Advanced Topics in HPSG*

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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 "⊕") the list of dependents of that very complement. This is illustrated in (3), where "$\boxed{1}$" now acts as a variable over lists.

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

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 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$_i$.'

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 *gap*s, must be present on VALENCE attributes. There are two things to note about (16). First, *gap*s, 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:

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

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):

$$\textit{hd-val-ph} \rightarrow \begin{bmatrix} \text{SLASH } \boxed{1} \\ \text{HD-DTR}|\text{SLASH } \boxed{1} \end{bmatrix}$$

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.

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.

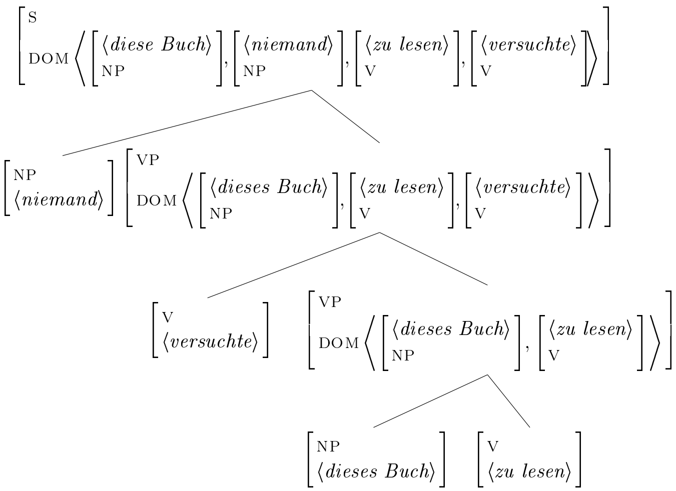
Concatenative approaches lends themselves rather straightforwardly to the description of the relation between constituency and order in a language like English. However, it is far less clear whether this also holds of languages such as German. For instance, Reape (1993,1994, 1996) observes that in German 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)


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)

$$\begin{bmatrix}\text{DOM}\left\langle \begin{bmatrix}\textit{l. s.}\\ \text{PHON}\langle \textit{daß}\rangle\\ \text{COMPL}\end{bmatrix}, \begin{bmatrix}\textit{mf.}\\ \text{P'N}\ \langle \textit{Lisa}\rangle\\ \text{NP[NOM]}\end{bmatrix}, \begin{bmatrix}\textit{mf.}\\ \text{P'N}\ \langle \textit{die Blume}\rangle\\ \text{NP[ACC]}\end{bmatrix}, \begin{bmatrix}\textit{r. s.}\\ \text{P'N}\ \langle \textit{sieht}\rangle\\ \text{V[FIN]}\end{bmatrix}\right\rangle\end{bmatrix}$$

(26)

$$\begin{bmatrix}\text{DOM}\left\langle \begin{bmatrix}\textit{l. s.}\\ \text{PHON}\langle \textit{sieht}\rangle\\ \text{V[FIN]}\end{bmatrix}, \begin{bmatrix}\textit{mf.}\\ \text{PHON}\langle \textit{Lisa}\rangle\\ \text{NP[NOM]}\end{bmatrix}, \begin{bmatrix}\textit{mf.}\\ \text{PHON}\langle \textit{die Blume}\rangle\\ \text{NP[ACC]}\end{bmatrix}\right\rangle\end{bmatrix}$$

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)

$$\begin{bmatrix}\text{DOM}\left\langle \begin{bmatrix}\textit{vf.}\\ \text{PHON}\langle \textit{die Blume}\rangle\\ \text{NP[ACC]}\end{bmatrix}, \begin{bmatrix}\textit{l. s.}\\ \text{PHON}\langle \textit{sieht}\rangle\\ \text{V[FIN]}\end{bmatrix}, \begin{bmatrix}\textit{mf.}\\ \text{PHON}\langle \textit{Lisa}\rangle\\ \text{NP[NOM]}\end{bmatrix}\right\rangle\end{bmatrix}$$

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 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

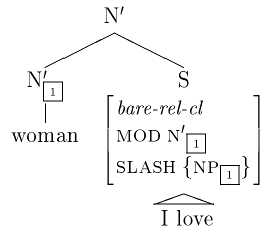
[10]Another possibility would be to attribute the relative clause behavior entirely to the verbal head. This would mean that finite verbs have to be treated as ambiguous between a "regular" and a relative clause version which licenses a gap and turns the finite clause into a noun-modifier. However, long-distance 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

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*.

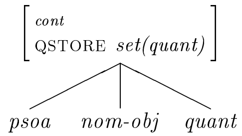
Below, we present a modification of Pollard & Yoo 1998, which is simpler than their analysis, and also avoids spurious ambiguities (i.e., multiple analyses of a sentence with the same syntax and semantics) and some other problems in Pollard & Yoo 1998, namely the analysis proposed in Przepiórkowski 1997, 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)
$$\begin{bmatrix} \textit{word} & \\ \text{PHON} & \langle\ a\ \rangle \\ \text{SYNSEM|LOC} & \begin{bmatrix} \text{CAT|HEAD} & \begin{bmatrix} \textit{det} \\ \text{SPEC N}':\boxed{1} \end{bmatrix} \\ \text{CONT} & \boxed{2}\begin{bmatrix} \textit{quant} & \\ \text{DETERMINER} & \textit{exists} \\ \text{RESTIND} & \boxed{1} \end{bmatrix} \end{bmatrix} \\ \text{ARG-ST} & \langle\,\rangle \\ \text{NEW-QS} & \{\boxed{2}\} \end{bmatrix}$$

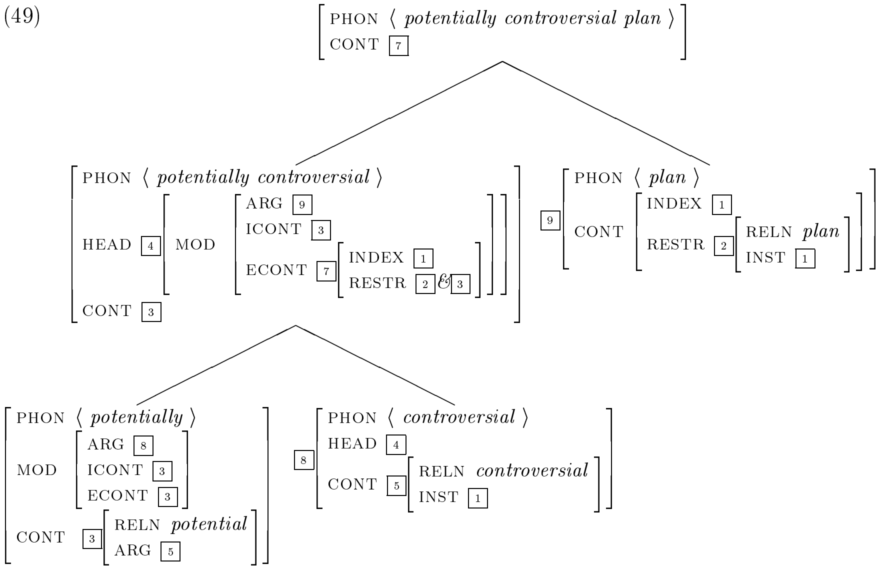
Third, quantifier retrieval is only allowed at the lexical level, as proposed in Manning *et al.* 1999. The new theory of quantification can schematically be represented as the implicational constraint in (40), where Desc_1 and Desc_2 are given in (41) and (42), respectively.

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

(47)
$$\begin{bmatrix} \textit{word} \\ \text{PHON} \ \langle \textit{potentially} \rangle \\ \text{SS}|\text{LOC} \begin{bmatrix} \text{CAT}|\text{HEAD} \begin{bmatrix} \textit{adv} \\ \text{MOD} \begin{bmatrix} \textit{mod} \\ \text{ARG} \begin{bmatrix} \text{HEAD} \ \textit{adj} \\ \text{CONT} \ \boxed{5}\,\textit{psoa} \end{bmatrix} \\ \text{ICONT} \ \boxed{3}\,\textit{psoa} \\ \text{ECONT} \ \boxed{3} \end{bmatrix} \end{bmatrix} \\ \text{CONT} \begin{bmatrix} \text{RELN} \ \textit{potential} \\ \text{ARG} \ \boxed{5} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

(48)
$$\begin{bmatrix} \textit{word} \\ \text{PHON} \ \langle \textit{controversial} \rangle \\ \text{SS}|\text{LOC} \begin{bmatrix} \text{CAT}|\text{HEAD} \begin{bmatrix} \textit{adj} \\ \text{PRD} \ - \\ \text{MOD} \begin{bmatrix} \textit{mod} \\ \text{ARG}|\text{CONT} \begin{bmatrix} \textit{nom-obj} \\ \text{INDEX} \ \boxed{1} \\ \text{RESTR} \ \boxed{2} \end{bmatrix} \\ \text{ICONT} \ \boxed{3} \\ \text{ECONT} \begin{bmatrix} \textit{nom-obj} \\ \text{INDEX} \ \boxed{1} \\ \text{RESTR} \ \boxed{2}\,\&\,\boxed{3} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \text{CONT} \begin{bmatrix} \text{RELN} \ \textit{controversial} \\ \text{INST} \ \boxed{1} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

(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:

(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.*

$$\left[\begin{array}{ll} \text{SS}|\text{LOC} & \left[\begin{array}{ll} \text{CONT} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{proposition}} \\ \text{SIT} & s_0 \\ \text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{soa}} \\ \text{QUANTS} & \langle\rangle \\ \text{NUCL} & \left[\begin{array}{ll}\multicolumn{2}{l}{\textit{leave-rel}} \\ \text{LEAVER} & \boxed{1}\end{array}\right]\end{array}\right]\end{array}\right] \\ \text{CONX}|\text{BKGRND} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{fact}} \\ \text{SIT} & s_1 \\ \text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{soa}} \\ \text{QUANTS} & \langle\rangle \\ \text{NUCL} & \left[\begin{array}{ll}\multicolumn{2}{l}{\textit{name-rel}} \\ \text{NAMED} & \boxed{1} \\ \text{NAME} & \text{Brendan}\end{array}\right]\end{array}\right]\end{array}\right] \end{array}\right] \end{array}\right]$$

(58) *Did Brendan leave?*

$$\left[\begin{array}{ll} \text{SS}|\text{LOC} & \left[\begin{array}{ll} \text{CONT} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{question}} \\ \text{PARAMS} & \{\} \\ \text{PROP} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{proposition}} \\ \text{SIT} & s_0 \\ \text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{soa}} \\ \text{QUANTS} & \langle\rangle \\ \text{NUCL} & \left[\begin{array}{ll}\multicolumn{2}{l}{\textit{leave-rel}} \\ \text{LEAVER} & \boxed{1}\end{array}\right]\end{array}\right]\end{array}\right]\end{array}\right] \\ \text{CONX}|\text{BKGRND} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{fact}} \\ \text{SIT} & s_1 \\ \text{SOA} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{soa}} \\ \text{QUANTS} & \langle\rangle \\ \text{NUCL} & \left[\begin{array}{ll}\multicolumn{2}{l}{\textit{name-rel}} \\ \text{NAMED} & \boxed{1} \\ \text{NAME} & \text{Brendan}\end{array}\right]\end{array}\right]\end{array}\right] \end{array}\right] \end{array}\right]$$

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.

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

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

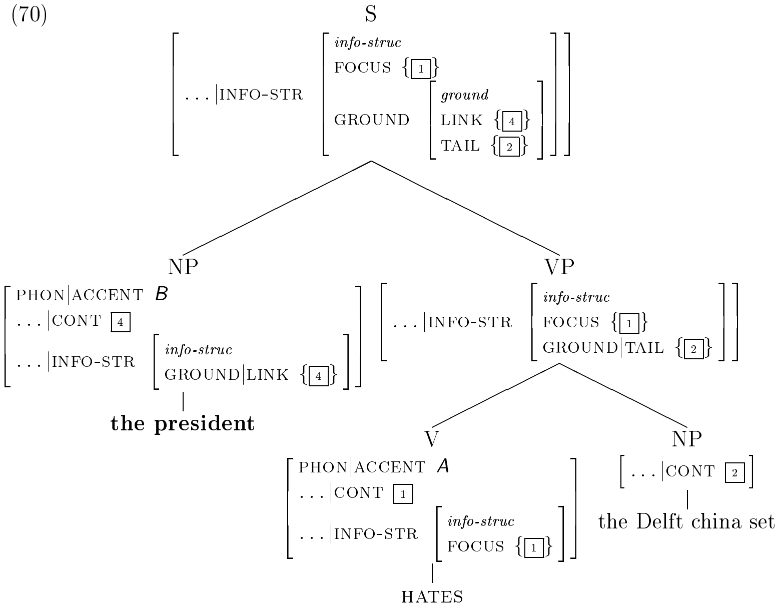
(65′) $\exists y(\mathsf{cat}'(y) \wedge \forall x(\mathsf{dog}'(x) \rightarrow \mathsf{chase}'(x,y)))$

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.*

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

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.

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

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 *signs*. Two main types of *non-canonical* synsems are *gaps* and *affixes*:

(80)

- *synsem*
  - *canon*
  - *noncan*
    - *gap*
    - *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) =
$$\begin{bmatrix} \textit{aff} & \\ \text{LOC} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix}\textit{noun} & \\ \text{CASE} & \textit{acc}\end{bmatrix} \\ \text{ARG-ST} & \langle\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix}\textit{ppro} & \\ \text{INDEX} & \textit{3pl}\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

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):
$$\begin{bmatrix} \textit{word} & \\ \text{SS|LOC|CAT} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{ARG-ST} & \left\langle \boxed{1}, \begin{bmatrix} \textit{synsem} & \\ \text{LOC|CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix}\textit{verb} & \\ \text{VFORM} & \textit{past-p} \\ \text{V-AUX} & \textit{avoir}\end{bmatrix} \\ \text{ARG-ST} & \langle\boxed{1}\rangle \oplus \boxed{2} \end{bmatrix}\end{bmatrix} \right\rangle \oplus \boxed{2} \end{bmatrix}\end{bmatrix}$$

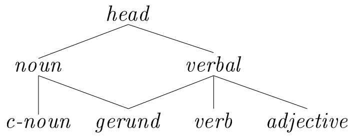
All arguments, including 'clitics', of the past participle (*past-p*) that the verb subcategorizes for are also present on the ARG-ST of *avoir*, where the constraint (78) applies and ensures that any clitics raised from the ARG-ST of the past participle are morphologically realized. Of course, since (78) is a constraint on all *words*, it nonvacuously applies to the past participle as well. Nevertheless, the F_{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.

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.

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} \\ \text{VFORM} \ \textit{prp} \end{bmatrix} \\ \text{VALENCE} & \begin{bmatrix} \text{SUBJ} & \langle \boxed{1}\text{NP} \rangle \\ \text{COMPS} & \boxed{2} \\ \text{SPR} & \langle \rangle \end{bmatrix} \end{bmatrix} \Rightarrow \begin{bmatrix} \text{HEAD} & \textit{gerund} \\ \text{VALENCE} & \begin{bmatrix} \text{SUBJ} & \langle \boxed{1} \rangle \\ \text{COMPS} & \boxed{2} \\ \text{SPR} & \langle \boxed{1} \rangle \end{bmatrix} \end{bmatrix}$$

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 *gerunds* 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).

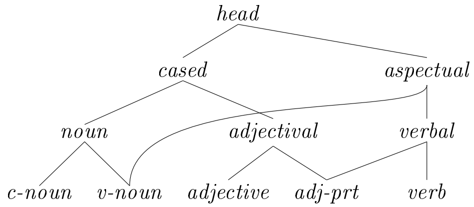
(90) a. I couldn't figure out [whose being late every day] Pat didn't like __.
(verbal POSS-*ing* gerund)

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.

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

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

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.
$$\left[\begin{array}{l} \textit{cat} \\ \text{HEAD}\ \textit{verb} \\ \text{ARG-ST}\ \langle \text{NP}^-[\textit{str}]\rangle \oplus \boxed{2} \end{array}\right] \rightarrow \left[\text{ARG-ST}\ \langle \text{NP}[\textit{snom}]\rangle \oplus \boxed{2}\right]$$

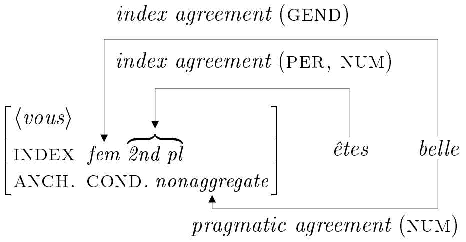
b.
$$\left[\begin{array}{l} \textit{cat} \\ \text{HEAD}\ \textit{verb} \\ \text{ARG-ST}\ \langle \boxed{1}, \text{NP}^-[\textit{str}]\rangle \oplus \boxed{2} \end{array}\right] \rightarrow \left[\text{ARG-ST}\ \langle \boxed{1}, \text{NP}[\textit{sacc}]\rangle \oplus \boxed{2}\right]$$

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.

(102)



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.

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):

$$(121') \ \forall \boxed{1} \left(\left(\begin{bmatrix} \textit{phrase} \\ \text{SYNSEM} \ \ldots \ \text{CASE} \ \boxed{1} \end{bmatrix} \wedge \left(\boxed{1}\textit{dative} \vee \boxed{1}\textit{instrumental} \right) \right) \rightarrow \right.$$
$$\left. \rightarrow \ \exists x \ {}^{x}\begin{bmatrix} \textit{inflected-word} \\ \text{SYNSEM} \ \ldots \ \text{CASE} \ \boxed{1} \end{bmatrix} \right)$$

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 *phrases* 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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