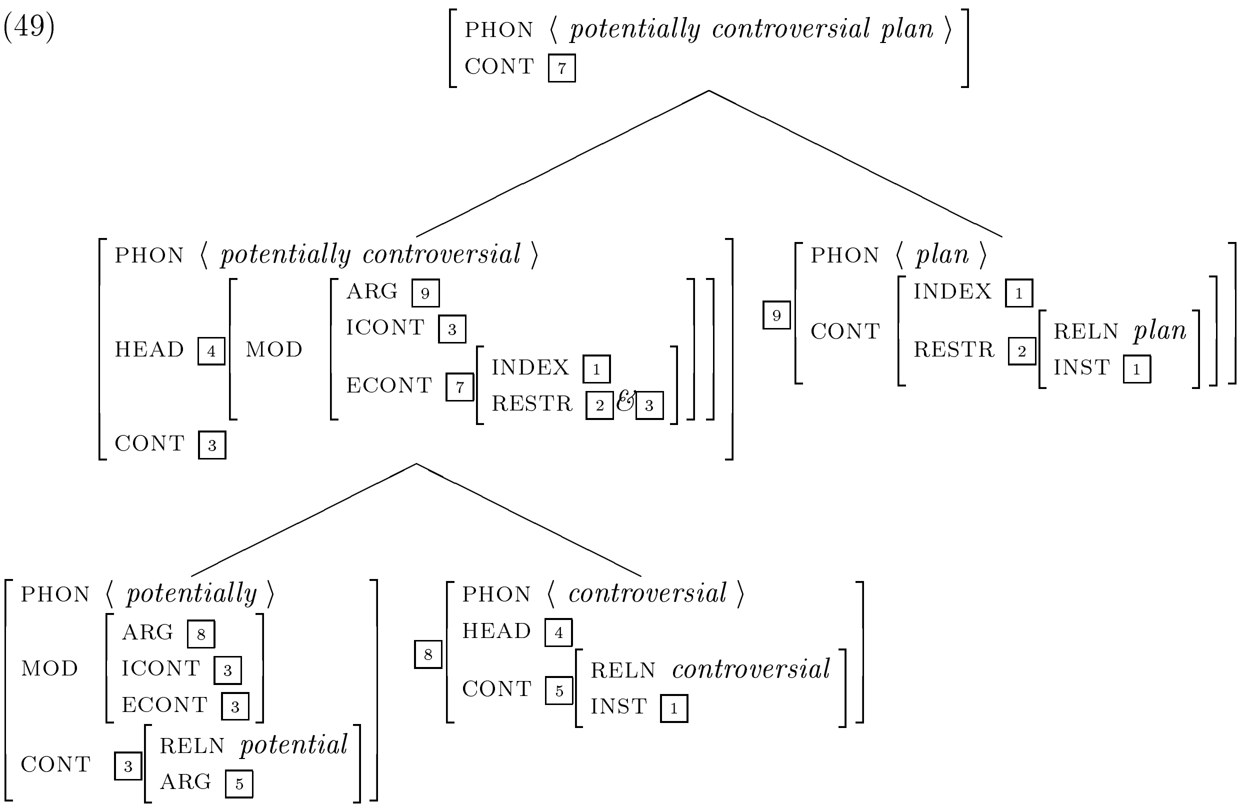
(47)

$$\left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{word}} \\
\text{PHON} & \langle \textit{potentially} \rangle \\
\text{SS}|\text{LOC} & \left[\begin{array}{ll}
\text{CAT}|\text{HEAD} & \left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{adv}} \\
\text{MOD} & \left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{mod}} \\
\text{ARG} & \left[\begin{array}{ll} \text{HEAD} & \textit{adj} \\ \text{CONT} & \boxed{5}\textit{psoa} \end{array}\right] \\
\text{ICONT} & \boxed{3}\textit{psoa} \\
\text{ECONT} & \boxed{3}
\end{array}\right]
\end{array}\right] \\
\text{CONT} & \left[\begin{array}{ll} \text{RELN} & \textit{potential} \\ \text{ARG} & \boxed{5} \end{array}\right]
\end{array}\right]
\end{array}\right]$$

(48)

$$\left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{word}} \\
\text{PHON} & \langle \textit{controversial} \rangle \\
\text{SS}|\text{LOC} & \left[\begin{array}{ll}
\text{CAT}|\text{HEAD} & \left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{adj}} \\
\text{PRD} & - \\
\text{MOD} & \left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{mod}} \\
\text{ARG}|\text{CONT} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{nom-obj}} \\ \text{INDEX} & \boxed{1} \\ \text{RESTR} & \boxed{2} \end{array}\right] \\
\text{ICONT} & \boxed{3} \\
\text{ECONT} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{nom-obj}} \\ \text{INDEX} & \boxed{1} \\ \text{RESTR} & \boxed{2}\,\&\,\boxed{3} \end{array}\right]
\end{array}\right]
\end{array}\right] \\
\text{CONT} & \left[\begin{array}{ll} \text{RELN} & \textit{controversial} \\ \text{INST} & \boxed{1} \end{array}\right]
\end{array}\right]
\end{array}\right]$$

(49)



Thus, this analysis correctly assigns the following meaning to the phrase *potentially controversial plan* (cf. $\boxed{7}$ above): 'x : $\mathsf{plan}'(x)$ & $\mathsf{potential}'(\mathsf{controversial}'(x))$'. See Kasper 1997 for further details and applications.

5.1.2 Propositions, Facts, Outcomes and Questions

Ginzburg & Sag (2000) extend previous HPSG approaches to semantics by considering contents of illocutionary acts other than just assertions. They propose that semantic content of clauses be *message*, with two immediate subtypes *propositional* and *question*.

Ginzburg & Sag (2000) distinguish between three types of *propositional* objects: *proposition*, *fact* and *outcome*. Propositions are semantic types of complements of predicates such as *believe*, *assert*, *assume*, *deny* or *prove*, so called *true/false* predicates (TF predicates). Such predicates, unlike factive predicates, e.g., *know* or *discover*, may only occur with nominal complements of which truth can be predicated:

(50) a.#Jackie believed/doubted/assumed… Bo's weight / my phone number.

b. Jackie knows/discovered Bo's weight / my phone number.

Moreover, TF predicates treat proposition-denoting complements purely referentially, in the sense of **(Quine 1961, pp. 139–145)**: AP

(51) a. **Substitutivity**:

The Fed's forecast was that gold reserves will be depleted by the year 2000.
Brendan believes/denies… the Fed's forecast.
Hence, Brendan believes/denies… that gold reserves will be depleted by year 2000.

b. **Existential Generalization**:

Brendan believes/denies… that gold reserves will be depleted by year 2000.
Hence, there is a claim/hypothesis/prediction that Brendan believes/denies…

On the other hand, factive predicates do not seem to treat proposition-denoting complements purely referentially, e.g.:

(52) **Substitutivity**:

The Fed's forecast was that gold reserves will be depleted by the year 2000.
(The Fed's forecast is true.)
Brendan discovered/was aware of the Fed's forecast.
IT DOES NOT FOLLOW THAT Brendan discovered/was aware that gold reserves will be depleted by year 2000.

This suggests that the denotata of complements of TF predicates (i.e., propositions) are different from the denotata of complements of factive predicates (i.e., facts or, more generally, possibilities).

Another difference between facts and prepositions is that the former, but not the latter, may enter into causal relations:

(53) a. The fact that Tony was ruthless made the flight against her difficult.

b. The possibility that Glyn might get elected made Tony's hair turn white.

c.#The claim/hypothesis/proposition that Tony was ruthless made the flight against her difficult.

On the other hand, truth is predictable only of propositions, not of facts (or possibilities):

(54) a.#The fact that Tony was ruthless is true.

b. The claim/hypothesis/proposition that Tony was ruthless is true/false.

Apart from complements of factive verbs, facts are the content of the illocutionary acts of reminding and exclaiming, e.g.:

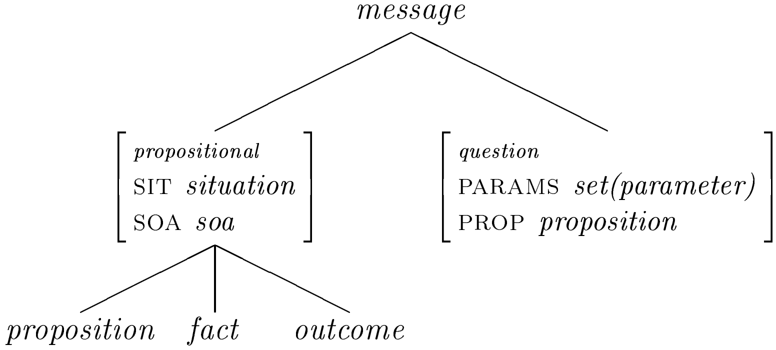
(55) a. Laurie: Why don't the vendors here speak Straits Salish?
Bo: We're in New York City for Pete's sake.

b. Bo reminded Laurie (of the fact) that they were in New York City.

It is considerations like these that lead Ginzburg & Sag (2000) to introduce *proposition* and *fact* as different subtypes of *propositional*. Another subtype of *propositional* which they distinguish is *outcome*, the type of imperative clauses, *inter alia*. What all these *propositional* contents have in common is their internal structure, which involves a situation (the value of the attribute SIT) and a state of affairs (SOA; the value of the attribute SOA), the latter corresponding to Pollard & Sag's (1994) parametrized state of affairs (*psoa*).

On the other hand, *questions*, which correspond to the denotata of clausal complements of such predicates as *wonder* and *ask*, are represented as propositional abstracts, with the relevant notion of abstraction being **(Aczel and Lunnon's 1992)** *simultaneous abstraction*. In terms of HPSG feature geometry, *questions* are *messages* with two new attributes, PARAMS, whose value is the set of (abstracted) parameters, and PROP, with values of type *proposition*. This is summarized below. AP

(56)



(57) and (58) below illustrate semantic representations of a simple declarative and a simple *yes/no* interrogative clauses, respectively, within Ginzburg & Sag's (2000) approach. Note that the value of PARAMS in (58) is the empty set, corresponding to the simultaneous abstraction of zero parameters in case of *yes/no* questions, and that background assumptions are represented as *fact*s.

(57) *Brendan left.*

$$\begin{bmatrix} \text{SS}|\text{LOC} & \begin{bmatrix} \text{CONT} & \begin{bmatrix} \textit{proposition} & \\ \text{SIT} & s_0 \\ \text{SOA} & \begin{bmatrix} \textit{soa} & \\ \text{QUANTS} & \langle\rangle \\ \text{NUCL} & \begin{bmatrix} \textit{leave-rel} & \\ \text{LEAVER} & \boxed{1} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \text{CONX}|\text{BKGRND} & \begin{bmatrix} \textit{fact} & \\ \text{SIT} & s_1 \\ \text{SOA} & \begin{bmatrix} \textit{soa} & \\ \text{QUANTS} & \langle\rangle \\ \text{NUCL} & \begin{bmatrix} \textit{name-rel} & \\ \text{NAMED} & \boxed{1} \\ \text{NAME} & \text{Brendan} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

(58) *Did Brendan leave?*

$$\begin{bmatrix} \text{SS}|\text{LOC} & \begin{bmatrix} \text{CONT} & \begin{bmatrix} \textit{question} & \\ \text{PARAMS} & \{\} \\ \text{PROP} & \begin{bmatrix} \textit{proposition} & \\ \text{SIT} & s_0 \\ \text{SOA} & \begin{bmatrix} \textit{soa} & \\ \text{QUANTS} & \langle\rangle \\ \text{NUCL} & \begin{bmatrix} \textit{leave-rel} & \\ \text{LEAVER} & \boxed{1} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \text{CONX}|\text{BKGRND} & \begin{bmatrix} \textit{fact} & \\ \text{SIT} & s_1 \\ \text{SOA} & \begin{bmatrix} \textit{soa} & \\ \text{QUANTS} & \langle\rangle \\ \text{NUCL} & \begin{bmatrix} \textit{name-rel} & \\ \text{NAMED} & \boxed{1} \\ \text{NAME} & \text{Brendan} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

See Ginzburg & Sag 2000 for further details and explication in terms of Situation Theory, as well as for extensive application of this approach to an analysis of English interrogatives.[12]

5.1.3 Beyond Situation Semantics

The extensions of HPSG approach to semantics presented in the two subsections above are exactly that: extensions of the standard (Pollard & Sag 1994) HPSG semantic theory, which was inspired by Situation Semantics. The last decade has also witnessed numerous proposals aiming at dethroning Situation Semantics as the provider of semantic resources for HPSG. These proposals can be classified into two overlapping categories: the first category comprises of analyses replacing the standard HPSG approach to semantics with a version of predicate logic, the second contains HPSG analyses of underspecified meanings. We will present these two classes of approaches in turn below.

Predicate Logics To the best of our knowledge, the first proposal to use a predicate logic as the semantic language of HPSG is that of Nerbonne 1992, 1993: it shows how to encode the language of generalized quantifiers in typed feature structures and it provides a treatment of scopal ambiguities (see below) within this encoding.

A more recent proposal of this type is adduced in Richter & Sailer 1999a, 1999b, which show in technical detail how a higher order type theoretic language Ty2 can be used as the semantic object language of HPSG. According to that proposal, values of CONTENT are of type *me* (*meaningful expression*), which introduces the attribute TYPE with values of type *type*, and which has the following subtypes: *variable*, *constant* (with a number of subtypes), *application*, *abstraction*, *equation*, *negation*, *logical-constant* and *quantifier*. Many of these types have their own attributes and further subtypes; thus, *application* has two *me*-valued attributes, FUNCTOR and ARGUMENT, *abstraction* has *variable*-valued VAR and *me*-valued ARG, both *equation* and *logical-constant* have two *me*-valued attributes, ARG1 and ARG2, and *logical-constant* also has subtypes such as *disjunction*, etc., *negation* has a *me*-valued attribute ARG, and, finally, *quantifier* introduces *variable*-valued VAR and *me*-valued SCOPE, and is further partitioned into *universal* and *existential*. Moreover, the type *type* is partitioned into *atomic-types* (*entity*, *truth*, *w-index*) and *complex-types* (with two *type*-valued attributes, i.e., IN and OUT). Given these assumptions, the formula (59a) can be represented by (59b).

(59) a. $\lambda x_e.\mathsf{professor}'_{\langle e,t\rangle}(x_e)$

[12]See also Przepiórkowski 1999b and Przepiórkowski & Kupść 1999 for a related approach to Negative Concord in Italian and in Polish.

b. $$\begin{bmatrix} \textit{abstraction} & \\ \text{TYPE} & \begin{bmatrix} \textit{c-type} & \\ \text{IN} & \boxed{1}\ \textit{entity} \\ \text{OUT} & \boxed{2}\ \textit{truth}\end{bmatrix} \\ \text{VAR} & \boxed{3} \begin{bmatrix}\textit{var} & \\ \text{TYPE} & \boxed{1}\end{bmatrix} \\ \text{ARG} & \begin{bmatrix} \textit{application} & \\ \text{FUNC} & \begin{bmatrix}\textit{professor} & \\ \text{TYPE} & \begin{bmatrix}\textit{c-type} & \\ \text{IN} & \boxed{1} \\ \text{OUT} & \boxed{2}\end{bmatrix}\end{bmatrix} \\ \text{ARG} & \boxed{3}\end{bmatrix}\end{bmatrix}$$

In this approach, combinatorial semantics is particularly simple: the CONTENT value of a *phrase* is always the result of functional application of the CONTENT value of one daughter to the CONTENT value of the other daughter (with additional applications of β-reductions, as needed).

Richter & Sailer 1999a, 1999b also introduce the following Quantifier Raising lexical rule[13] responsible for type shifting.

(60) $$\begin{bmatrix}\textit{word} & \\ \text{SYNSEM}|\text{LOC}|\text{CONTENT} & \lambda x_1 \ldots \lambda x_i \ldots \lambda x_n.\phi\end{bmatrix} \Longrightarrow \begin{bmatrix}\textit{word} & \\ \text{SYNSEM}|\text{LOC}|\text{CONTENT} & \lambda x_1 \ldots \lambda X_i \ldots \lambda x_n.X_i(\lambda x_i.\phi)\end{bmatrix}$$

With this type shifting lexical rule in hand, one of the two meanings of, say, *someone loves everyone* may be derived by type shifting the basic meaning of *love* (given in (61a)) to (61b) and, subsequently, to (61c), and then by usual functional applications, indicated in (62).

(61) a. $\lambda y \lambda x.\mathsf{love}'(x, y) \stackrel{(60)}{\Longrightarrow}$

b. $\lambda y \lambda X.X(\lambda x.\mathsf{love}'(x, y)) \stackrel{(60)}{\Longrightarrow}$

c. $\lambda Y \lambda X.Y(\lambda y.X(\lambda x.\mathsf{love}'(x, y)))$

[13] They call it *Quantifier Raising Derivational Rule* to indicate that this is a description-level (derivational) lexical rule in the sense of, e.g., Meurers 1995.

(62)

$$\forall y \exists x.\mathsf{love}'(x,y)$$

$$\lambda Q \exists x.Q(x) \qquad \lambda X \forall y.X(\lambda x.\mathsf{love}'(x,y))$$

$$\lambda Y \lambda X.Y(\lambda y.X(\lambda x.\mathsf{love}'(x,y))) \qquad \lambda P \forall y.P(y)$$

someone *loves* *everyone*

Note that, on this approach, scope ambiguities as in *someone loves everyone* result from different placements of the new variable introduced by the Quantifier Raising lexical rule (60): were λY placed after λX in (61c), the opposite scoping would result (i.e., $\exists x \forall y.\mathsf{love}'(x,y)$).

Richter & Sailer 1999a, 1999b extensively illustrate this approach to HPSG semantics by utilizing it in their analyses of Negative Concord in French and Polish.

Underspecification One of the first discussions of the proper representation of semantic underspecification in HPSG is Nerbonne 1992, 1993, which shows how underspecified *descriptions* of meanings may correctly denote semantic *objects* corresponding to fully specified meanings. For example, although the grammar leaves open which quantifier outscopes the other in, say, *everybody loves somebody*, each object corresponding to this phrase is disambiguated one way or the other. This is, in fact, also the approach adopted in Pollard & Sag 1994, Pollard & Yoo 1998, and other works mentioned above. According to all these works, although *descriptions* of (semantic) objects are underspecified with respect to meaning, the *objects* themselves correspond to fully resolved semantic representations.

Recent years have witnessed a number of proposals of truly underspecified semantics for HPSG, i.e., semantics in which both descriptions *and objects* correspond to underspecified meanings. According to such approaches, the semantic object described (generated) by an HPSG grammar and corresponding to, say, *everybody loves somebody* does not resolve the relative scope of the two quantifiers. It is only an extragrammatical resolution step which provides such disambiguated readings, if they are necessary at all — some logics, such as Underspecified Discourse Representation Theory (UDRT; Reyle 1993), define truth conditions for underspecified semantic representations and provide a proof theory which makes it possible to draw inferences from such partial semantic structures. In fact, the first (to the best of our knowledge) proposal for underspecified semantics for HPSG simply embeds UDRT into HPSG — Frank & Reyle (1992, 1995, 1996) use this formalism in their analysis of interactions between word order and quantifier scope, and of the collective /

distributive readings of plural NPs.

A related approach, which has, however, gained greater attention from HPSG practitioners is the Minimal Recursion Semantics (MRS; Copestake *et al.* 1997), an underspecified version of predicate calculus. Although originally devised (and described in Copestake *et al.* 1997) as a computationally-oriented semantic formalism, it is assumed in various theoretical linguistic works. Below, we will briefly describe MRS on the basis of Pollard 1998.

The main idea of MRS is that grammar does not determine scope relations; they are resolved at a post-grammatical resolution stage (if at all). The grammar proper generates semantic representations such as (63), corresponding to *every dog chased some cat*:

(63)
$$\left[\begin{array}{l} \textit{mrs} \\ \text{LTOP } \boxed{0} \\ \text{RELS } \left\{ \left[\begin{array}{l} \textit{every} \\ \text{HNDL } \boxed{1} \\ \text{BV } \boxed{x} \\ \text{RESTR } \boxed{l} \\ \text{SCOPE } \boxed{m} \end{array}\right], \left[\begin{array}{l} \textit{dog} \\ \text{HNDL } \boxed{2} \\ \text{INST } \boxed{x} \end{array}\right], \left[\begin{array}{l} \textit{some} \\ \text{HNDL } \boxed{3} \\ \text{BV } \boxed{y} \\ \text{RESTR } \boxed{n} \\ \text{SCOPE } \boxed{p} \end{array}\right], \left[\begin{array}{l} \textit{cat} \\ \text{HNDL } \boxed{4} \\ \text{INST } \boxed{y} \end{array}\right], \left[\begin{array}{l} \textit{chase} \\ \text{HNDL } \boxed{5} \\ \text{ACT } \boxed{x} \\ \text{UND } \boxed{y} \end{array}\right] \right\} \end{array}\right]$$

The main attribute of *mrs* structures is REL: it is a set of semantic predicates together with their argument roles (ignore the attribute HNDL for a couple of sentences). Note, however, that some arguments, namely, arguments of scope-taking relations (*every* and *some* in (63)) are not 'filled', i.e., their values are not determined by this representation. For example, (63) says that the SCOPE of the quantifier *every* is $\boxed{l}$, but does not say whether $\boxed{l}$ represents the predicate *chase* directly, or whether it represents *some*, which in turn scopes over *chase*.

This resolution step is done outside the grammar[14] and it consists in equating such undetermined argument values with HNDL values of other relations. Thus, HNDLs are, at first approximation, used as labels of particular relations.[15] For example, two disambiguations of the meaning represented in (63) are given in (64)–(65) below; they can be represented in the traditional notation as in (64′)–(65′).

[14] An alternative approach might be to have *two* content attributes, say, UNSCOPED-CONTENT and SCOPED-CONTENT, one of which represents underspecified meanings, and the other — resolved meanings. On this approach, the values of these two attributes would be related via a set of constraints encoding the resolution step. (Pollard 1998, fn. 10, and personal communication.)

[15] In fact, HNDL values indicate scope information: two relations with the same scope share their HNDLs.

(64) $$\begin{bmatrix} \textit{mrs} \\ \text{LTOP } \boxed{0} \\ \text{RELS } \left\{ \begin{bmatrix} \textit{every} \\ \text{HNDL } \boxed{1} \\ \text{BV } \boxed{x} \\ \text{RESTR } \boxed{l} \\ \text{SCOPE } \boxed{m} \end{bmatrix}, \begin{bmatrix} \textit{dog} \\ \text{HNDL } \boxed{2} \\ \text{INST } \boxed{x} \end{bmatrix}, \begin{bmatrix} \textit{some} \\ \text{HNDL } \boxed{3} \\ \text{BV } \boxed{y} \\ \text{RESTR } \boxed{n} \\ \text{SCOPE } \boxed{p} \end{bmatrix}, \begin{bmatrix} \textit{cat} \\ \text{HNDL } \boxed{4} \\ \text{INST } \boxed{y} \end{bmatrix}, \begin{bmatrix} \textit{chase} \\ \text{HNDL } \boxed{5} \\ \text{ACT } \boxed{x} \\ \text{UND } \boxed{y} \end{bmatrix} \right\} \end{bmatrix}$$

(65) $$\begin{bmatrix} \textit{mrs} \\ \text{LTOP } \boxed{0} \\ \text{RELS } \left\{ \begin{bmatrix} \textit{some} \\ \text{HNDL } \boxed{3} \\ \text{BV } \boxed{y} \\ \text{RESTR } \boxed{n} \\ \text{SCOPE } \boxed{p} \end{bmatrix}, \begin{bmatrix} \textit{cat} \\ \text{HNDL } \boxed{4} \\ \text{INST } \boxed{y} \end{bmatrix}, \begin{bmatrix} \textit{every} \\ \text{HNDL } \boxed{1} \\ \text{BV } \boxed{x} \\ \text{RESTR } \boxed{l} \\ \text{SCOPE } \boxed{m} \end{bmatrix}, \begin{bmatrix} \textit{dog} \\ \text{HNDL } \boxed{2} \\ \text{INST } \boxed{x} \end{bmatrix}, \begin{bmatrix} \textit{chase} \\ \text{HNDL } \boxed{5} \\ \text{ACT } \boxed{x} \\ \text{UND } \boxed{y} \end{bmatrix} \right\} \end{bmatrix}$$

(64′) $\forall x(\mathsf{dog}'(x) \rightarrow \exists y(\mathsf{cat}'(y) \wedge \mathsf{chase}'(x,y)))$

(65′) $\exists y(\mathsf{cat}'(y) \wedge \forall x(\mathsf{dog}'(x) \rightarrow \mathsf{chase}'(x,y)))$

Of course, not all identifications of values of RESTR and SCOPE with HNDLs of particular relations lead to well-formed formulae. For example, there is no well-formed formula consistent with the identification of $\boxed{m}$ with $\boxed{1}$: such identity would mean that the quantifier *every* is in scope of itself.

It should be clear by now that the function of the LTOP attribute is to single out the (HNDL value of the) relation with outermost scope. Apart from LTOP and RELS, all *mrs*s have two more attributes, namely, KEY and H-CONS. The role of the attribute KEY is to single out the 'head' relation of a phrase, i.e., the relation introduced by the syntactic head of the phrase. In the example above, the value of KEY would be $\boxed{5}$, the HNDL of *chase*. Finally, the attribute HCONS (for *handle conditions*) collects other, linguistic, constraints on possible identifications of arguments and handles. For example, in case of a sentence like *Kim thinks that Sue did not make it*, *not* cannot outscope *thinks*, even though such a reading would be allowed by considerations of well-formedness alone. The unavailability of this interpretation is ensured by adding to HCONS a constraint—to be taken into account during the post-grammatical disambiguation process—to the effect that negation cannot scope outside its clause. See Copestake *et al.* 1997 and Pollard 1998 for the format of such constraints and for further details.

Minimal Recursion Semantics has been shown to provide a natural solution to the problem of recursive modification discussed above (Copestake *et al.*

1997; Pollard 1998), has been employed in an analysis of modification in general and various uses of the locative *on* in particular (Pollard 1998), and in an analysis of English number names (Smith 1999), *inter alia*. An interesting variant of MRS has also been presented in Egg 1998 and used as a basis for a (syntactico-)semantic HPSG account of *wh*-questions. Finally, Richter & Sailer (1999c), following Bos (1995), show how, for any object logical language, a semantic underspecified version of this language can be defined as the semantic representation for HPSG, in a way generalizing over previous HPSG approaches to underspecified semantics.

5.2 Forays into Pragmatics

5.2.1 Information Structure

Since the HPSG framework is well-suited for studying interactions between various grammatical levels, it is only natural that there is some HPSG work on information structure (also called *topic-focus*, *theme-rheme*, *new-given*, *topic-ground*), which is known to interact with syntax and prosody in interesting ways. The most influential approach is based on Vallduví's (1992) account of information structure, and it includes Engdahl & Vallduví 1994, Engdahl & Vallduví 1996, Vallduví & Engdahl 1996, and Engdahl 1999. We will illustrate this approach with a simple example, from Engdahl & Vallduví 1996.

Consider the mini-dialogue in (66), where **bold face** corresponds to so-called B-accent (L+H*), while SMALL CAPITALS correspond to so-called A-accent (H*).

(66) A: In the Netherlands I got a big Delft china tray that matches the set in the living room. Was that a good idea?

B: (Maybe.) The **president** [$_F$ HATES] the Delft china set. (But the **first lady** LIKES it.)

Vallduví (1992) assumes a 3-way partition of information structure of sentences: first, the information conveyed by a sentence is split into new information (*focus*) and information already present in the discourse (*ground*). Second, *ground* is further subdivided into *link* (what the sentence is about, sometimes called *topic*) and *tail*. Under the assumption that every utterance contains new information, this leads to a four-way classification of utterances: *all-focus* (no ground), *link-focus* (no tail), *focus-tail* (no link) and *link-focus-tail*. The sentence in (66B) represents the *link-focus-tail* type.

Engdahl & Vallduví 1994, 1996 and Engdahl 1999 propose that information structure be represented within *signs*' CONX (context) values in the following way:

(67)
$$\begin{bmatrix} \textit{context} & \\ \textsc{info-str} & \begin{bmatrix} \textit{info-struc} & \\ \textsc{focus} & \textit{set(content)} \\ \textsc{ground} & \begin{bmatrix} \textit{ground} & \\ \textsc{link} & \textit{set(content)} \\ \textsc{tail} & \textit{set(content)} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

They also posit principles expressing the claims that, for each word, this word's semantic contribution is part of the focus if and only if it bears the A-accent, and it is part of link if and only if it bears the B-accent:

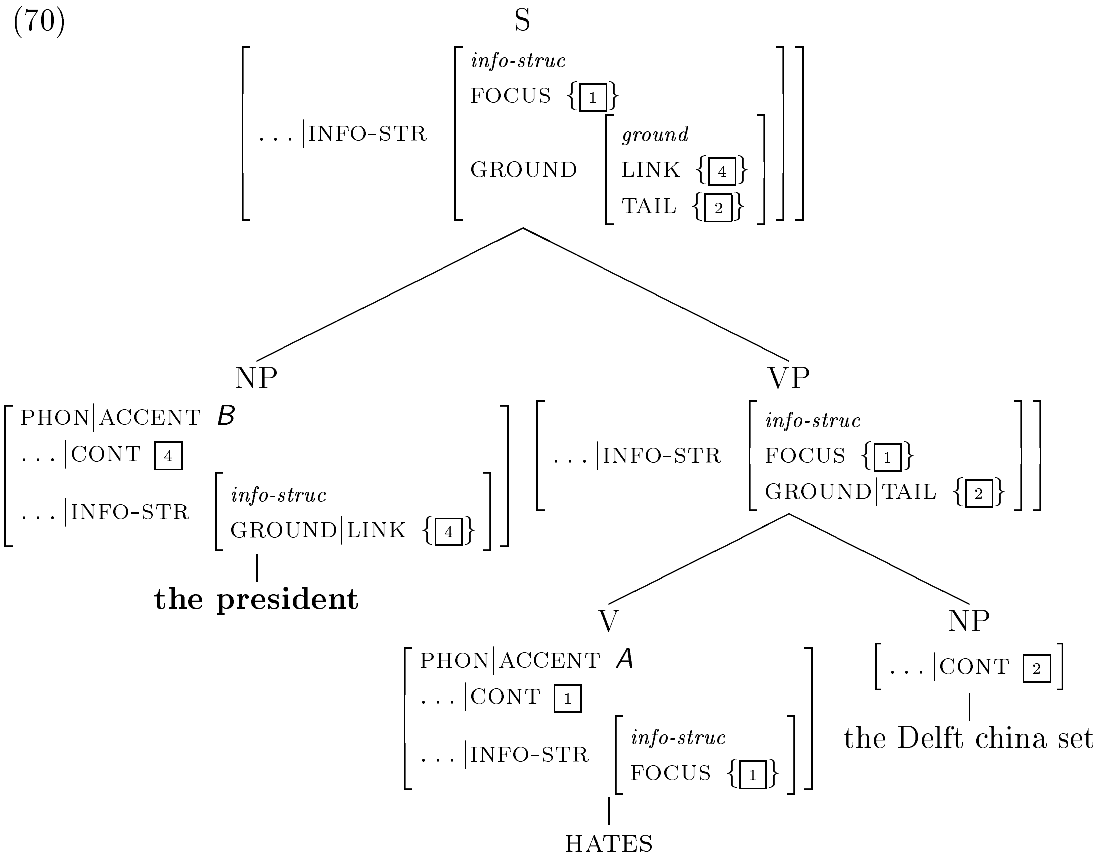
(68)
$$\textit{word} \rightarrow \left(\begin{bmatrix} \textsc{phon}|\textsc{accent} & \mathsf{A} \end{bmatrix} \leftrightarrow \begin{bmatrix} \ldots|\textsc{loc} & \begin{bmatrix} \textit{local} & \\ \textsc{cont} & \boxed{1} \\ \textsc{conx}|\textsc{info-str}|\textsc{focus} & \{\boxed{1}\} \end{bmatrix} \end{bmatrix} \right)$$

(69)
$$\textit{word} \rightarrow \left(\begin{bmatrix} \textsc{phon}|\textsc{accent} & \mathsf{B} \end{bmatrix} \leftrightarrow \begin{bmatrix} \ldots|\textsc{loc} & \begin{bmatrix} \textit{local} & \\ \textsc{cont} & \boxed{1} \\ \textsc{conx}|\textsc{info-str}|\textsc{ground}|\textsc{link} & \{\boxed{1}\} \end{bmatrix} \end{bmatrix} \right)$$

There are additional principles specifying how a phrases's information structure is constrained by information structures of its daughters.

This leads to the following (much simplified) structure of (66B), in which values of the DTRS attribute are presented in the familiar constituent tree notation.

(70)



Note that this analysis simultaneously accesses and constrains various grammatical levels: prosody (PHON values) and pragmatics (CONX|INFO-STR values), but also semantics (CONT values) and constituent structure (DTRS values; not shown explicitly here). This account clearly illustrates the advantages of constraint-based theories, such as HPSG, over derivational theories, like Minimalism, where it is not clear how such an analysis, making simultaneous use of various levels of grammatical knowledge, could be stated.[16]

Among recent HPSG analyses concerned with information structure in various languages are: Avgustinova 1997, Kolliakou 1998, Kolliakou 1999, Alexopolou 1998 and Przepiórkowski 1999b.

5.2.2 Beliefs and Intentions

Green 1994 and Green 2000 seek to spell out in further detail the kind of information normally represented by CONTEXT values and argue that this

[16]See Engdahl 1999 for some discussion on how information packaging could be represented in Minimalism and in HPSG.

information does not correspond to the real world directly (as it apparently does, e.g., in Pollard & Sag 1994 and in (57)–(58) in §5.1.2 above), but rather describes speakers' beliefs about the world and their intentions.

Thus, Green 1994 reiterates arguments that "the relevant background propositions are not about objective aspects of any world, but rather are propositions about beliefs which the speaker supposes to be mutual" (p. 5); for example, the sentence (71) is felicitous provided that both the speaker and the hearer believe the presupposition (that french fries are bad for Clinton), even if that presupposition is in fact false.

(71) Clinton realizes french fries are bad for him.

Moreover, Green 1994 argues that restrictions on INDEX values, normally taken to be a part of CONTENT (i.e., values of the attribute RESTRICTION) should rather be treated as beliefs about how referential expressions may be used, i.e., as parts of CONTEXT. This is because "as language users, we are free to use any word to refer to anything at all, subject only to the purely pragmatic constraint that... our intended audience will be able to correctly identify our intended referent from our use of the expression we choose" (p. 7). If, nevertheless, expressions such as *dog* have certain 'standard' or 'normal' meanings it is due to the mutual belief of the speaker and the hearer as to what a normal belief about the referential use of *dog* is within a given language community. According to these considerations, a partial simplified ('naive') version of the lexical entry for *dog* would be (72).

(72)
$$
\left[\begin{array}{ll}
\text{PHON} & \langle\ \textit{dog}\ \rangle \\
\text{SS}|\text{LOC} & \left[\begin{array}{ll}
\text{CONT}|\text{INDEX} & \boxed{1} \\
\text{CONX} & \left[\begin{array}{ll}
\text{C-INDS} & \left[\begin{array}{ll} \text{SPEAKER} & \boxed{2} \\ \text{ADDRESSEE} & \boxed{3} \end{array}\right] \\
\text{BKGRND} & \left\{ \left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{mutually-believe}} \\
\text{EXPERIENCER} & \boxed{2} \\
\text{STANDARD} & \boxed{3} \\
\text{SOA} & \left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{normally-believe}} \\
\text{EXPERIENCER} & \textit{English speakers} \\
\text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{canis}} \\ \text{INST} & \boxed{1} \end{array}\right]
\end{array}\right]
\end{array}\right] \right\}
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

This approach to referential expressions is a step towards representation of cases of transferred reference, extensively discussed by Nunberg (1978), such as (73) below.

(73) The milkshake claims you kicked her purse.

Here, *milkshake* may refer to whoever purchased milkshake by virtue of the mutual belief of the speaker and the addressee that, within sales agents' parlance, the thing purchased may designate the purchaser. This means that the BACKGROUND value of the *sign* corresponding to (73) contains the following mutual belief (in addition to the belief that *milkshake* normally refers to a milkshake and other beliefs; see Green 1994 for further details):

(74)
$$\left[\begin{array}{ll} \multicolumn{2}{l}{\textit{mutually-believe}} \\ \multicolumn{2}{l}{\text{EXPERIENCER } \boxed{2} \text{ (speaker)}} \\ \multicolumn{2}{l}{\text{STANDARD } \boxed{3} \text{ (addressee)}} \\ \text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{normally-believe}} \\ \multicolumn{2}{l}{\text{EXPERIENCER } \textit{sales agents}} \\ \text{SOA} & \left[\begin{array}{l} \textit{rfunction} \\ \text{DEMONSTRATUM } \textit{purchase} \\ \text{DESIGNATUM } \textit{purchaser} \end{array}\right] \end{array}\right] \end{array}\right]$$

Further, Green 2000 seeks to represent the illocutionary force of utterances within the value of CONTEXT|BACKGROUND[17] as speakers' intentions. For example, the illocutionary force of promising is analysed as a speaker's intention that the addressee recognize the speaker's intention that the addresse believe that the speaker commits himself or herself to be responsible for the content of the promise:

(75) Illocutionary force of promising:

$$\left[\begin{array}{ll} \text{CONX} & \left[\begin{array}{ll} \text{C-INDS} & \left[\begin{array}{l} \text{SPEAKER } \boxed{1} \\ \text{ADDRESSEE } \boxed{2} \end{array}\right] \\ \text{BKGRND} & \left\{ \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{intend}} \\ \multicolumn{2}{l}{\text{EXPERIENCER } \boxed{1}} \\ \text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{recognize}} \\ \multicolumn{2}{l}{\text{EXPERIENCER } \boxed{2}} \\ \text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{intend}} \\ \multicolumn{2}{l}{\text{EXPERIENCER } \boxed{1}} \\ \text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{believe}} \\ \multicolumn{2}{l}{\text{EXPERIENCER } \boxed{2}} \\ \text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{commit}} \\ \multicolumn{2}{l}{\text{AGENT } \boxed{1}} \\ \text{SOA} & \left[\begin{array}{l} \textit{responsible} \\ \text{THEME } \boxed{1} \\ \text{SOA } \textit{psoa} \end{array}\right] \end{array}\right] \end{array}\right] \end{array}\right] \end{array}\right] \end{array}\right] \right\} \end{array}\right] \end{array}\right]$$

[17]Contrast this with the representation of basic illocutionary types within CONTENT in Ginzburg & Sag 2000; cf. §5.1.2.

6 Issues in morphosyntax

6.1 Romance and Slavic Clitics

Romance clitics. There is a recent body work in HPSG on Romance cliticization, represented by, e.g., Miller 1992, Miller & Sag 1997 (for French), and Monachesi 1993 and Monachesi 1999 (for Italian), which argues that Romance 'clitics' are actually lexical affixes and provides a lexicalist account, contra earlier claims that such a lexicalist approach to Romance cliticization cannot be uniformly executed (Sportiche 1996). We present the main features of this account on the basis of Miller & Sag 1997.

The main idea of this analysis is that French 'clitics' corresponding to arguments of a head are present on this head's ARG-ST, but not on its VALENCE attributes. Thus, 'clitics' do not constitute separately licensed syntactic entities. Instead, there is a morphological constraint which takes the presence of 'clitics' on ARG-ST into consideration when 'calculating' the actual morphological form of the head.

Specifically, *word*s are assumed to have a feature MORPH, whose values introduce three further features, STEM, I-FORM and FORM:

(76) $$\begin{bmatrix} \textit{word} & \\ \text{MORPH} & \begin{bmatrix} \text{FORM} \ \ldots \\ \text{I-FORM} \ \ldots \\ \text{STEM} \ \ldots \end{bmatrix} \end{bmatrix}$$

The values of STEM correspond to the morphological stem of the head, I-FORM represents the inflected form of the head before 'clitics' are taken into account, while FORM values represent full inflected forms including any 'clitics' realized on the head. For example, the 3rd person singular present tense indicative form of the lexeme LAVER 'wash' with its object realized as an anaphoric affix has the following MORPH value:

(77) $$\begin{bmatrix} \text{FORM} \ \textit{se-lave} \\ \text{I-FORM} \ \textit{lave} \\ \text{STEM} \ \textit{lav-} \end{bmatrix}$$

Simplifying a little, FORM values are derived from I-FORM values, taking into account HEAD and ARG-ST information, via the following constraint:

(78) $$\textit{word} \rightarrow \begin{bmatrix} \text{MORPH} & \begin{bmatrix} \text{FORM} \ \mathrm{F}_{\text{PRAF}}(\boxed{0},\boxed{1},\boxed{2}) \\ \text{I-FORM} \ \boxed{0} \end{bmatrix} \\ \text{SYNSEM}|\text{LOC}|\text{CAT} & \begin{bmatrix} \text{HEAD} \ \boxed{1} \\ \text{ARG-ST} \ \boxed{2} \end{bmatrix} \end{bmatrix}$$

In case ARG-ST contains no clitics, the function F_{PRAF} behaves like the identity function on its first argument, i.e., the value of FORM is identical to the value of I-FORM. However, if there are clitics on ARG-ST, the F_{PRAF} function encodes a rather complex constraint which 'calculates' the order of clitics with respect to each other and with respect to the verb. For example, in the case of an indicative verb with only one pronominal 3rd person plural accusative 'clitic' on its ARG-ST, the F_{PRAF} function adds the affix *les* in front of the value of I-FORM:

(79)
$$\left[\begin{array}{ll} \text{MORPH} & \left[\begin{array}{ll} \text{FORM} & \text{F}_{\text{PRAF}}(\boxed{0},\boxed{1},\boxed{2}) = \textit{les-}\boxed{0} \\ \text{I-FORM} & \boxed{0} \end{array}\right] \\ \text{SYNSEM}|\text{LOC}|\text{CAT} & \left[\begin{array}{ll} \text{HEAD} & \boxed{1}\left[\begin{array}{ll} \textit{verb} & \\ \text{VFORM} & \textit{indic} \end{array}\right] \\ \text{ARG-ST} & \boxed{2}\langle \text{NP}, \text{`clitic'}[\text{pron},\textit{acc},\textit{3pl}]\rangle \end{array}\right] \end{array}\right]$$

How are 'clitics' distinguished from other ARG-ST elements? Simplifying again, Miller & Sag 1997 assume that *synsem* elements can be partitioned into *canonical* synsems, i.e., those which may be realized as *sign*s, and *non-canonical* synsems, which cannot 'project' to full *sign*s. Two main types of *non-canonical* synsems are *gaps* and *affixes*:

(80)
$$\Tree[.\textit{synsem} \textit{canon} [.\textit{noncan} \textit{gap} \textit{aff}]]$$

With this type hierarchy of *synsem* objects in hand, a 'clitic' element of an ARG-ST is a synsem of type *aff*, e.g.:

(81) 'clitic'[pron,*acc*,*3pl*] in (79) =
$$\left[\begin{array}{ll} \textit{aff} & \\ \text{LOC} & \left[\begin{array}{ll} \text{CAT} & \left[\begin{array}{ll} \text{HEAD} & \left[\begin{array}{ll} \textit{noun} & \\ \text{CASE} & \textit{acc} \end{array}\right] \\ \text{ARG-ST} & \langle\rangle \end{array}\right] \\ \text{CONT} & \left[\begin{array}{ll} \textit{ppro} & \\ \text{INDEX} & \textit{3pl} \end{array}\right] \end{array}\right] \end{array}\right]$$

Of course, the real challenge for any lexicalist approach to Romance cliticizations are the cases of so-called 'clitic climbing', where 'clitics' originating on the ARG-ST of one verb, such as *laver* in (82), are realized on a higher verb, such as the tense auxiliary *avoir* in (82).

(82) Pierre les a lavés.
Pierre 3PL has washed
'Pierre washed them.'

In order to deal with such cases, Miller & Sag (1997) assume the argument composition approach, in which higher verbs in such climbing environments do not subcategorize for a VP, but rather combine with the lexical head of the VP and 'take over' ('attract', 'raise') all arguments of this head to their own ARG-ST. For example, a partial and schematic lexical entry for the auxiliary *avoir* is given in (83):

(83) AVOIR (tense auxiliary):

$$\begin{bmatrix} \textit{word} \\ \textsc{ss}|\textsc{loc}|\textsc{cat} \begin{bmatrix} \textsc{head}\ \textit{verb} \\ \textsc{arg-st}\ \langle \boxed{1}, \begin{bmatrix} \textit{synsem} \\ \textsc{loc}|\textsc{cat} \begin{bmatrix} \textsc{head} \begin{bmatrix} \textit{verb} \\ \textsc{vform}\ \textit{past-p} \\ \textsc{v-aux}\ \textit{avoir} \end{bmatrix} \\ \textsc{arg-st}\ \langle \boxed{1} \rangle \oplus \boxed{2} \end{bmatrix} \end{bmatrix} \rangle \oplus \boxed{2} \end{bmatrix} \end{bmatrix}$$

All arguments, including 'clitics', of the past participle (*past-p*) that the verb subcategorizes for are also present on the ARG-ST of *avoir*, where the constraint (78) applies and ensures that any clitics raised from the ARG-ST of the past participle are morphologically realized. Of course, since (78) is a constraint on all *word*s, it nonvacuously applies to the past participle as well. Nevertheless, the $\mathrm{F}_{\textsc{praf}}$ function is defined in such a way that, in case its second argument ($\boxed{2}$ in (78)) is a *past-p* head, it is the identity function on the first argument. The overall result of this is that no 'clitics' are realized on past participles.

Slavic clitics. Another analysis of morphosyntactic aspects of cliticization is that of Borsley (1999), who presents an HPSG analysis of so-called *mobile inflections* in Polish discussed earlier in GB terms in Borsley & Rivero 1994, and argues that the former is more satisfactory in a number of ways. In particular, Borsley (1999) analyzes the enclitic *-ś* in (84b) as a 'weak auxiliary' which subcategorizes for a participial verb, i.e., as a syntactic item. At the same time, he also argues that the similarly looking element *-eś* in (84a) should rather be analyzed as attaching to the verb in the lexicon, that is, within the morphology proper.

(84) a. Ty widziałe**ś** tę książkę.
you saw that book
'You saw that book.'

b. Ty**ś** widział tę książkę.
you saw that book

This does not mean, though, that Borsley (1999) is forced to postulate two different morphemes *-(e)ś*. On the contrary, there is only one lexical entry for the weak auxiliary *-(e)ś*, i.e., (85).

(85)
$$\begin{bmatrix} \textit{weak-aux} & \\ \text{PHON} & \text{-(e)ś} \\ \text{SYNSEM}|\text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} \\ \text{VFORM } \textit{fin} \end{bmatrix} \\ \text{VALENCE} & \begin{bmatrix} \text{SUBJ} & \boxed{1} \\ \text{COMPS} & \left\langle \begin{bmatrix} \ldots|\text{HEAD} & \begin{bmatrix} \textit{verb} \\ \text{VFORM } \textit{part} \end{bmatrix} \\ \ldots|\text{VALENCE} & \begin{bmatrix} \textit{valence} & \\ \text{SUBJ} & \boxed{1} \\ \text{COMPS} & \boxed{2} \end{bmatrix} \\ \ldots|\text{LEX} & + \end{bmatrix} \right\rangle \oplus \boxed{2} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

(85) essentially states that *-(e)ś* is a finite verb which subcategorizes for a participle word (cf. the first element on the COMPS of *-(e)ś*), and takes over all arguments of this participle, in a way analogous to *avoir* in (83). As a result , a *syntactic* verbal complex 'participle + *-(e)ś*' is created, whose subcategorizing properties are exactly those of the participle. There is also a separate word order principle which states that the weak auxiliary must occur before (but not necessarily immediately before) the participle it subcategorizes for. A simplified version of this word order principle is given in (86).

(86)
$$\begin{bmatrix} \textit{weak-aux} \\ \ldots|\text{COMPS } \langle \ldots \boxed{1} \ldots \rangle \end{bmatrix} < \boxed{1} \begin{bmatrix} \ldots|\text{HEAD} & \begin{bmatrix} \textit{verb} \\ \text{VFORM } \textit{part} \end{bmatrix} \\ \ldots|\text{LEX} & + \end{bmatrix}$$

These two principles are responsible for (84b). In the case of (84a), however, *widziałeś* is analysed as a *morphological* verbal complex, described by (87).

(87)
$$
\left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{complex-verb}}\\
\text{PHON} & \boxed{1} + \boxed{2}\\
\text{MORPH-B} & \left\langle \left[\begin{array}{l}\text{PHON } \boxed{1}\\ \text{SYNSEM } \boxed{3}\end{array}\right], \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{weak-aux}}\\ \text{PHON} & \boxed{2}\\ \text{SYNSEM}|\text{CAT} & \left[\begin{array}{ll}\text{HEAD} & \left[\begin{array}{l}\textit{verb}\\ \text{VFORM } \textit{fin}\end{array}\right]\\ \text{VALENCE} & \left[\begin{array}{l}\text{SUBJ } \boxed{4}\\ \text{COMPS } \langle\boxed{3}\rangle \oplus \boxed{5}\end{array}\right]\end{array}\right]\end{array}\right]\right\rangle\\
\text{SYNSEM}|\text{CAT} & \left[\begin{array}{ll}\text{HEAD} & \left[\begin{array}{l}\textit{verb}\\ \text{VFORM } \textit{fin}\end{array}\right]\\ \text{VALENCE} & \left[\begin{array}{l}\text{SUBJ } \boxed{4}\\ \text{COMPS } \boxed{5}\end{array}\right]\end{array}\right]
\end{array}\right]
$$

Here, Borsley (1999) follows Riehemann (1998) in assuming that morphologically complex words have the feature MORPH-B (morphological base), whose value is a list of *sign*s. In (87), the same weak auxiliary occurs within the morphological makeup of the complex verb *widziałeś* as described in (85). However, since this finite auxiliary combines with the participle at the lexical level, it may (in fact, *must*, according to the order of elements of MORPH-B in (87)) occur after the verb (the LP constraint (86) does not apply at the level of MORPH-B) and it may participate in various word-level morphophonological processes.

(Add references to Kupść, Penn and Avgustinova and Crysmann?) AP

6.2 Mixed Categories

HPSG, with its type hierarchies and the mechanism of multiple inheritance, is particularly well-suited for analyzing mixed categories, i.e., categories which simultaneously share various properties of different major categories such as verb or noun.

Malouf (1998, 2000b) utilizes these mechanisms to provide an HPSG account of verbal gerunds in English (like (88a)–(88b), but not (88c)), well known for their mixed verbal/nominal properties.

(88) a. Everyone was impressed by [Pat's artfully folding the napkins]. (verbal POSS-*ing* gerund)

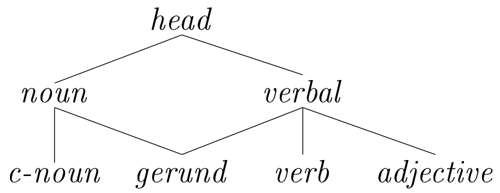
b. Everyone was impressed by [Pat artfully folding the napkins]. (verbal ACC-*ing* gerund)

c. Everyone was impressed by [Pat's artful folding of the napkins]. (nominal gerund)

On the nominal side, verbal gerunds have a distribution similar to that of NPs, but not that of VPs or sentences; in particular, they may occur as complements of prepositions and as clause-internal subjects. On the verbal side, they seem to have an internal structure similar to that of verbs. Thus, they take the same complements as the corresponding verbs would, including accusative NPs, and they can be modified by adverbs, and not by adjectives.

Malouf 2000b accounts for this behavior by postulating the (partial) type hierarchy for *head* in (89a) and the lexical rule (89b).

(89) a.



b. $$\begin{bmatrix} \textsc{head} & \begin{bmatrix} \textit{verb} \\ \textsc{vform}\ \textit{prp} \end{bmatrix} \\ \textsc{valence} & \begin{bmatrix} \textsc{subj}\ \langle \boxed{1}\text{NP} \rangle \\ \textsc{comps}\ \boxed{2} \\ \textsc{spr}\ \langle\rangle \end{bmatrix} \end{bmatrix} \Rightarrow \begin{bmatrix} \textsc{head}\ \textit{gerund} & \\ \textsc{valence} & \begin{bmatrix} \textsc{subj}\ \langle \boxed{1} \rangle \\ \textsc{comps}\ \boxed{2} \\ \textsc{spr}\ \langle \boxed{1} \rangle \end{bmatrix} \end{bmatrix}$$

Since *gerund* is a subtype of *noun* (toghether with common-*noun*s), it is able to occur anywhere an NP is selected for. Since *gerund* is a subtype of *verbal*, and adverbs modify any *verbal* category, it is modifiable by adverbs, but not by adjectives, which—by assumption—modify only *c-noun*s. Further, assuming that *noun*s have the attribute CASE and *verb*s (but not *verbal*s) have the attribute VFORM, *gerunds* have the attribute CASE (morphologically invisible in English), but not VFORM.

Finally, since the external argument of *gerund*s is, according to (89b), their subject and their specifier at the same time, gerundial phrases can instantiate either specifier-head constructions or subject-head constructions. More specifically, according to the type hierarchy of *phrase* assumed in Malouf 2000b, gerundial phrases can be either of type *nonfin-head-subj-cx*, in which case the external argument receives accusative case (cf. (88b)), or of type *noun-poss-cx*, in which case it gets the genitive case (cf. (88a)). Malouf 2000b shows also how this analysis accounts for the difference between POSS-*ing* and ACC-*ing* verbal gerunds in terms of their ability to be pied-piped together with their external argument, cf. (90a).

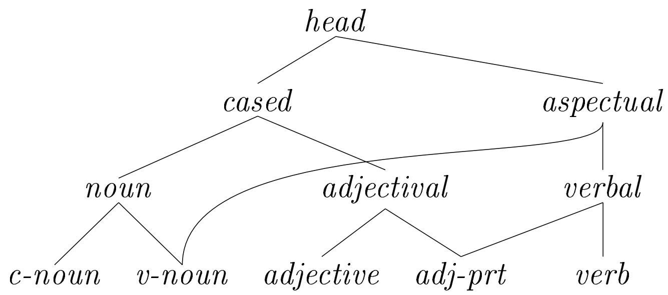
(90) a. I couldn't figure out [whose being late every day] Pat didn't like __.
(verbal POSS-*ing* gerund)

b.*I couldn't figure out [who(m) being late every day] Pat didn't like __.
(verbal ACC-*ing* gerund)

Languages with more morphology than English provide additional evidence for the essential usefulness of this approach to mixed categories. For example, in Polish, there is a number of mixed categories. One of them, called *verbal noun*, is verbal in the sense that the argument structure of a verbal noun is systematically related to that of the corresponding verb and, more importantly, in the sense that verbal nouns show both aspect and negation morphologically, just like Polish verbs do. On the other hand, verbal nouns are nominal in the sense that they occur in positions reserved for NPs, and also have gender (neutral), decline for case and number, and can be modified by adjectives, just like ordinary nouns. Another mixed category in Polish is that of *adjectival participles*, which inflect for case and number, and modify nouns, just like other adjectives, but may inflect for negation and (to some extent) aspect, like verbs, and also pattern with verbs in the way they assign case to their arguments (e.g., they combine with accusative NPs, which undergo the genitive of negation; cf. Przepiórkowski 1999a).

Note that these Polish mixed categories are somewhat more complex that English verbal gerunds in that they combine properties of different major categories *at the same level*; for example, Polish verbal nouns display internal structure and morphology of both nominal (e.g., case) and verbal (e.g., aspect and negation) elements. This makes them ineligible for accounts, often proposed for English verbal gerunds, which posit that such verbal/nominal elements are purely verbal as far as their internal structure is concerned, but they project to nominal phrases, which explains their distribution (cf. Malouf 1998, 2000b for a review of such approaches). On the other hand, the multiple inheritance type hierarchy approach can be applied straightforwardly; e.g., a partial *head* type hierarchy for Polish could be:[18]

(91)



[18]See Przepiórkowski 1999a, appendix, for a more comprehensive *head* type hierarchy for Polish.

Assuming that the CASE feature is introduced by the type *cased*, while ASPECT and NEGATION are introduced by the type *aspectual*, the facts mentioned above are accounted for as follows. Since *v-noun* is a subtype of *noun*, verbal nouns have the distribution of NPs and may be modified by adjectival elements. Since it is a subtype of *cased*, they inflect for case. And since it is also a subtype of *aspectual*, they bear the morphosyntactic features ASPECT and NEGATION. Similarly, since *adj-prt* is a subtype of *adjectival*, adjectival participles may modify nouns just like adjectives; since it is a subtype of both *cased* and *aspectual*, they bear the features CASE, ASPECT and NEGATION; and, finally, since it is a subtype of *verbal*, they assign (structural) case to their arguments according to general case assignment rules valid for all verbal elements.

6.3 Case and Case Assignment

Although Pollard & Sag (1994:30) suggest that in HPSG, "[t]here is no separate theory of case (or Case). Nominative case assignment takes place directly within the lexical entry of the finite verb," while "the subject SUBCAT element of a nonfinite verb... does not have a CASE value specified", it has since become clear that a (partially) syntactic theory of case assignment is needed.

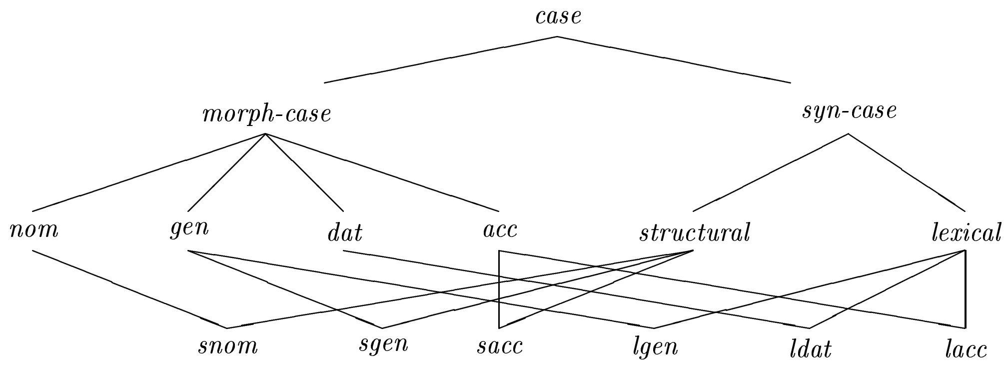
The most explicit such a theory is that of Heinz & Matiasek 1994.[19] This approach consists of three parts:

First, the type hierarchy for *case* does not simply list possible morphological cases (*nom*, *acc*, etc.) as subtypes of *case*, but is structured in such a way that it distinguishes between lexical (or inherent) case, assigned directly within lexical entries, and structural case, assigned in syntax proper.[20] For example, Heinz & Matiasek 1994 propose the following type hierarchy for *case* in German, which says that *nom*inative is always structural, *gen*itive and *acc*usative are either structural or lexical, and *dat*ive is always lexical.

[19] See Przepiórkowski 1999a, ch. 3 for a brief history of approaches to case assignment within HPSG and within other linguistic theories.

[20] This distinction is, of course, based on a similar dichotomy present in Chomskyan theories.

(92)



Second, lexical entries of predicates (verbs, nouns, etc.) are assumed to distinguish between *str*uctural arguments and *lex*ical arguments: only the latter, not the former, are morphologically specified in such lexical entries. For example, German verbs *unterstützen* 'support' and *helfen* 'help' are assumed to have following ARG-ST (originally, SUBCAT) specifications:

(93) a. *unterstützen*: [ARG-ST ⟨NP[*str*], NP[*str*]⟩]

b. *helfen*: [ARG-ST ⟨NP[*str*], NP[*ldat*]⟩]

The criterion for deciding which arguments are structural (i.e., bear a *str*uctural case) and which are lexical is roughly the stability of the morphological case of these arguments across syntactic configurations. For example, the case of the second argument of *unterstützen* (i.e., its object) is unstable because it is accusative in active voice and nominative in passive, cf. (94), while the second argument of *helfen* is stable, because it is dative in both voices, cf. (95).

(94) a. Der Mann unterstützt **den Installateur**.
the.NOM man supports the.ACC plumber
'The man is supporting the plumber.'

b. **Der Installateur** wird unterstützt.
the.NOM plumber AUX supported
'The plumber is supported.'

(95) a. Der Mann hilft **dem Installateur**.
the.NOM man helps the.DAT plumber
'The man is helping the plumber.'

b. **Dem Installateur** wird geholfen.
the.DAT plumber AUX helped
'The plumber is helped.'

Similarly, the subject of most verbs, including *unterstützen* and *helfen*, is unstable in the sense that it is realized as nominative (when the subject is not raised to a higher verb) or as accusative (when the subject is raised to the object position of a higher verb).

Third, *str*uctural case is resolved by configurational constraints such as (96).

(96) a.

$$\left[\begin{array}{ll} \mathrm{SYNSEM}|\mathrm{LOC}|\mathrm{CAT} & \left[\begin{array}{ll} \mathrm{HEAD} & \left[\begin{array}{l} \textit{verb} \\ \mathrm{VFORM}\ \textit{fin} \end{array}\right] \\ \mathrm{SUBCAT} & \langle\rangle \end{array}\right] \\ \mathrm{DTRS} & \left[\begin{array}{l} \textit{h-c-str} \\ \mathrm{HEAD\text{-}DTR}|\ldots|\mathrm{SUBCAT}\ \langle \mathrm{NP}[\textit{str}], \ldots \rangle \end{array}\right] \end{array}\right] \rightarrow$$

$$\left[\mathrm{DTRS}|\mathrm{HEAD\text{-}DTR}|\ldots|\mathrm{SUBCAT}\ \langle \mathrm{NP}[\textit{snom}], \ldots \rangle\right]$$

b.

$$\left[\begin{array}{ll} \mathrm{SYNSEM}|\mathrm{LOC}|\mathrm{CAT} & \left[\begin{array}{l} \mathrm{HEAD}\ \textit{verb} \\ \mathrm{SUBCAT}\ \langle\rangle \vee \langle \textit{synsem} \rangle \end{array}\right] \\ \mathrm{DTRS} & \left[\begin{array}{l} \textit{h-c-str} \\ \mathrm{HEAD\text{-}DTR}|\ldots|\mathrm{SUBCAT}\ \langle \textit{synsem}, \mathrm{NP}[\textit{str}], \ldots \rangle \end{array}\right] \end{array}\right] \rightarrow$$

$$\left[\mathrm{DTRS}|\mathrm{HEAD\text{-}DTR}|\ldots|\mathrm{SUBCAT}\ \langle \textit{synsem}, \mathrm{NP}[\textit{sacc}], \ldots \rangle\right]$$

What these two constraints say is, roughly, that the first SUBCAT element of a finite verb is assigned nominative case provided this element is *str*uctural and realized locally (as the subject; cf. (96a)), and that the second element of a SUBCAT of a verb is assigned accusative case provided this element is *str*uctural and it is realized locally (as the object; cf. (96a)). Note that, assuming more current feature architecture in which SUBCAT is replaced by VALENCE features and by ARG-ST (cf. §2.2), SUBCAT plays here the rôle of VALENCE attributes SUBJECT and COMPLEMENTS, and not the rôle of ARG-ST.

This theory nicely accounts for data such as (94)–(95), as well as for more complex data, e.g., involving so-called remote passivization in German (Pollard 1994a; Heinz & Matiasek 1994). Nevertheless, as discussed in Przepiórkowski 1999a, such a configurational theory faces a number of conceptual and technical problems which require considerable modifications; in particular, it is incompatible with current HPSG approaches to extraction and to cliticization. In brief, this is because case is crucially assigned on VALENCE attribute(s) here, while various case-receiving elements are absent from VALENCE attribute(s) on current approaches to extraction and cliticization.

An approach to case assignment which solves these problems was proposed in Przepiórkowski 1996 and is most fully described and illustrated in Przepiórkowski 1999a. This approach accepts the first two parts of Heinz & Matiasek's (1994), i.e., it assumes the structural/lexical case dichotomy, but it changes the actual case-assigning principles in such a way that case is assigned strictly locally and non-configurationally (without recourse to DTRS) to the elements of ARG-ST, rather than being assigned on VALENCE attribute(s).[21]

Such an approach has long been deemed impossible because of, e.g., the so-called remote passive in German, where correct resolution of the *str*uctural case of an argument seems to crucially depend on the tree-configurational realization of this argument. Przepiórkowski 1999a shows, though, that the only non-local information that is required to correctly assign structural case is binary, roughly, whether a given argument is realized locally or raised to be realized higher up. Once elements of ARG-ST are marked with this binary information, case can be assigned to them strictly locally and non-configurationally. For example, the constraints in (96) above would be restated within this approach as (97) below, where 'NP^{-}' describes an occurrence of an NP which is not raised to a higher ARG-ST.[22]

(97) a. $\begin{bmatrix} \textit{cat} \\ \text{HEAD } \textit{verb} \\ \text{ARG-ST } \langle \text{NP}^{-}[\textit{str}] \rangle \oplus \boxed{2} \end{bmatrix} \rightarrow \begin{bmatrix} \text{ARG-ST } \langle \text{NP}[\textit{snom}] \rangle \oplus \boxed{2} \end{bmatrix}$

b. $\begin{bmatrix} \textit{cat} \\ \text{HEAD } \textit{verb} \\ \text{ARG-ST } \langle \boxed{1}, \text{NP}^{-}[\textit{str}] \rangle \oplus \boxed{2} \end{bmatrix} \rightarrow \begin{bmatrix} \text{ARG-ST } \langle \boxed{1}, \text{NP}[\textit{sacc}] \rangle \oplus \boxed{2} \end{bmatrix}$

This approach, apart from being arguably conceptually cleaner, avoids the technical problems of Heinz & Matiasek's (1994) analysis to do with extraction and cliticization: regardless of which approach to extraction (traced or traceless) or cliticization (syntactic or morphophonological) is adopted, all case-bearing arguments (more generally, dependents) of a predicate are present on this predicate's ARG-ST (or DEPENDENTS, assuming the architecture of Bouma *et al.* 1999b) and may be assigned case in a uniform way. See Przepiórkowski 1999a for details and extensive application to case assignment in Polish and

[21]A similar approach is sometimes assumed in LFG, but has never been substantiated, to the best of our knowledge.

[22]Various ways of representing such information about (not) being raised to a higher ARG-ST are adduced in Przepiórkowski 1999a and Meurers 1999a.

other languages, as well as Calcagno & Pollard 1997, Chung 1998b, Kupść 1999, Calcagno 1999, Meurers 1999a, 1999b and Malouf 2000a for other applications.

6.4 Agreement

Considerably more detailed attention to agreement phenomena is paid in HPSG than other grammatical frameworks. Part of the reason may lie in the fact that the multiple layers of linguistics information represented simultaneously in HPSG-style signs are particularly amenable to a view of agreement that considers it to straddle (morpho-)syntax, semantics, and pragmatics. In fact, Pollard & Sag (1994) argue that agreement is not actually a unfied phenomenon at all, but instead may involve these three components of the grammar to different degrees, depending on the kind of dependency involved (e.g., NP-internal agreement vs. pronoun-antecedent agreement, etc.) and the choices made by particular grammars.

The central concept of the HPSG theory of agreement is that of an INDEX, a concept that unifies some of the properties of constants and variables from logical formalisms. In the simplest cases an index is an abstract linguistic entity that is referentially linked to some object in the interpretation domain. Indices are also used with quantificational expressions, in which case they behave very much like variables. Unlike constants and variables in logic, however, indices have internal organization that reflects properties of the associated linguistic entities or referential objects, or both. In English, this information includes number, gender, and person. This makes it possible to straightforwardly account for a number of agreement phenomena. For instance, if we assume that the relation between reflexive pronouns and their antecedents involves identity in index values, then the distribution of forms in (98) falls out automatically.

(98) a. I saw {myself/*himself/*herself} in the mirror.
b. He saw {*myself/himself/*herself} in the mirror.
c. She saw {*myself/*himself/herself} in the mirror.

The necessity of indices as essential mediaries between form and meaning has been challenged for instance by Dowty & Jacobson (1988), who propose a strictly semantic approach to agreement relations of the kind illustrated in (99). However, as Pollard & Sag (1994) point out, a purely semantic approach runs into difficulties when there exist conflicting ways of referring to some entity by a linguistic form. For instance, English allows pets to be referred to either in terms of the neuter pronoun or in terms of their natural gender. A strictly semantic approach predicts that these conventions can be used independently of each other, and in fact, that is what we find across sentences, cf. (99):

(99) That dog is so stupid, every time I see **it** I want to kick **it**. **He**'s a damn good hunter, though.

However, within certain grammatical domains, the linguistic convention used must be respected in subsequent referrals. This is why the alternations between neuter and masculine pronominals in (100c,d) give rise to illformedness:

(100) a. That dog is so ferocious, it even tried to bite itself.

b. That dog is so ferocious, he even tried to bite himself.

c.*That dog is so ferocious, it even tried to bite himself.

d.*That dog is so ferocious, he even tried to bite itself.

If we adopt indices as a device which in a sense keeps a record of aspects of the linguistic form that was used to introduce an entity into the discourse then these domain effects can readily be explained simply via structure sharing among indices.

As Pollard & Sag (1994) point out, however, there are cases where properties of the linguistic form need to be distinguished from properties of the referent itself. An illustration from French of such a situation is given in (101):

(101) Vous êtes belle.
you are-PL beautiful-SG.FEM
'You are beautiful.'

Here, the subject *vous* with a single female as the intended referent is involved in two agreement relations. It triggers plural morphology on the verb *êtes*. At the same time, the predicative adjective exhibits feminine singular morphology. Whereas the first can straightforwardly be attributed to the number properties of the index of *vous*, Pollard & Sag (1994) propose that the singular marking of the adjective be seen as a reflection of inherent, semantic properties of the subject's referent. Thus, we need to distinguish between the index per se and the conditions under which an index is referentially linked ("anchored to") an entity of the world. The singular morphology on *belle* can be viewed as a fact about the pragmatics of using morphologically plural *vous* with a nonaggregate referent. The two-way split between syntactic/semantic index-agreement and pragmatic agreement of the latter kind is illustrated in (102):

(102) *index agreement* (GEND)

index agreement (PER, NUM)

$\begin{bmatrix} \langle \textit{vous} \rangle & \\ \text{INDEX} & \textit{fem}\ \overbrace{\textit{2nd pl}} \\ \text{ANCH. COND.} & \textit{nonaggregate} \end{bmatrix}$ *êtes* *belle*

pragmatic agreement (NUM)

Finally, there exist cases of agreement that do not plausibly involve indices at all. Indices only carry information about number, person, and gender (as reflected by the slots in the pronominal paradigm). However, they do not encode distinctions in case. This is well-motivated because typically pronoun-antecedent relations involve discrepancies in case marking while sharing all the index information (cf. (98)). Yet, in many languages there is covariation of case within NPs, cf. the following data from German:

(103)	NOMINATIVE	ein	lieb**er**	Verwandt**er**
	ACCUSATIVE	ein**en**	lieb**en**	Verwandt**en**
		a	dear	relative

Such cases of what Pollard & Sag (1994) call "case concord" are dealt with by assuming that adjectives have their own CASE feature whose value is constrained to be identical to that of the noun. Thus the potential of morphological variation of the head (noun) and the dependent (adjective) is directly reflected in their own independent CASE features. This contrasts with Pollard & Sag's (1994) view of other agreement relations. In particular verbal agreement morphology is taken to be a mere reflection of the combinatorial potential of a given verb. For instance, English *-s* only tells us something about the ability of a verbal form to combine with a third person dsingular subject—there is no independent reflection of third singular properties within the lexical description of *walks*.

As Kathol (1999b) argues, this position is somewhat unsatisfactory in view of constructions in which there is no subject present. Consider for instance the case of impersonal passives in German. Here, the passive auxiliary instantiates third singular morphology even though there is no agreement "target":

(104) An jenem Abend {wurde/*wurden} viel gelacht.
on that evening was.3.SG/were.3.PL much laughed
'There was much laughter that evening.'

Data like these indicate that agreement as a relation between syntactic forms needs to be distinguished from morphological form as possible, but not necessary exponent of a dependency among syntactic units. For that reason Kathol (1999b) proposes that all inflecting lexical categories have a description of their morphological form in terms of the head feature MORSYN. Embedded inside the value of MORSYN is the attribute AGR, which groups together all morphosyntactic features that are, in principle, subject to covariation.[23] For example, nominals are typically assumed to have the following attributes within AGR values: CASE, GENDER, NUMBER, while verbs are assumed to have the attributes PERSON, NUMBER and, in some languages, GENDER (but not CASE):

(105) a. nouns, adjectives, etc.:

$$\begin{bmatrix} \text{AGR} & \begin{bmatrix} \text{CASE} & \textit{case} \\ \text{GENDER} & \textit{gender} \\ \text{NUMBER} & \textit{number} \end{bmatrix} \end{bmatrix}$$

b. verbs:

$$\begin{bmatrix} \text{AGR} & \begin{bmatrix} \text{PERSON} & \textit{person} \\ \text{NUMBER} & \textit{number} \\ (\text{GENDER} & \textit{gender}) \end{bmatrix} \end{bmatrix}$$

As a consequence, NP-internal agreement (between the noun and its adjectival modifiers) can be treated as a concord of all agreement-relevant features, not just CASE, as previously assumed by Pollard & Sag (1994). This is illustrated with the following example from Polish where there is NP-internal agreement between demonstratives, adjectives, and nouns involving case, number, and gender:

(106)	ten	duży	chłopiec
	this.NOM.SG.MASC	big.NOM.SG.MASC	boy.NOM.SG.MASC
	$\begin{bmatrix} \text{AGR} & \boxed{1} \end{bmatrix}$	$\begin{bmatrix} \text{AGR} & \boxed{1} \end{bmatrix}$	$\begin{bmatrix} \text{AGR} & \boxed{1} \begin{bmatrix} \textit{index} & \\ \text{CASE} & \textit{nom} \\ \text{GENDER} & \textit{masc} \\ \text{NUMBER} & \textit{sg} \end{bmatrix} \end{bmatrix}$

The assumption of AGR as a bundle of features that may participate in an agreement relation allows for a greater differentiation in terms of which pieces of lexical information bear a systematic relation with morphology and semantics/pragmatics—and what kinds of mismatches are possible. A detailed

[23]Along similar lines, Wechsler & Zlatić (forthcoming) group locally shared information under CONCORD.

study of these correlations and possible exceptions in Serbo-Croation is undertaken by Wechsler & Zlatić (forthcoming), who also also bring into view the role that declension classes play in determining agreement behavior. As a result, Wechsler & Zlatić distinguish four levels at which agreement-related information can be brought to bear. In addition to semantics (i.e., anchoring conditions), index, and concord, they propose that the declension class should also be represented lexically. While declension class is not a direct parameter of covariation, nevertheless the morphological shape determined by a declension class may be responsible for certain concord facts which are in apparent conflict with the semantically conditioned feature assignment (given in terms of *index* features). Consider the following data from Serbo-Croatian:

(107) a. *det-e* ('child')

declension class	I (typically for masc. and neut. nouns)
concord	neuter sing
index	neuter sing

b. *det-a* ('children')

declension class	II (typically for fem. nouns)
concord	feminine sing
index	neuter plural

The morphological realization of the plural *deta (det-a)* ('children') is in terms of declension class II, which is normally associated with femine nouns. The plural form of this noun acts "as if" it were singular feminine for the purposes of adjectival concord (108b):

(108) a. ovo lepo dete
that.NEUT.SG beautiful.NEUT.SG child.NEUT.SG
'that beautiful child'

b. ova lepa deca
that.FEM.SG beautiful.FEM.SG child.FEM.SG
'those beautiful children'

Outside of the NP more semantically based become operative again, as evidenced by plural marking on an agreeing verb, cf. (109):

(109) Ta dobra deca dolaze.
that.FEM.SG good.FEM.SG children come.PAST.3.PL
'Those good children came.'

Contrast this now with the situation in which the declension class mismatch has no bearing on the covariance behavior of dependent elements. For instance, *Steva* ('Steve') is also inflected according to declension class II, yet as the example in (110b) illustrates, the determiner and the adjective exhibit masculine agreement:

(110) a. *Stev-a* ('Steve')

declension class	II (typically for fem. nouns)
concord	masculine sing
index	masculine sing

b.

Vratio	mi	je	ovaj	ludi	Steva
returned	me	AUX	this.NOM.M.SG	crazy.NOM.M.SG	Steve.NOM

violinu	koju	sam	mu	pozajmio.
violin	which	AUX	him	loaned

'This crazy Steve returned to me the violin which I loaned him.'

If we represent declension, concord, index, and semantics as four parameters of variation the case of totally transparent morphological and covariation properties can be represented as in (111a). Where there is a split between morphology, NP-internal concord and NP-external covariation behavior—as with *deca* in (108, 109), there is a misalignment between concord and index-based properties, as shown in (111b). Finally, the situation where the exceptionality is restricted to morphology, as in (110), can be represented schematically as in (111c).

(111)								
	a.	declension	$\Leftrightarrow$	concord	$\Leftrightarrow$	index	$\Leftrightarrow$	semantics
	b.	declension	$\Leftrightarrow$	concord	$\|\|$	index	$\Leftrightarrow$	semantics
	c.	declension	$\|\|$	concord	$\Leftrightarrow$	index	$\Leftrightarrow$	semantics

As Wechsler & Zlatić (forthcoming) show, this conception of agreement as a multi-layer phenomenon based on a number of default alignments between "modules" makes correct predictions with respect to the expected scope of different kinds of covariation as well as possible possible exceptions.

7 Advances in Logical Foundations (RSRL)

Within the last 15 years or so, a number of different formalisms have been proposed for formalizing HPSG-style analyses, e.g., Kasper & Rounds 1986, King 1989 and Carpenter 1992. These different formalisms often reflect the state of the art in HPSG theorizing at the time when they were developed and more or less straighforwardly allow to encode large parts of HPSG grammars. However, they lack mechanisms necessary to encode other parts of HPSG analyses, mainly those involving so-called relational constraints and quantification. As Richter *et al.* 1999 and Richter 2000 point out, analyses making implicit or explicit reference to such mechanisms abound in HPSG literature.

One famous case in point is Pollard & Sag's (1994) Binding Theory, cited in (112) below.

(112) The Binding Theory (Pollard & Sag 1994:401):

> *Principle A:* A locally o-commanded anaphor must be locally o-bound.
> *Principle B:* A personal pronoun must be locally o-free.
> *Principle C:* A nonpronoun must be o-free.

This principle relies on notions such as *(local) o-command*, *(local) o-binding* and *(local) o-freeness*, which in turn rely on the notion of obliqueness. Relevant definitions are cited below (Pollard & Sag 1994:401):

(113) a. One *synsem* object is *more oblique* than another provided it appears to the right of the other on the SUBCAT list of some word.

b. One referential *synsem* object *locally o-commands* another provided they have distinct LOCAL values and either (1) the second is more oblique than the first, or (2) the second is a member of the SUBCAT list of a *synsem* object that is more oblique than the first.

c. One referential *synsem* object *o-commands* another provided they have distinct LOCAL values and either (1) the second is more oblique than the first, or (2) the second is a member of the SUBCAT list of a *synsem* object that is o-commanded by the first, or (3) the second has the same LOCAL | CATEGORY | HEAD value as a *synsem* object that is o-commanded by the first.

d. One referential *synsem* object *(locally) o-binds* another provided it (locally) o-commands and is coindexed with the other. A referential *synsem* object is *(locally) o-free* provided it is not (locally) o-bound. Two *synsem* entities are *coindexed* provided their LOCAL | CONTENT | INDEX values are token-identical.

It is clear that the definitions in (113) are really definitions of relations. For example, according to (113a), two *synsem* objects x and y stand in the *more oblique* relation provided there exsists a word w such that x is to the right of y on w's SUBCAT list. Similarly, according to (113b), two objects x and y

stand in the *local o-command* relation if and only if both have LOCAL | CONTENT | INDEX values of type *ref*, their LOCAL values are not token-identical and, moreover, either y and x stand in the *more oblique* relation, or there exists a *synsem* object s such that y is a member of s's LOCAL | CATEGORY | SUBCAT, and s and x stand in the *more oblique* relation. Similar paraphrases can be given for the notions introduced in (113c–d).

These paraphrases already show that there is a great deal of existential quantification hidden in Pollard & Sag's (1994) Binding Theory. The definition of the *more oblique* relation makes reference to *some word*, the definition of *local o-command* refers to *a synsem object*, etc.

Any direct formalization of this Binding Theory must also make use of universal quantification. This is because the logical structure of Principles A–C is actually as follows: *For each x such that x is a locally o-commanded anaphor / a personal pronoun / a nonpronoun, x is locally o-bound / locally o-free / o-free, respectively.* Note that, apart from universal quantification, these principles also make direct use of existential quantification. For example, the more careful paraphrase of Principle A would be:

(114) Principle A of Pollard & Sag's (1994) Binding Theory (paraphrased):

> For each x such that, both, x is an anaphor and there exists y such that y and x stand in the local o-command relation, there exists z such that z and x stand in the local o-binding relation.

Finally, the definition of *(local) o-freeness* in (113d) calls for the presence of logical negation in the underlying formalism: two objects x and y stand in the *(local) o-freeness* relation if and only if they do not stand in the *(local) o-binding* relation.

Although relations, quantification and general logical negation are commonly (even if often implicitly) used in HPSG, for a long time there existed no HPSG formalism providing the logical foundations for these notions. A formalism meeting these desiderata has been proposed in Richter *et al.* 1999 and, more comprehensively, in Richter 2000 under the name "RSRL" (Relational Speciate Re-entrant Language). It is based on Paul King's SRL (Speciate Re-entrant Logic; cf. King 1989, 1994, 1999 and Pollard 1999) but extends SRL by introducing relations and restricted quantification. A formal introduction to RSRL would be well beyond the scope of this survey, so we will only illustrate this formalism here.

Let us look again at Principle A, as paraphrased in (114). Assuming the existence of relation symbols `loc-o-command` and `loc-o-bind` which correspond to *local o-command* and *local o-binding*, respectively, this principle could be rendered in RSRL as follows (Richter 2000:§4.2):

(115) Principle A of Pollard & Sag's (1994) Binding Theory (in RSRL):

$$\forall x\ (({}^{x}[\textsc{loc cont}\ \mathit{ana}]\ \wedge\ \exists y\ \texttt{loc-o-command}(y,x))\ \rightarrow$$
$$\rightarrow\ \exists z\ \texttt{loc-o-bind}(z,x))$$

(explain notation here?) AK

Similarly, taking into consideration the fact that being *(locally) o-free* is tantamount to *not* being *(locally) o-bound* (cf. (113d)), Principles B and C could be formalized in RSRL as follows:

(116) Principles B and C of Pollard & Sag's (1994) Binding Theory (in RSRL):

a. $\forall x\ ({}^{x}[\textsc{loc cont}\ \mathit{ppro}]\ \rightarrow\ \neg\exists y\ \texttt{loc-o-bind}(y,x))$

b. $\forall x\ ({}^{x}[\textsc{loc cont}\ \mathit{npro}]\ \rightarrow\ \neg\exists y\ \texttt{o-bind}(y,x))$

For these formalizations of Principles A–C of Pollard & Sag's (1994) Binding Theory to have the intended effect it is necessary to define the meaning of relation symbols `loc-o-command`, `loc-o-bind` and `o-bind`. We will first define the simpler relation `more-oblique`:

(117) $\texttt{more-oblique}(x,y)\ \stackrel{\forall}{\Longleftarrow}$

$${}^{w}\begin{bmatrix} \mathit{word} \\ \textsc{ss loc cat subcat}\ \boxed{1} \end{bmatrix}\ \wedge\ \texttt{to-the-right}(x,y,\boxed{1})$$

According to this definition, x and y stand in the `more-oblique` relation if and only if there are w and $\boxed{1}$ such that w is a *word* whose SYNSEM | LOCAL | CATEGORY | SUBCAT is $\boxed{1}$ and y is `to-the-right` of x on $\boxed{1}$.[24] Note that this definition relies on the convention according to which (i) variables present on the left hand side of '$\stackrel{\forall}{\Longleftarrow}$' are quantified universally, while (ii) variables present only on the right hand side of '$\stackrel{\forall}{\Longleftarrow}$' are quantified existentially.

The definition of `loc-o-command` is more complex but its overall logical structure corresponds to the prose in (113b).

(118) $\texttt{loc-o-command}(x,y)\ \stackrel{\forall}{\Longleftarrow}$

$$({}^{x}[\textsc{loc}\ \boxed{1}[\textsc{cont index}\ \mathit{ref}]]\ \wedge$$
$${}^{y}[\textsc{loc}\ \boxed{2}[\textsc{cont index}\ \mathit{ref}]]\ \wedge$$
$$\neg\boxed{1}=\boxed{2})\ \wedge$$
$$(\texttt{more-oblique}(y,x)\ \vee$$

[24]See Richter 2000, §4.2 for the straightforward definition of `to-the-right` as used in (117) and `member` as used in (118). Also, note that both letters and tags are used as variables in RSRL descriptions.

$$(^{s}\left[\begin{array}{l}\textit{synsem}\\ \text{LOC CAT SUBCAT } \boxed{3}\end{array}\right] \wedge$$
$$\texttt{more-oblique}(s, x) \ \wedge$$
$$\texttt{member}(y, \boxed{3})))$$

Similar definitions can be given for relations `loc-o-bind` and `o-bind`.

One important aspect of RSRL that should not be overlooked is the restricted character of its quantification mechanism: the range of quantifiers used in an RSRL description is restricted to components of the described object. Let us illustrate this aspect with a generalization regarding Serbo-Croatian case assignment discussed in Wechsler & Zlatić 1999, 2000 and cited in (119) below.

(119) Serbo-Croatian Dative/Instrumental Case Realization Condition.

If a verb or noun assigns dative or instrumental case to an NP, then that case must be morphologically realized by some element within the NP.

The element which 'realizes' the dative/instrumental case on an NP does not have to be the head of this NP: in Serbo-Croatian, there is a class of uninflected female names which do not decline for case at all and, hence, are grammatical in dative and instrumental positions only when accompanied by a determiner or an adjective which is overtly inflected for case, cf. (120).

(120)	Divim	se	*(mojoj)	Miki.
	admire.1ST.SG	REFL	my.DAT.SG	Miki
	'I admire (my) Miki.'			

The generalization in (119) is difficult to state without quantification (cf. Wechsler & Zlatić 1999 for an attempt), but straighforward when quantification is available; (121) is a slightly modified version of the constraint given in Wechsler & Zlatić 2000.

(121) $$\left[\begin{array}{l}\textit{phrase}\\ \text{SYNSEM}|\ldots|\text{CASE } \boxed{1}(\textit{dative} \vee \textit{instrumental})\end{array}\right] \rightarrow$$
$$\rightarrow \ \exists x \mid x = \left[\begin{array}{l}\textit{inflected-word}\\ \text{SYNSEM}|\ldots|\text{CASE } \boxed{1}\end{array}\right]$$

This constraint is already almost an RSRL principle. The RSRL version is given below.

$$(121') \ \forall \boxed{1} \ ((\begin{bmatrix} \textit{phrase} \\ \text{SYNSEM} \ldots \ \text{CASE} \ \boxed{1} \end{bmatrix} \land \ (\boxed{1}\textit{dative} \lor \boxed{1}\textit{instrumental})) \ \rightarrow$$

$$\rightarrow \ \exists x \ {}^{x}\begin{bmatrix} \textit{inflected-word} \\ \text{SYNSEM} \ldots \ \text{CASE} \ \boxed{1} \end{bmatrix})$$

Constraint (121) illustrates an important aspect of RSRL: this constraint has the effect intended in the informal description (119) only because RSRL quantification is restricted to components of the described object, i.e., to values of paths within the described object. Since (121) is a constraint on *phrase*s with *dative* or *instrumental* SYNSEM|...|CASE values, the existential quantifier $\exists x$ ranges over objects within such a phrase, so the *word* overtly inflected for case must be somewhere within this phrase. Without this restriction on quantification, the existential quantifier could pick up a dative or instrumental element somewhere else within the sentence (or, more generally, anywhere within the model), and the constraint (121) would in effect state that, whenever there is a *dative* or *instrumental phrase*, there must be an *inflected-word* with the same case value *anywhere* in the sentence (or in the model).

Despite its relative novelty, RSRL has already been employed in HPSG accounts of a variety of phenomena, including German clause structure (Richter 1997b; Richter & Sailer 2000), semantic scope (Przepiórkowski 1997), underspecified semantics (Richter & Sailer 1999c), linearization (Penn 1999a), negative concord (Richter & Sailer 1999a, 1999b), Montagovian semantics (Sailer 2000), case assignment (Przepiórkowski 1999a; Meurers 1999a; Wechsler & Zlatić 2000) and morphology (Reinhard 2000).

8 Conclusion

More than a well-defined theory of grammar, HPSG is probably best seen as a collection of analyses by a research community that is linked by a common commitment to nonderivational, lexicalist, formally precise, and computationally tractable descriptions of natural language phenomena. Together with LFG it can claim to be the most popular formal grammar paradigm outside of the transformational "mainstream" and the number of researchers working in it has steadily been on the rise. Beginning in 1993 there has been an annual conference exclusively devoted to HPSG-based work that has attracted a truly international audience and done much to foster a sense of community among HPSG researchers of all trades. Given the attention to descriptive precision and sound formal foundations, it should not come as a surprise that there are now numerous implementations of the framework and even a commercial spin-off that relies heavily on HPSG-based ideas (YY Corporation). While the history of linguistics has seen its share of "movements" that fizzled out after only a few productive years, we hope to have conveyed to the reader our confidence that there is still a tremendous amount of unrealized potential in HPSG.

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