Proceedings

Joint Conference on Formal Grammar, Head-Driven Phrase Structure Grammar, and Categorial Grammar

Saarbrücken (Germany), August 1998

Edited by

Gosse Bouma, Geert-Jan M. Kruijff and Richard T. Oehrle

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Preface

The Joint Conference on Formal Grammar, Head-driven Phrase Structure Grammar, and Categorial Grammar, held in Saarbrücken, August 14-16, 1998, combines the 4th conference on Formal Grammar and the 5th conference on Head-driven Phrase Structure Grammar. The conference presents work on all aspects of formal grammar, including formal and computational aspects of phonology, syntax, semantics, and pragmatics; model-theoretic and proof-theoretic methods in linguistics, constraint-based and resource-sensitive approaches to grammar; and foundational and architectural issues in linguistics. Themes of special interest are information packaging and unbounded dependencies.

The conference precedes the 10th European Summer School in Logic, Language, and Information (ESSLLI X), which, in the past decade, has become an important forum for work on formal grammar, encompassing the overlapping interests of work in formal linguistics, computational linguistics, and the role of logic and grammar formalisms.

These proceedings contain the papers accepted for the regular sessions and for the special session, as well as contributions from our invited speakers. A total of 63 papers was submitted, 18 of which were accepted for the regular sessions, and 7 of which were accepted for the special session on information packaging. The quality of the submitted papers was very high, and we would like to thank the members of the Program Committee as well as the external reviewers for reading, reviewing, and evaluating substantial portions of the submitted papers.

We would like to thank the invited speakers for accepting our invitation, and for providing us with written versions of their presentations.

Finally, we would like to thank Geert-Jan Kruijff, for organizing the practical aspects of the submission and reviewing process, and for the amount of work he put into the editing of this volume; the German Research Centre for Artificial Intelligence, DFKI, for hosting this conference and for financial support; and Klaus Netter, for his help in all practical matters and for taking care of local arrangements.

July 1998,
Gosse Bouma and Dick Oehrle

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Schedule

Friday, August 14, 1998

	Special Session on Information Packaging I
9.30 - 10.00	*Rhematicity as a default information status* Enric Vallduvi, Universitat Pompeu Fabra, Barcelona (Invited Lecture)
10.00 - 10.30	*Information packaging and information states* Elisabet Engdahl, University of Gothenburg (Invited Lecture)
10.30 - 11.00	*A strong theory of link and focus interpretation* Herman Hendriks, University of Utrecht
11.00 - 11.30	**break**
	Special Session on Information Packaging II
11.30 - 12.00	*Linkhood and multiple definite marking* Dimitra Kolliakou, University of Newcastle, Hebrew University of Jerusalem
12.00 - 12.30	*Unbounded dependencies and the syntactic realisation of Information Packaging* Theodora Alexopolou, University of Edinburgh
12.30 - 13.00	*Information Repackaging* Petr Kubon, Simon Fraser University
13.00 - 14.30	**break**
	Special Session on Information Packaging III
14.30 - 15.00	*Topic, adverbial quantification, and backwards anaphora* Ileana Comorovski, Universite de Nancy 2
15.00 - 15.30	*Information Packaging in Japanese* John Fry and Stefan Kaufmann, CSLI Stanford
15.30 - 16.00	*Topic and focus structures: The dynamics of tree growth* Wilfried Meyer-Viol and Ruth Kempson, Imperial College/University of London
16.00 - 16.30	**break**
	Regular Session I
16.30 - 17.00	*French subject inversion and extraction contexts* Olivier Bonami, Daniele Godard, Jean-Marie Marandin, CNRS
17.00 - 17.30	*Towards a General Theory of Partial Constituent Fronting in German* Kordula de Kuthy and Detmar Meurers, University of the Saarland/University of Tübingen
17.30 -18.00	*A relational approach to relativization in Turkish* Zelal Gungordu and Elisabet Engdahl, Bilkent University/University of Gothenburg

Saturday, August 15, 1998

	Regular Session II
9.30 - 10.00	*Minor and expletive pronouns* Frank Van Eynde, University of Leuven
10.00 - 10.30	*Noun phrases as NPs - The case of Hebrew* Shuly Wintner, University of Tübingen
10.30 - 11.00	*Determiners as nominal heads* Andreas Kathol, University of California, Berkeley
11.00 - 11.30	**break**
	Regular Session III
11.30 - 12.00	*Case, Obliqueness, and Linearization in Korean* Chan Chung, Dongseo University (Seoel)
12.00 - 12.30	*An informal sketch of a formal architecture for Construction Grammar* Paul Kay, University of California, Berkeley
12.30 - 13.00	*'A unified theory of scope' revisited* Adam Przepiorkowski, University of Tübingen and Polish Academy of Sciences
13.00 - 14.30	**break**
	Regular Session IV
14.30 - 15.00	*On certain properties of Romanian auxiliary (and modal) verbs* Paola Monachesi, University of Utrecht
15.00 - 15.30	*Categories, prototypes, and default inheritance* Robert Malouf, Stanford University
15.30 - 16.00	*Looks Like a Trojan Horse Got Into the Argument Structure* Emily Bender and Dan Flickinger, Stanford University
16.00 - 16.30	**break**
	Regular Session V
16.30 - 17.00	*A point-based event phonology for the phonetics-phonology interface* Peter Kuehnle and Petra Wagner, University of Bielefeld
17.00 - 17.30	*How to match the mismatch: prosody-syntax interface for Japanese spoken sentences* Kei Yoshimoto, Tohoku University (Sendai,Japan)
17.30 - 18.00	*Morphosyntactic and morphological paradoxa in Fox* Berthold Crysmann, University of the Saarland

Sunday, August 16, 1998

	Regular Session VI
10.30 - 11.00	*A weakly context free facet of LIGs* Jens Michaelis, Christian Wartena, University of Potsdam
11.00 - 11.30	*A formal interpretation of relations and quantifiers in HPSG* Frank Richter, Manfred Sailer, University of Tübingen
11.30 - 12.00	*Island effects in type-logical approaches to the Minimalist Program* Tom Cornell, University of Tübingen
12.00 - 14.00	**break**
	Symposium on Unbounded Dependencies
14.00 - 14.40	Ivan Sag, Stanford University
14.40 - 15.20	Annie Zaenen, Xerox Research Centre Europe
15.20 - 16.00	Anne Abeillé, University of Paris
16.00 - 16.30	**break**
16.30 - 17.10	Michael Moortgat, University of Utrecht
17.10 - 17.50	Ed Stabler, UCLA
17.50 - 18.30	discussion: Bob Carpenter, Lucent Bell Labs

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Part I

Special Session on Information Packaging

Chapter 1

Information Packaging and Information States

Elisabet Engdahl

[Vallduví, 1992] uses the term *information packaging* to refer to the way an utterance is structured given the speaker's beliefs and assumptions concerning the hearer, in particular what the hearer already knows and what s/he is attending to at the time of the utterance. Different languages use different realisation strategies to signal which part of an utterance conveys e.g. new information for the hearer, and which part should be understood as being part of the common ground. Some languages use prosodic contrasts as the prime means of signalling information packaging (English is a good example); other languages rely primarily on word order alternations, (e.g. the Romance languages); yet other languages use morphological cues (e.g. Japanese). Most languages use some combination of these different realisation strategies. From the point of view of linguistic theory it is important to realise that the information packaging strategies used in individual languages are systematic and that mastering them is an integral part of a speaker's competence. (See [Vallduví & Engdahl, 1996] for an overview of linguistic realisation strategies for information packaging.)

This way of looking at information packaging is inherently pragmatic, i.e. the informational distinctions which are conveyed by choosing a particular form of an utterance reflect the speaker's mental model of the hearer's mental model. I will refer to the mental models of the discourse participants as *information states*. In this talk I want to discuss some options for how a formal theory of information states can be integrated with a constraint-based linguistic theory. In [Engdahl & Vallduví, 1996] we exploited the fact that the CONTEXT field of a sign in HPSG allows pragmatic constraints to be integrated with phonological, syntactic and semantic aspects of the expression. Here I will explore further what distinctions need to be available in the representation of information states in order to account for phenomena like accenting and deaccenting, the choice of referring expressions and elliptical utterances.

Bibliography

[Engdahl & Vallduví, 1996] Elisabet Engdahl and Enric Vallduví, "Information packaging in HPSG'," in *Edinburgh Working Papers in Cognitive Science 12*, pp. 1-32, 1996.

Proceedings of FHCG'98
Gosse Bouma, Geert-Jan Kruijff & Richard Oehrle (editors).

[Vallduví, 1992] Enric Vallduví, *The informational component*. Garland, New York, 1992.

[Vallduví & Engdahl, 1996] Enric Vallduví and Elisabet Engdahl, "The linguistic realization of information packaging," *Linguistics 34-3*, pp. 459-519, 1996.

Chapter 2

A Strong Theory of Link and Focus Interpretation

HERMAN HENDRIKS

ABSTRACT. This paper deals with the interpretive significance of the basic information packaging concepts of *link* and *focus*. We will argue that a discourse-representation-theoretical approach yields a generalized theory of link and focus interpretation that may contribute to the integration of pragmatic theories of information packaging with work in formal semantics, since it provides a sound background for an analysis of the phenomenon commonly referred to as 'association with focus' that is also capable of handling the attested cases where 'focus-sensitive' expressions do *not* associate with the focus of the sentence. These include cases where such expressions associate with so-called 'second occurrence focus', with proper subparts of the focus, and with non-focal links.

1 Introduction

1.1 Information Packaging

The basic idea of information packaging is that speakers do not present information in an unstructured way, but that they provide a hearer with detailed instructions on how to manipulate and integrate this information according to their beliefs about the hearer's knowledge and attentional state. Consequently, truth-conditionally equivalent sentences that encode different information packaging instructions are not mutually interchangeable *salva felicitate* in a given context of utterance. It is this context-sensitivity which has traditionally placed information packaging within the realm of pragmatics. Vallduví's account of information packaging in [Vallduví, 1992] and [Vallduví, 1994] is a combination of two influential earlier pragmatic approaches, the topic/comment approach and the focus/ground approach. He distinguishes three parts in the way in which sentences package information: *focus*, *links* ($\approx$ topics) and *tails*. Together, links and tails constitute the *ground*. Sentences may lack a ground, but cannot do without a focus. The focus expresses the 'new' information to be processed in the hearer's information state, and the ground has an ushering role with respect to this information: links indicate *where* it goes, and tails indicate *how* it fits there. Thus the information of language users is supposed to be organized in files, which are represented as collections of file cards: the metaphor employed in the file change semantics of [Heim, 1982] is taken literally. Similar 'locational' theories of pragmatic aboutness are presented in [Reinhart, 1982] and [Erteschik-Shir, 1997].

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1.2 Sign-Based Categorial Grammar

Cross-language comparison shows that in expressing information packaging, different languages exploit the structural means of word order and prosody in various ways. Since information packaging involves syntax as well as prosody, any attempt to reduce information packaging to either syntax or prosody will be inadequate from a cross-linguistic point of view. Accordingly, the background of the present paper is an analysis of the different structural realizations of information packaging that is formulated in terms of a both intonationally/syntactically and semantically/informationally interpreted sign-based categorial grammar (cf. [Hendriks, 1996a]). This sign-based set-up takes its inspiration from [Oehrle, 1988] and shares characteristics with HPSG (see [Pollard & Sag, 1994]). The signs, the grammatical resources of the formalism, are Saussurian form-meaning units which reflect the fact that the dimensions of linguistic form and meaning contribute to well-formedness in an essentially parallel way:

$$\text{intonational term} \triangleleft \text{type} \triangleright \text{informational term}$$

The type calculus that functions as the proof-theoretic engine of the grammar represents sequents as composed of such multidimensional signs. This calculus represents phonological head/non-head dependencies in terms of a 'dependency' variant of the non-associative calculus Lambek [Lambek, 1961] that is enriched with unary modal operators, where the concomitant brackets serve as demarcations of specific intonational domains.

1.3 Defocusing Operators

On the *intonational/syntactic* side, the treatment of information packaging in this sign-based framework differs from most of its predecessors, in that it does not employ focusing operators, but, instead, makes use of 'defocusing' operators that license the presence of links and tails. Acccording to most approaches, focused constituents are semantic functors which take the non-focused part of the sentence as their argument. These analyses are based on arguments concerning so-called 'focus-sensitive' expressions such as *only*, *even*, *not* and *also*. However, [Vallduví, 1992] and [Vallduví & Zacharski, 1993] argue convincingly that 'association with pragmatic focus' is not an inherent semantic property of such expressions, which may express their semantics on partitions other than the focus/ground one—witness obvious and non-marginal cases of association with subparts of the informational focus, with links, and with other non-focal parts of the ground. This dissociation of the pragmatic focus/background distinction from issues of focus-sensitivity dispels the need of analyzing focused constituents as operators that semantically take scope over the non-focused parts of the sentence, which can be considered an advantage. As sentences may lack links and tails, such analyses do not immediately reflect the core status of the focus, which is the only non-optional part of a sentence. In some sense, then, all-focus sentences constitute the basic case, from which the cases where there is a ground are somehow derived.

1.4 Non-Monotonic Anaphora

On the *semantic/informational* side, the derivations of the grammar are interpreted into DRT (see [Kamp & Reyle, 1993]), a deviation from the approach of [Vallduví, 1994] which is motivated in [Hendriks & Dekker, 1995]. In the latter paper it is argued that the conclusion that 'the internal structure of information states which is, in fact, crucially exploited by the different information-packaging strategies used by speakers in pursuing communicative efficiency' ([Vallduví, 1994], page 7) is at least a system of file cards connected by pointers begs the question, and that, moreover, the idea that information states are such systems is problematic for various reasons. Therefore, [Hendriks, 1996b] proposes a 'non-locational' theory of aboutness as a special kind of anaphora, in which information states are modeled by means of discourse representation structures, which are ontologically less committed than the 'dimensionally richer' file card systems because they do not come with locations. This requires and leads to a different perspective on the function of links. They are argued to signal non-monotonic anaphora:

> The discourse referent Y of a link is anaphoric to an antecedent discourse marker X such that X does not denote a subset of the denotation of Y.

This hypothesis, which can be considered a partial—viz., for L+H* pitch accent—execution of the intonational-informational program that was outlined in [Pierrehumbert & Hirschberg, 1990] (see also [Hendriks, *to appear*]), subsumes 'non-identity' anaphora, correctional and contrastive stress, pronoun referent resolution, and restrictiveness of relatives and adjectives. Note that this transition to a non-locational notion of information state may proceed in the type-theoretical terms of [Muskens, 1993], who shows that DRT can be reduced to type theory, and hence connected to categorial proof theory in the standard fashion of the Curry-Howard isomorphism.

2 Link and Focus Interpretation

2.1 Alternative Semantics

In the present paper we will show that the resulting perspective on information packaging can be connected in an interesting way to the theory of alternative semantics presented in [Rooth, 1985] and [Rooth, 1992], presumably the most influential current theory of focus interpretation. In alternative semantics, syntactic phrases do not only get an ordinary semantic value, but are also assigned a second semantic value. This *focus semantic value* is a set of alternatives of the same type as the ordinary semantic value. The members of this set are, roughly speaking, obtainable from the ordinary semantic value of the phrase by making a substitution in the position(s) corresponding to the focused subphrase(s). In [Rooth, 1992], focus is interpreted by means of a binary operator $\sim$ which is adjoined to some constituent C containing a focus F. The containing constituent C is the first argument of $\sim$, and the second argument of the operator is a free variable , :

$$[_C \ldots \mathrm{F} \ldots] \sim ,$$

This variable , is constrained to be of the type either of members of the focus semantic value for C, or of sets of such members. The interpretation of $C \sim$, is as follows:

> $C \sim$, asserts the ordinary semantic value of C and presupposes
> (a) that , is a (pragmatically determined) subset of the focus semantic value of C containing both the ordinary semantic value of C and another distinct member (SET CASE); *or*
> (b) that , is a member of the focus semantic value of C distinct from the ordinary semantic value of C (INDIVIDUAL CASE).

The variable , is interpreted by being associated with some contextually available antecedent meaning. As Pulman notes, 'it is essentially interpreted as an anaphor' ([Pulman, 1997], page 77).

$$\textit{John likes } [_{\mathrm{F}}\textit{Bill}\,] \tag{2.1}$$

$$\textit{Who does John like?} \tag{2.2}$$

$$\{\textsc{like}(\text{john},x) \mid x \text{ is of type } e\} \tag{2.3}$$

$$\textsc{like}(\text{john},\text{bill}) \tag{2.4}$$

Thus in interpreting the sentence (18.1) in the context of the question (18.2), the free variable , will be associated with—i.e., instantiated as—the semantic value of the question, which is roughly specified in (18.3), so that the sentence asserts (18.4) and presupposes that (18.3) is a subset of the focus semantic value of the sentence. (It can be noted that in the present case it is actually identical to the focus semantic value.) By separating the interpetation of focus from the process of identifying the antecedent for the variable introduced by focus interpretation, a variety of focus phenomena is allowed to fall under a single principle: besides questions and answers, these include focus-sensitive expressions, contrasting phrases, scalar implicatures and bare remnant ellipsis.

2.2 Strong and Intermediate Versions of the Theory

[Rooth, 1992] distinguishes between what he calls a strong and an intermediate version of the theory of alternative semantics. The *strong* version of the theory entails—among other things—that there is no construction-specific stipulation of a focus-related effect in constructions containing focus sensitive expressions and predicts that association with focus is always optional. The 'coherent and only somewhat less attractive' [Rooth, 1992] *intermediate* alternative does allow lexical stipulation of focus, for instance in the presence of focuse-sensitive expressions.

[Rooth, 1992] seems to have a light methodological preference for the strong position, but the intermediate position is the one defended in [Rooth, 1996]. The present paper claims that—a modified version of—Rooth's strong theory of focus interpretation is to be preferred, not only because such a theory is 'maximally explanatory' [Rooth, 1992], but also because there are linguistic reasons for this preference.

2.3 Modification

We will propose two modifications. Firstly, we will argue that (b), the 'INDIVIDUAL CASE' clause in the interpretation of Rooth's focus operator $\sim$ (which is solely included in order to be able to account for contrasting phrases), should be dropped. This simplification considerably increases the elegance of the definition, but—as we will show—enhances its empirical adequacy as well, in that it actually leads to a better theory of what is known as 'contrast'. And secondly, we will adduce linguistic evidence for a simplification of the remaining 'set case' clause, which consists in doing away with the requirement that the contextually restricted subset of the focus semantic value must always contain the ordinary semantic value as a member.

2.4 Unification

Moreover, we will show that the resulting residual theory of the interpretation of focus—on account of which C $\sim$, (asserts the ordinary semantic value of C and) presupposes that , is a contextually restricted subset of the focus semantic value of C which contains a member distinct from the ordinary semantic value α of C, so that , merely is presupposed to be a non-subset of $\{\alpha\}$—can straightforwardly be *assimilated* with the theory of the interpretation of links which was sketched above, and which essentially claims that the discourse referent Y of a link must be anaphoric to a discourse marker X such that X does not denote a subset of the denotation of Y. The unified theory covers a wide range of phenomena, for just as the non-monotonic anaphora theory of link interpretation can be shown to have implications for the empirical domains of non-identity anaphora, contrastive stress, restrictiveness of modification by means of relative clauses and adjectives, pronoun referent resolution, and correction, Rooth's theory of focus interpretation sheds light on a range of apparently heterogeneous phenomena: questions and answers, focus-sensitive expressions, scalar implicatures, contrasting phrases, and bare remnant ellips.

3 Focus Insensitivity

3.1 Presuppositional Anaphora

In addition to the aforementioned advantages, we claim that having a unified theory of link and focus interpretation has the pleasant corollary that it admits an analysis of 'association with focus' which is capable of accounting for all attested cases where focus-sensitive expressions do *not* associate with the focus of the sentence in which they occur.

Basically, we will adopt a strong version of Rooth's theory in hypothesizing that association with focus is a special, presuppositional kind of anaphora. It is the anaphoric nature of the phenomenon that is responsible for the possibility of association of focus-sensitive expressions with what is known as 'second occurrence focus' and for the occurrence of what we will call 'Partee marble effects'. More specifically, we will claim that association with focus is an epiphenomenon of the fact that, due to the lexical semantics of focus-sensitive expressions, this anaphora is non-trivial if and only if it is non-monotonic—that is: non-subset—anaphora in the sense defined above. Thus for the focus-sensitive expression *only* we will make the standard assumption that it denotes the superset relation between two sets A and B:

$$\mathit{only}_E AB \text{ iff } A \supseteq B$$

Here A is the set $\{\alpha\}$ consisting of the denotation α of the expression a with which *only* is associated, and B is the (p-set-like) denotation of the 'rest' of the sentence S:

$$B = \{\, Y \mid [Y/a]\mathrm{S} \,\}$$

3.2 Contextual Restriction and Contrast

Along the lines of [De Hoop, 1995], moreover, we may assume that the context set X which functions as the antecedent of *only* serves as the contextual restriction in the sense of [Westerståhl, 1985] of the domain of quantification—that is: the argument on which the denotation of *only* lives. In the case of superset-denoting *only* this is the second argument, since $\mathit{only}_E AB$ if and only if $\mathit{only}_E (A \cap B)B$ (but not $\mathit{only}_E AB$ if and only if $\mathit{only}_E A(A \cap B)$!). This means that for the restricted denotation only_E^X of *only* it holds that $\mathit{only}_E^X AB$ if and only if $\mathit{only}_E A(B \cap X)$, i.e., if and only if $A \supseteq B \cap X$. The latter has an important consequence. Since $X \subseteq A$ if and only if for all B: $A \supseteq B \cap X$, we have that the contextual restriction of *only* is non-trivial if and only if $X \not\subseteq A$. For the focus-sensitive expressions *only* and *even*, the non-monotonic anaphora can be shown to display the characteristics of the contextual restriction that is known to play a role in the interpretation of quantificational determiners and adverbs, but we will present evidence that the same holds for items such as *also* and *not*, where the non-monotonicity usually surfaces as a contrast with a parallel element in the 'active context'.

3.3 Empirical Consequences

The above has some interesting linguistic ramifications. The hypothesis of lexically induced non-monotonic anaphora against the background of a unified theory of link and focus interpretation has the nice advantage that it is able to accommodate the ubiquity of association with focus, but it also accounts for the various forms of association with *non*-focus, which, we believe, are far less marginal than some authors have suggested. First, the strong tendency of expressions such as *only* to associate with the focus of the sentence can be clarified: for focal expressions a with denotation α, there is an accessible discourse referent X that denotes the context set: the 'implicit question' that is 'answered' by a. While usually—though not necessarily—this context set contains α, it invariably contains a—positive—number of alternatives to α, so that $X \not\subseteq \{\alpha\}$, which means that X is a suitable, non-trivial contextual restriction. Besides, the anaphora hypothesis is capable of handling the cases of association of focus-sensitive expressions with non-focal parts of the sentence. First, given that 'association with focus' is an instance of anaphora, the phenomenon of 'second occurrence focus' and, more specifically, the possibility of sentences with multiple focus-sensitive expressions is straightforwardly accounted for. Focus-sensitive expressions do not inherit their association with an expression from a previous sentence, but simply share their antecedent with another focus-sensitive expression, just as two anaphoric pronouns can have a common antecedent. Similarly, sentences with multiple focus-sensitive expressions are simply the counterparts of sentences with multiple pronouns with possibly different antecedents. And finally, the observed link-sensitivity of focus-sensitive expressions is easily explained in terms of the analysis of links as non-monotonic anaphora that was sketched above. On this analysis it holds that if an expression is a link, then its discourse referent Y is anaphoric to an antecedent discourse marker X such that X does not denote a subset of the denotation of Y. This means that links always come with their own suitable, non-trivial contextual restriction and can be readily associated with by 'focus-sensitive' expressions.

Bibliography

[Erteschik-Shir, 1997] Erteschik-Shir, N. (1997), *The Dynamics of Focus Structure*. Cambridge University Press.

[Heim, 1982] Heim, I. (1982), *The Semantics of Definite and Indefinite Noun Phrases*, Dissertation University of Massachusetts at Amherst. Published in 1989 by Garland, New York.

[Hendriks, 1996a] Hendriks, H. (1996a), 'Intonation, Derivation, Information. A Proof-Theoretic Framework for the Representation of Information Packaging'. In: M. Abrusci and C. Casadio (eds.), *Proofs and Linguistic Categories. Proceedings of the Third Roma Workshop*. Editrice CLUEB, Bologna.

[Hendriks, 1996b] Hendriks, H. (1996b), 'Information Packaging: From Cards to Boxes'. In T. Galloway and J. Spence (eds.), *Proceedings of Semantics And Linguistic Theory VI*, CLC Publications, Ithaca, New York.

[Hendriks, *to appear*] Hendriks, H. (*to appear*), 'L+H* Accent and Non-Monotonic Anaphora'. In R. Kager and W. Zonneveld (eds.), *Proceedings of the Utrecht Workshop on Phrasal and Prosodic Phonology*. Foris Publications, Dordrecht.

[Hendriks & Dekker, 1995] Hendriks, H., and P. Dekker (1995), 'Links without Locations', in P. Dekker and M. Stokhof (eds.), *Proceedings of the Tenth Amsterdam Colloquium*, ILLC, University of Amsterdam.

[De Hoop, 1995] Hoop, H. de (1995), '*Only* a Matter of Context?'. In M. den Dikken and K. Hengeveld (eds.), *Linguistics in the Netherlands 1995*. John Benjamins Publishing Company. Amsterdam.

[Kamp & Reyle, 1993] Kamp, H., and U. Reyle (1993), *From Discourse to Logic. Introduction to Modeltheoretic Semantics of Natural Language, Formal Logic and Discourse Representation Theory*, Kluwer, Dordrecht.

[Lambek, 1961] Lambek, J. (1961), 'On the Calculus of Syntactic Types'. In R. Jakobson (ed.), *Structure of Language and its Mathematical Aspects*. Providence.

[Muskens, 1993] Muskens, R. (1993), 'A Compositional Discourse Representation Theory'. In P. Dekker and M. Stokhof (eds.), *Proceedings of the Ninth Amsterdam Colloquium*. ILLC, University of Amsterdam.

[Oehrle, 1988] Oehrle, R. (1988), 'Multidimensional Compositional Functions as a Basis for Grammatical Analysis', in R. Oehrle, E. Bach and D. Wheeler (eds.), *Categorial Grammars and Natural Language Structures*, Reidel, Dordrecht.

[Pierrehumbert & Hirschberg, 1990] Pierrehumbert, J., and J. Hirschberg (1990), 'The Meaning of Intonational Contours in the Interpretation of Discourse', in P. Cohen, J. Morgan and M. Pollack (eds.), *Intentions in Communication*, MIT Press, Cambridge.

[Pollard & Sag, 1994] Pollard, C., and I. Sag (1994), *Head-Driven Phrase Structure Grammar*, University of Chicago Press, Chicago, and CSLI, Stanford.

[Pulman, 1997] Pulman, S. (1997), 'Higher Order Unification and the Interpretation of Focus', *Linguistics and Philosophy* **20**.

[Reinhart, 1982] Reinhart, T. (1982), 'Pragmatics and Linguistics: An Analysis of Sentence Topics', *Philosophica* **27**.

[Rooth, 1985] Rooth, M. (1985), *Association with Focus*, Dissertation University of Massachusetts at Amherst.

[Rooth, 1992] Rooth, M. (1992), 'A Theory of Focus Interpretation'. *Natural Language Semantics* **1**.

[Rooth, 1996] Rooth, M. (1996), 'On the Interface Principles for Intonational Focus', in T. Galloway and J. Spence (eds.), *Proceedings of Semantics And Linguistic Theory VI*, Cornell University.

[Vallduví, 1992] Vallduví, E. (1992), *The Informational Component*, Garland, New York.

[Vallduví, 1994] Vallduví, E. (1994), 'The Dynamics of Information Packaging', in E. Engdahl (ed.) (1994), *Integrating Information Structure into Constraint-based and Categorial Approaches*. ESPRIT Basic Research Project 6852, Dynamic Interpretation of Natural Language. DYANA-2 Deliverable R1.3.B. ILLC, University of Amsterdam.

[Vallduví & Zacharski, 1993] Vallduví, E., and R. Zacharski (1993), 'Accenting Phenomena, Association with Focus, and the Recursiveness of Focus-Ground'. In P. Dekker and M. Stokhof (eds.), *Proceedings of the Ninth Amsterdam Colloquium*. ILLC, University of Amsterdam.

[Westerståhl, 1985] Westerståhl, D. (1985), 'Determiners and Context Sets'. In J. van Benthem and A. ter Meulen (eds.), *Generalized Quantifiers in Natural Language*.

Chapter 3

Linkhood and Multiple Definite Marking

DIMITRA KOLLIAKOU

ABSTRACT. This paper discusses a definite construction from Modern Greek, henceforth a *polydefinite*, which is associated with contextual constraints that go beyond the uniqueness presupposition of standard definites. I argue that the idiosyncratic syntax of polydefinites achieves effects similar to those induced in other languages solely by prosodic means and illustrated by phenomena subsumed within the term *deaccenting*. I explicate the semantic-pragmatic import of polydefinites in terms of *non-monotone anaphora* and Vallduví's notion of *linkhood* (cf. e.g. Vallduví 1992, Vallduví and Engdahl 1996), as revised by Hendriks and Dekker 1996. Given the view that polydefinites are links in the Hendriks & Dekker sense of the term, I explore how they relate to a broader theory of the prosodic or structural realization of information packaging – in particular, one expressed in HPSG by Engdahl and Vallduví 1994, Engdahl and Vallduví 1996.

1 Basic data – problems to previous accounts

Modern Greek exhibits two modification strategies in definite NPs: an 'English-style' one, with attributive adjectives linearly preceding the N head, and a single definite article in the left periphery – such definites will be referred to as monadics, and a 'Semitic-style' one, i.e., a strategy reminiscent of languages with multiple definite determiner systems such as Semitic, Balkan and Scandinavian; the latter type of definites will be referred to as polydefinites. The two strategies are illustrated in (1a,b) and (1c,d), respectively.

(1) a. to kokino podilato
the-NEUT.SG red-NEUT.SG bike-NEUT.SG
'the red bike'

b. *to podilato kokino

c. to kenurio to podilato
the-NEUT.SG new-NEUT.SG the-NEUT.SG bike-NEUT.SG
'the new bike'

d. to kenurio podilato to kokino
the new bike the red
'the new red bike'

Previous approaches to Greek NPs (cf. e.g. Stavrou 1996, Androutsopoulou 1995) assume a unified structure for monadics and polydefinites, with the definite article

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being construed as syntactically distinct from quantifier determiners (and demonstratives) – which are generated under D^0 – and heading a more embedded functional projection DefP (for Definiteness Phrase):

(2) a. [DP D^0 [DefP Def^0 to [AP Adj^0 kenurio [NP ... podilato ...]]]]

b. [DP D^0 [DefP Def^0 to [AP Adj^0 kenurio [DefP Def^0 to [AP Adj^0 kokino [DefP Def^0 to [NP ... podilato ...]]]]]]]

However, this type of analysis encounters a number of problems, which include: (a) the repetitive occurrence of functional (or lexical) projections is normally blocked; e.g. in Minimalist terms, the grammatical features borne by redundant phrases would remain 'unchecked', thus giving rise to ungrammaticality; (b) monadics and polydefinites exhibit distinct linear order patterns (with adjectives exclusively appearing pre-nominally in monadics (1a,b), but being free to occur pre- or post-nominally in polydefinites (1c,d)); Androutsopoulou stipulates optional movement of a DefP dominating NP past an originally prenominal AP onto a higher specifier position, but admits that it is not clear what the trigger of such movement might be, or what prevents similar types of movement from applying to monadics; (c) the two constructions are not semantically identical, as the unified analysis takes them to be (e.g. Androutsopoulou has to assume that all definite articles in a polydefinite but one are expletives): polydefinites do not freely alternate with monadics, rather, the former are felicitous in only a subset of the contexts where the latter may occur.

To illustrate the semantic difference between the two, let us take a look at *deaccenting*. In the dialogue in (3) below, from Vallduví and Zacharski 1993, *a blue shirt* and *a red shirt* in (3b&d), respectively, are both *informational foci* (*relational* new information) of the sentences they occur in. Nonetheless, they are prosodically different: in the former, the nuclear accent (marked with small capitals) falls on the noun, whereas in the latter, the noun is 'deaccented', and the accent lands instead on the adjective. Vallduví and Zacharski argue that the exact placement of focal pitch accent within the focal constituent can be due to the interaction of a number of factors, including *deaccenting*, which is in turn associated with some anaphoric device of concept-givenness – in case of (3d), shirts are 'given', for they have already been mentioned once in the previous discourse.

(3) a. Ann: What did you get Ben for Christmas?
b. Clara: I got him [FOCUS a blue SHIRT].
c. Ann: What did you get Diane?
d. Clara: I got her [FOCUS a RED shirt].

There exists an interesting parallel between deaccenting and polydefinites, which is illustrated in the dialogue in (4). All the bracketed NPs in (4b, b′, b″, d, d′, d″) are focal; however, a polydefinite or a deaccented monadic are infelicitous in the context of (4a) (see (4b′, b″)), but constitute the only felicitous options in the context of (4c) (see infelicitous (4d″)). These data suggest that polydefinites (like deaccented monadics) are felicitous *only* in contexts which involve some notion of contrast with some salient alternatives in discourse.

(4) a. Zoe: Ti pires tu Yanni gia ta Xristugena?
('What did you get Yiannis for Christmas?')

b. Daphne: Tu pira [tin asimenia PENA].
(I-got him the silver pen; 'I got him the silver PEN.')
b′. # Tu pira [tin pena tin asimenia].
(lit.: # I-got him the pen the silver)
b″. # Tu pira [tin ASIMENIA pena]. (# 'I got him the SILVER pen.')
c. Zoe: Ti pires tis Marias? ('What did you get Maria?')
d. Daphne: Tis pira [tin pena ti xrisi].
(lit.: I got her the pen the gold)
d′. Tis pira [ti XRISI pena]. ('I got her the GOLD pen.')
d″. # Tis pira [ti xrisi PENA]. (# 'I got her the gold PEN.')

Further data show that *explicit* contrast between one (or more) alternatives is not a necessary condition for felicitously employing a polydefinite. Rather, it suffices that the polydefinite 'narrow down' a given pool of referents by picking out a proper subset of it. (5a) below (based on an example from Hendriks and Dekker 1996), with a monadic definite *i mikres gates*, is a priori four-way ambiguous, depending on (a) whether *gates* is accented and construed as *subsectionally anaphoric* to *ta zoa* (thus implying that Yannis fed at least one non-cat), or unaccented, with the set of animals Yannis fed being understood to entirely consist of cats, and (b) whether *mikres* is interpreted as restrictive or nonrestrictive, and being accented or unaccented, respectively. (5a) can thus entail (a) that all the animals John fed were young cats, (b) that all the animals John fed were cats, but there were young and non-young cats, (c) that John fed cats and non-cats, and all of the cats were young, and (d) that John fed cats and non-cats, and there were young and non-young cats. Interestingly, in (5b), where the monadic is replaced by a polydefinite, two of the four readings – those that involve a non-restrictive interpretation for the adjective *i mikres* – are lost. (5b) can therefore signify solely either (a) that all the animals John fed were cats, but there were young and non-young cats, or (b) that John fed cats and non-cats, and there were young and non-young cats. Such evidence also shows that the restrictive import of the polydefinite construction is not affected by the presence of independent contrasts.

(5) a. O Yannis taise ta zoa. *I mikres gates* itan pinasmenes. ('John fed the animals. The young cats were hungry.') All four readings.

b. O Yannis taise ta zoa. *I mikres i gates* itan pinasmenes. ('John fed the animals. The young cats were hungry.') Two readings only.

2 Polydefinites as *links*

To account for the special import of polydefinites, I rely on an extended notion of linkhood explicated by Hendriks and Dekker 1996. Hendriks and Dekker propose a unified treatment of (a) non-monotone anaphora phenomena (including subsectional and relational anaphora, cf. e.g. Deemter 1994), (b) (contrastive) links (cf. e.g. Engdahl and Vallduví 1994), and (c) restrictive adjectives and relatives – all three being uniformly characterized in English by the so-called B Accent (L+H* pitch accent). Their Kamp-style system for modelling information states enables linkhood to be stated as a condition on discourse referents, as in (6). Thus, they arguably circumvent the problems they raise for Vallduví's Heim-style approach, which relies on a notion less well understood, that of a file-card that provides 'the current locus of information update'.

(6) *Hendriks and Dekker's Non-Monotone Anaphora Hypothesis:* Linkhood (marked by B Accent) serves to signal non-monotone anaphora. If an expression is a link, then its discourse referent Y is anaphoric to an antecedent discourse referent X, such that X $\not\subseteq$ Y.

In the analysis proposed herein, monadic definites are viewed as potentially ambiguous between a monotone anaphoric and a non-monotone anaphoric reading, with prosody disambiguating between the two, like in English. Polydefinites, on the other hand, are unambiguously non-monotone anaphoric – *links*, in the sense of Hendriks and Dekker. From this follow a number of consequences.

First, we can maintain Vallduví's conjecture that there are no 'subordinate' *informational* foci – a (simplex) sentence allows for only one informational focus, though there may be sentences with multiple *prosodic* foci (see also Vallduví and Zacharski 1993).[1] Therefore, the proposed analysis is not susceptible to problems that pertain to accounts which posit subordinate foci (cf. e.g. Rooth 1992, Krifka 1991-92, Erteschik-Shir 1997); in the latter, the definite adjectives of polydefinites (and similarly for the accented adjective in deaccented monadics) would be presumably viewed as foci embedded within a topic, as shown in (7):

(7) a. Speaker A: What did Bill's sisters do?
Speaker B: [$_T$ Bill's [$_F$ YOUNGEST] sister] [$_F$ kissed John]
(From Krifka 1991-92)

b. [[I mikres]$_{FOC-sub}$ [i gates]$_{TOP-sub}$]$_{TOP}$ [ine eksipnes]$_{FOC}$
the young the cats are intelligent; 'the YOUNG cats are intelligent'
(using Erteschik-Shir's terminology)

However, the pitch accent associated with *youngest* / *i mikres* in (7a,b) is the B accent characteristically pertaining to topics, which is incompatible with an analysis of such elements as foci. In addition, the subordinate focus analysis is not supported by crosslinguistic evidence: if *youngest* and *i mikres* were pragmatic foci, we would expect them to be realized as such (possibly by non-prosodic means) across languages. However, this is not the case as was shown by Vallduví and Zacharski 1993 and Ladd 1996, for Catalan and Italian, respectively: such languages resist deaccenting altogether.

Second, the analysis of polydefinites (and deaccented monadics) as links, in the Hendriks and Dekker sense of the term, is compatible with their being or contributing to the focus or to the ground in the overall informational structure; linkhood being specified as a CONTEXT | BACKGROUND *psoa* (see below) that constrains the index to be anchored to an entity that forms a proper subset of a group previously introduced in discourse. This is a desirable conclusion, since polydefinites can be shown to constitute (or be part of) the focal constituent, as e.g. in (4d) above, or the ground, as e.g. in case of (5b), where *i mikres i gates* functions as a (contrastive) link, in the sense of Vallduví.

[1] Vallduví & Zacharski show that accounts positing embedded foci rely on either of the following two false assumptions: (a) that all prosodic foci are informational foci, and (b) that quantificational nuclei of focus-sensitive operators like *even* or *only* must be informational foci.

Third, the otherwise puzzling fact that non-intersective adjectives are admissible only in monadics, and not in polydefinites (as shown in (8) below), directly follows. Within the Montagovian tradition (see e.g. Siegel 1976), only intersective adjectives denote a property that the referent of the NP is required to instantiate. Non-intersective adjectives, on the other hand, are assigned quite different semantics: they are taken to denote a property that takes another property as its argument, and identifies a kind of entity or event. The semantics of non-intersective adjectives therefore clashes with that of polydefinites: by its presence in a polydefinite construction, *ipotithemeni* is required to pick out a proper subset of the set of terrorists – those that are 'alleged'. However, *ipotithemeni* cannot denote 'alleged' entities at all, rather it identifies entities that are allegedly terrorists.

(8) i ipotithemeni tromokrates ('the alleged terrorists') VS *i ipotithemeni i tromokrates

Fourth, once the idiosyncratic import of polydefinites is acknowledged, polydefinites' kinship to close apposition – which was noticed long ago (e.g. Stavrou 1991) – follows very naturally. It is well-known that NPs in close apposition are restrictive: the phrase *my brother the lawyer* entails that I have at least another brother, who is not a lawyer. In that respect, NPs in close apposition are quite different from NPs in loose apposition, the latter involving a uniqueness presupposition for the denotation of the NP they are associated with. It will be shown that close apposition (unlike loose apposition) entails non-monotone anaphora.

Finally, a treatment of polydefinites and monadics as two distinct constructions, on semantic-pragmatic grounds, will enable a straightforward account of the distinct linear order patterns to be provided. Given the observation that languages with a (true) multiple definite determiner system exhibit only one N-Adj order, the same one everywhere, as e.g. shown in (9) below for Hebrew, the case of Greek definites need not be taken to constitute an exception. Rather, polydefinites will be shown to be syntactically on a par with nominals that consist of a head and an adnominal modifier.

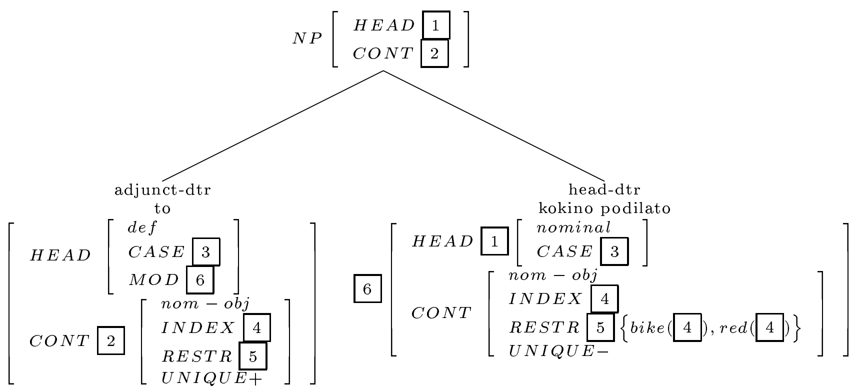
(9) a. ha-sefer ha-adom (the-book the-red; 'the red book')
b. *ha-adom ha-sefer
c. sefer adom (book red; 'a red book')
d. *adom sefer

3 An HPSG analysis

In the analysis proposed herein, monadics and polydefinites are treated as two distinct constructions as far as their internal syntax is concerned. Polydefinites (but also deaccented monadics) are differentiated from 'canonical' non-deaccented monadics as far as their context specification is concerned.

Monadics are assigned an internal structure very close to the one proposed for English NPs in Pollard and Sag 1994, modulo a treatment of the definite article inspired by the approach to functional heads provided in Netter 1994. Unlike Netter, who models the difference between 'functional' (minor) and 'lexical' (major) nominal heads in terms of partial clash in head feature specification, the Greek definite article and phrases with a head value of sort *nominal* (the latter subsumes both *noun* and *adjective*, for reasons exposited in Kolliakou 1995 and elsewhere, and corresponds to the supercategory the definite article syntactically combines with) are differentiated by means of their content value: both are specified for a content value of sort *nom-obj*, but the definite article introduces a further constraint on the anchoring of the index: definite NPs (or APs) are specified UNIQUE+ (UNIQUE being a novel attribute of *nom-obj*), and are thus constrained to pick out a uniquely instantiable property in a certain local setting (the *resource situation*). Bare indefinites, on the other hand, are specified UNIQUE⇔, which signifies that no such constraint applies; this way, we express in HPSG terms the Situation Semantics approach to definiteness of Gawron and Peters 1990. The UNIQUE+ specification is the essential contribution of the definite article to the nominal it appears in, and is instantiated on the mother as a consequence of the Semantics Principle: the definite article is modelled as an adjunct that incorporates the restrictions of its nominal sister and adds the uniqueness presupposition. (This account is briefly illustrated in the tree in (10) below.) Notice that lack of any other syntactic specification for distinguishing between 'determinerful' definite nominals and 'determinerless' bare indefinites is consistent with the fact that all types of bare indefinites in Greek (including singular count terms) can qualify as syntactic arguments of nominal-taking verbs. (For details, see Kolliakou 1995, Kolliakou 1996, Kolliakou 1998, Kolliakou in preparation).

(10)



Definite APs of polydefinites are assigned a syntactic status similar to that of adjuncts to N^{max} (cf. Sadler and Arnold 1994), or reduced relatives, in the sense of Sag 1997. In particular, they are required to modify definite NPs, i.e. phrases with a head value of sort *noun*, empty valence features, and that are specified UNIQUE+. The category and content specification of a polydefinite is not any different from that of its monadic counterpart, thus allowing for iteration of definite APs in the former construction. An analysis a la Sag 1997 in terms of construction type specification, allows us to generalize over the commonalities between definite APs of polydefinites and other types of 'adnominal' modifiers, e.g. (a) predicative adjectives in the sense of Bolinger, as in *the rivers, impassable in the winter, ...* (noticeably, predicative APs in Greek can appear both pre- and post-nominally, exactly like definite APs in polydefinites, and it has been previously proposed that they should be viewed as modifiers of maximal nominal projections, cf. Stavrou 1996); (b) NPs in close apposition, e.g. *my brother the lawyer*, and (c) participles functioning as reduced relatives, e.g. *a man sitting on the bench.* NP-internal adjectives of monadics (which have been argued independently to be syntactic heads rather than adjuncts, cf. Kolliakou 1998) are constrained (by a linear precedence statement) to preceed their nominal (NP or AP) sister; on the other hand, adnominal modifiers of polydefinites are unconstrained and can preceed or follow the NP head.

The difference between a polydefinite and its 'canonical', non-deaccented monadic counterpart lies in their context specification. Polydefinites and deaccented monadics bear an additional restriction specified in their CONTEXT | BACKGROUND attribute (see (11a)), which is not relevant for monotone anaphoric nominals (e.g. 'canonical' non-deaccented monadics) (see (11b)). The restriction requires their index to be anchored to an entity that is included in, i.e. forms a proper subset of, a group previously introduced in discourse. Thus, in (11a), which illustrates the content and context attributes of the polydefinite *i gates i mikres* (or, equivalently, a deaccented monadic *i* MIKRES *gates*), the value of the argument SUBSET of the *include-in* relation is identified with the value of the index $\boxed{1}$, whereas the value $\boxed{2}$ of the other argument SUPERSET stands for an antecedent discourse referent such that $\boxed{1} \subset \boxed{2}$. In (11b), for the canonical *i mikres gates*, the background set is empty.

(11) a.
$$\begin{bmatrix} CONTENT & \begin{bmatrix} INDEX\ \boxed{1} \\ RESTR \left\{ \begin{bmatrix} RELN\ cat \\ INST\ \boxed{1} \end{bmatrix}, \begin{bmatrix} RELN\ young \\ INST\ \boxed{1} \end{bmatrix} \right\} \\ UNIQUE + \end{bmatrix} \\ CONTEXT \mid BACKGROUND & \left\{ \begin{bmatrix} include-in \\ SUPERSET\ \boxed{2} \\ SUBSET\ \boxed{1} \end{bmatrix} \right\} \end{bmatrix}$$

b.
$$\begin{bmatrix} CONTENT & \begin{bmatrix} INDEX\ \boxed{1} \\ RESTR \left\{ \begin{bmatrix} RELN\ cat \\ INST\ \boxed{1} \end{bmatrix}, \begin{bmatrix} RELN\ young \\ INST\ \boxed{1} \end{bmatrix} \right\} \\ UNIQUE + \end{bmatrix} \\ CONTEXT \mid BACKGROUND\ \{\} & \end{bmatrix}$$

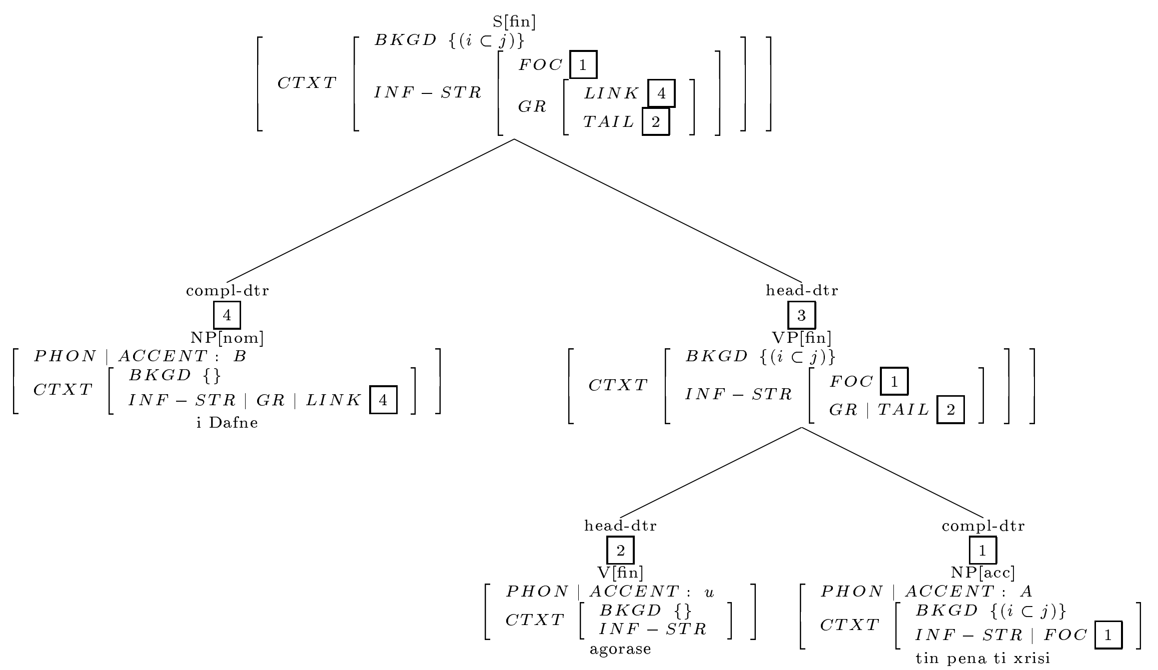
I assume that the background restriction in (11a) originates from the definite adjective *i mikres*, in case of a polydefinite, and the accented adjective *mikres*, in case of a deaccented monadic. This can be stated by construction type specification: a Greek definite adjective (*i mikres*) is required to satisfy the constraint in (12) below, and thereby be specified for the *include-in* psoa, which is subsequently passed on the context attribute of the phrase the adjective appears in, and from there propagates up, by some version of the Principle of Contextual Consistency (cf. Pollard and Sag 1994). I do not attempt to pin the non-monotonicity constraint onto the 'extra' definite article of the polydefinite, thus postulating two sets of homonymous, albeit semantically distinct forms of the definite article for Greek: this is because the very same constraint is borne by deaccented monadics that contain a single article – presumably, one introducing the uniqueness constraint a la Gawron and Peters – and is prosodically expressed by the accent of their (indefinite) adjective. The background restriction of deaccented monadics can thus be due to a constraint similar in spirit to (12) that associates ACCENT B (viewed as an attribute of PHONOLOGY) with the background *include-in* psoa, in a way reminiscent of Engdahl & Vallduví's constraint that enforces the correlation between accenting and (their own notion of) linkhood (as a partition of GROUND).

(12) $$\textit{def-adj-link} \Rightarrow \begin{bmatrix} CATEGORY \mid HEAD\ adj \\ CONTENT \begin{bmatrix} INDEX\ i \\ UNIQUE+ \end{bmatrix} \\ CONTEXT \mid BACKGROUND\ \{(i \subset j)\} \end{bmatrix}$$

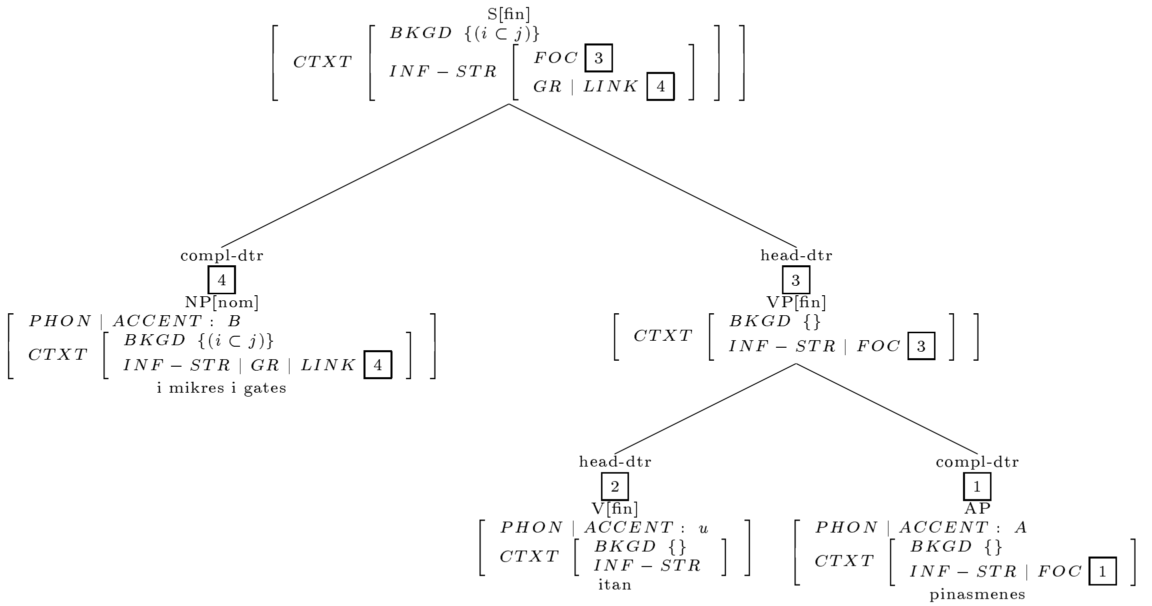
Information packaging in Engdahl and Vallduví 1994, Engdahl and Vallduví 1996 is represented as part of the CONTEXT (CTXT) attribute. The values of FOCUS (FOC) and GROUND (GR) of *info-struct (inf-str)* are instantiated through structure-sharing with those constituents that realize the focus and the ground parts of the instruction, respectively. The polydefinites in (13) and (14) are associated (a) with focus and ground informational contribution, respectively – which they pass on the overall information structure of the sentence they occur in by Engdahl and Vallduví's INFO-STRUCT instantiation constraints – and (b) with the *include-in* contextual restriction which they propagate up by Pollard & Sag's Principle of Contextual Consistency.

(13) *Polydefinite as object NP focus:*

... (context where pens are mentioned)
A: Kai ti agorase i Dafni? ('And what did Daphne buy?)
B: I Daphne agorase tin pena tin xrisi. (Daphne bought the pen the gold; 'Daphne bought the gold pen')



(14) *Polydefinite as link in S with VP focus:* (see (5b))



4 Conclusion

Modern Greek monadic definites and polydefinites should not be unified: they differ both semantically and syntactically. Polydefinites signal non-monotone anaphora whereas monadics can be monotone or non-monotone anaphoric. A treatment of polydefinites (and deaccented monadics) as *links* (in the Hendriks and Dekker 1996 sense) is compatible with their being or contributing to the focus or to the ground in the overall informational structure, and does not require positing subordinate foci. In HPSG terms, linkhood can be expressed as a restriction on the anchoring of the index, specified inside the CONTEXT attribute. Thereby, it is entirely compatible with the broader theory of information packaging proposed by Engdahl and Vallduví. An analysis inspired by Netter's 1994 account of functional heads and which expresses in HPSG terms Gawron and Peters's 1990 Situation Semantics approach to definiteness is applicable to both types of definites. Syntactically, definite APs of polydefinites are adjuncts to N^{max}, unlike adjectives of monadics which have been argued elsewhere to be heads selecting for a nominal (NP or AP) complement.

Bibliography

Androutsopoulou, A.: 1995, The Licensing of Adjectival Modification, in *Proceedings of the 14th West Coast Conference on Formal Linguistics*, CSLI, Stanford

Deemter, K. v.: 1994, What's New? A Semantic Perspective on Sentence Accent, *Journal of Semantics* 11

Engdahl, E. and Vallduví, E.: 1994, Information packaging and grammar architecture, in E. Engdahl (ed.), *Integrating informational structure into constraint-based and categorial approaches*, ILLC, Amsterdam

Engdahl, E. and Vallduví, E.: 1996, Information packaging in HPSG, in C. Grover and E. Vallduví (eds.), *Studies in HPSG*, Centre for Cognitive Science: Edinburgh

Erteschik-Shir, N.: 1997, *The Dynamics of Focus Structure*, CUP, Cambridge

Gawron, M. and Peters, S.: 1990, *Anaphora and Quantification in Situation Semantics*, CSLI Publications, Stanford

Hendriks, H. and Dekker, P.: 1996, Links without Locations: Information Packaging and Non-Monotone Anaphora, in *Proceedings of the 10th Amsterdam Colloquium*, ILLC/Department of Philosophy, Amsterdam

Kolliakou, D.: in preparation *Issues in NP Grammar: a constraint-based approach*, CSLI Publications, Stanford

Kolliakou, D.: 1995, *Definites and Possessives in Modern Greek: an HPSG syntax for Noun Phrases*, PhD dissertation, University of Edinburgh

Kolliakou, D.: 1996, Definiteness and the Make-up of Nominal Categories, in C. Grover and E. Vallduví (eds.), *Studies in HPSG*, Centre for Cognitive Science: Edinburgh

Kolliakou, D.: 1998, A Composition Approach to Modern Greek 'Weak Form' Possessives, in G. Webelhuth, A. Kathol, and K. Jean-Pierre (eds.), *Lexical and Constructional Aspects of Linguistic Explanation*, CSLI: Stanford

Krifka, M.: 1991-92, A Compositional Semantics for Multiple Focus Constructions, *Linguistische Berichte*, 17–53

Ladd, R.: 1996, *Intonational Phonology*, Cambridge University Press, Cambridge

Netter, K.: 1994, Towards a Theory of Functional Heads: German nominal phrases, in J. Nerbonne, K. Netter, and C. Pollard (eds.), *German in Head-driven Phrase Structure Grammar*, CSLI Publications, Stanford

Pollard, C. and Sag, I.: 1994, *Head-driven Phrase Structure Grammar*, CSLI Publications, Chicago

Rooth, M.: 1992, A Theory of Focus Interpretation, *Natural Language Semantics*, 75–116

Sadler, L. and Arnold, D.: 1994, Prenominal Adjectives and the Phrasal/Lexical Distinction, *Journal of Linguistics* 30, 187–226

Sag, I.: 1997, English Relative Clause Constructions, *Journal of Linguistics*

Siegel, M.: 1976, *Capturing the Adjective*, PhD dissertation, UMass: Amherst, MA

Stavrou, M.: 1991, Nominal Apposition: more evidence for a DP analysis of NP., in J. Payne (ed.), *Empirical Approaches to Language Typology*, Mouton de Gruyter, Berlin

Stavrou, M.: 1996, Adjectives in Modern Greek: an instance of predication

or an old issue revisited, *Journal of Linguistics* 32, 79–112
Vallduví, E.: 1992, *The Informational Component*, Garland, New York
Vallduví, E. and Engdahl, E.: 1996, The Linguistic Realization of Information Packaging, *Linguistics* 34, 459–519
Vallduví, E. and Zacharski, R.: 1993, Accenting phenomena, association with focus, and the recursiveness of focus-ground, in *Proceedings of the 9th Amsterdam Colloquium*, ILLC/Department of Philosophy, Amsterdam

Chapter 4

Unbounded Dependencies and the Syntactic Realisation of Information Packaging

THEODORA ALEXOPOULOU

ABSTRACT. This[1] paper focuses on languages employing the structures known as Topicalisation, Focus movement and Clitic Left Dislocation to encode Information Packaging. I argue that these structures share the same underlying syntax which can be captured by Unbounded Dependencies (UDCs) in HPSG. Thus, one syntactic mechanism, UDC, is available for more than one discourse function (focus-topic). I sketch an account of Information Packaging for Greek, a language exploiting UDCs for this purpose, based on Engdahl & Vallduví (1996).

1 Data

In Greek, as in Hungarian, Information Packaging is encoded through word order and intonation. Both languages display the structures known as Topicalisation and Focus-movement, which allow topics[2] and focused constituents to appear preverbally. Consider the following from Hungarian (Kiss 1995); small caps indicate nuclear accent placement:

(4.1) Janos EVAT varta a mozi elott
John Eve-acc waited the cinema in-front-of
'John waited for EVE in front of the cinema'

In (4.1) the accented NP, *Evat*, instantiates narrow focus while the non-accented *Janos* is a topic. The following examples illustrate similar structures in Greek:

(4.2) a. tin PARASTASI skinothetise o Dimitris Potamitis
the performance-ACC directed-3SG the Dimitris Potamitis-NOM
'Dimitris Potamitis directed the performance'

b. tin parastasi skinothetise o Dimitris POTAMITIS
the performance-ACC directed-3SG the Dimitris Potamitis-NOM
'Dimitris Potamitis directed the performance-The performance was directed by Dimitris Potamitis'

[1]I am indebted to my supervisors Caroline Heycock and Ronnie Cann, as well as, Claire Grover, Dimitra Kolliakou and two anonymous reviewers. All errors are mine.

[2]I use *topic* in the sense of *link* as defined in Vallduví & Engdahl (1996).

Example (4.2a) displays Focus-movement and (4.2b) Topicalisation of the object NP, *tin parastasi*. Preverbal focus in Greek (4.2a) is narrow and very often gives rise to a contrastive reading. As the availability of contrastive readings does not interfere with focus assignment it will not be discussed in this paper. Postverbal focus is also available in Greek. Unlike preverbal focus, which is always narrow, accent on the postverbal subject in (4.2b) is ambiguous between narrow and VP focus. Greek is claimed to have VSO as basic order (Tsimpli 1995; Alexopoulou 1998b). Thus, the postverbal subject in (4.2b) appears in-situ.

Though Topicalisation of objects is available in Greek (4.2b), most often object topics participate in Clitic Left Dislocation (CLLD):

(4.3)	tin parastasi	*tin*	skinothetise	o	Dimitris	POTAMITIS
	the performance-ACC	it-CL	directed-3SG	the	Dimitris	Potamitis-NOM

It is worth pointing out that *doubling* (in CLLD and Clitic Doubling) is a process of discourse-linking distinct from Information Packaging (Alexopoulou 1998b). Crucially, (4.2b) and (4.3) have the same Information Structure, but differ minimally in that in (4.3) the object is doubled.

Topicalisation, CLLD and Focus-movement may involve long distance extraction; the following display long distance Focus-movement and CLLD:

(4.4)	a.	to YANI	ipe	oti	apelisan	
		the Yani-ACC	said-3SG	that	fired-3PL	
		'S/he said that they fired Yanis'				
	b.	to Yani	ipe	oti	*ton*	APELISAN
		the Yani-ACC	said-3SG	that	him-CL	fired-3PL
		'S/he said that they fired Yanis'				

Adjuncts may also undergo long distance Topicalisation or Focus-movement:

(4.5)	a.	me	kokini	mpoya	ipe	oti	tha	vapsi	ta PARATHIRA
		with	red	paint	said-3SG	that	will	paint-3SG	the windows
		'S/he said that s/he will paint the windows with red paint'							
	b.	me KOKINI mpoya ipe oti tha vapsi ta parathira							

2 Discourse Configurational Approaches

In the literature, the discourse functions of Topic and Focus have been associated with preverbal Functional Projections (Kiss 1995; Rizzi 1995; Tsimpli 1995; Iatridou 1995). Topics and foci move to the Specifier position of the relevant discourse phrases to check their discourse features. Furhtermore, Focus-movement is analysed as A-bar movement, which is quantificational in nature, and Topicalisation as A-movement, which is anaphoric in nature (Kiss 1995; Lasnik & Stowell 1991; Rizzi 1995). This distinction is based on contrasts in weak crossover effects (wco). Focus gives rise to wco effects but Topicalisation does not. Finally, CLLDed elements are base generated at the Specifier of some preverbal projection (Cinque 1990; Iatridou 1995; Tsimpli 1995). In sum, Discourse Functions are encoded in Phrase Structure. The term *Discourse Configurational Languages* has been recently coined for languages expressing topic-focus distinctions through structural operations (Kiss 1995).

By encoding Discourse Functions in Phrase Structure, Discourse Configurational Approaches fail to account for various mismatches beteen syntax and Information Structure (IS). For example, it has been observed that, unlike syntax, IS is not organised in a recursive way (Heycock 1993; Vallduví & Zacharski 1994; Alexopoulou 1998a). Further, Focus does not obey subjacency (Rooth 1996; Giannakidou 1997). Finally, by associating Topicalisation, CLLD and Focus-movement with three distinct syntactic operations, Discourse Configurational Approaches fail to capture some syntactic similarities between these structures.

In contrast to Discourse Configurational approaches, I argue that Topicalisation, CLLD and Focus movement, rather than instantiating three distinct syntactic operations (A-movement, base-generation, A-bar movement), have the same underlying syntax (Alexopoulou 1998a). At the heart of this approach lies the idea that one syntactic operation is available for more than one discourse function.

In Section 3 I present linguistic evidence supporting the claim that Topicalisation, CLLD and Focus-movement share the same syntax. In Section 4 I give an account of the syntactic properties of these structures employing Unbounded Dependencies in HPSG. Finally, in Section 5 I propose an HPSG account of the interactions between phonology, syntax and Information Structure.

3 A unified syntax

Topicalisation, CLLD and Focus-movement share the following properties:

i) Crosslinguistically all three constructions allow long distance extraction.

ii) Crosslinguistically, all three constructions obey strong islands (Iatridou 1995; Kiss 1995; Tsimpli 1995; Rizzi 1995).

iii) In all three constructions in Greek, the XP may occur to either side of the complementiser *oti*:

(4.6) ipe (to YANI) **oti** (to YANI) ide
said-3SG the Yani-ACC that the Yani-ACC saw-3SG
'S/he said that s/he saw Yanis'

(There is a preference for topics to appear after *oti*, but the other order is also possible).

iv) In Greek extracted XPs may appear to the left of an indirect question:

(4.7) rotise to YANI pios ide
asked-3SG the Yani-ACC who-NOM saw-3SG
'S/he asked who saw Yanis'

This is also true of CLLD in Italian (Rizzi 1995).

v) None of the three constructions blocks selection from a higher verb (4.6&4.7).

vi) None of the three constructions creates islands for extraction:

(4.8) pios nomizis ti Maria oti tha tin psifize
who you-think the Maria-ACC that FUT her vote
'Who do you think would vote for Mary?'

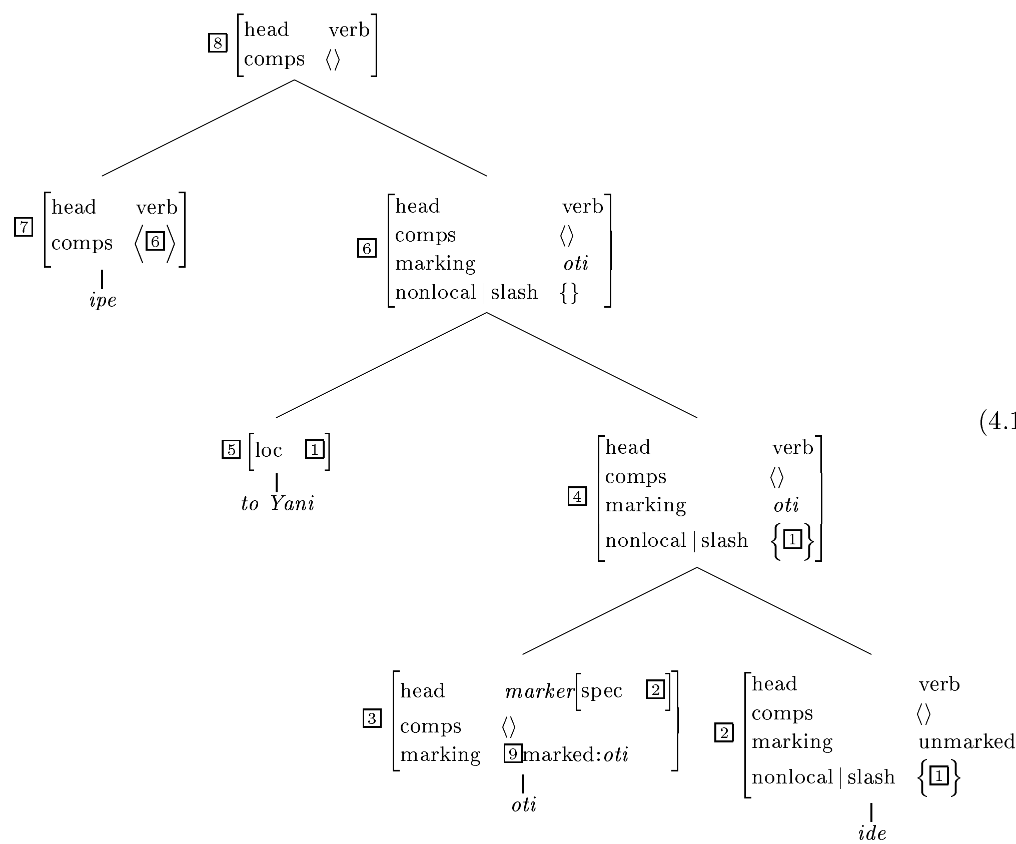
(Iatridou 1995)

The facts (i-v) indicate that the distribution of the extracted XPs is not affected by their discourse import. Note that the syntax is disambiguated by intonation. The (a) examples in (4.2&4.5) differ minimally from the (b) ones in accent placement.

4 Unbounded Dependencies as the underlying syntax of Topicalisation, CLLD and Focus-movement

The syntactic properties of Topicalisation, CLLD and Focus-movement are captured straightforwardly by the HPSG mechanism of Unbounded Dependencies. The tree (4.10) illustrates example (4.9):

(4.9) ipe to YANI **oti** ide
said-3SG the Yani-ACC that saw-3SG
'S/he said that s/he saw Yanis'



(4.10)

First, a non-configurational/flat structure is assumed for Greek clauses with no SUBJ-DTR in the VALENCY of verbs. Thus, $\boxed{2}$ is a saturated S(entence). The complementiser *oti* is analysed as a MARKER (Pollard & Sag 1994). The HEAD-MARKER ID SCHEMA licenses $\boxed{4}$. Further, the SLASH INHERITANCE PRINCIPLE (SLIP) (Bouma *et al.* 1997) ensures the propagation of the *gap* $\boxed{1}$ to the MOTHER $\boxed{4}$. The *head-filler-phrase* $\boxed{6}$ is licensed by the HEAD-FILLER ID SCHEMA (Pollard & Sag 1994). For Greek, this schema requires that the HEAD-DTR is an S ($\left[\text{head} \quad \textit{verb}\right]$ and $\left[\text{comps} \quad \langle\rangle\right]$), underspecified for MARKING. The HEAD-DTR $\boxed{4}$ satisfies this description. The MARKING PRINCIPLE (Pollard & Sag 1994) ensrures the propagation of the MARKING value *oti* from $\boxed{4}$ to $\boxed{6}$. Thus, $\boxed{6}$ satisfies the selection requirements of the martix verb *ipe*.

The HEAD-FILLER-SCHEMA allows the HEAD-DTR of a *head-filler-phrase* to be *unmarked*. This is the case in examples of long distance extraction (4.4) and post-*oti* XPs.

5 Syntactic and Phonological constraints on Information Structure

Below I summarise some descriptive generalisations about the realisation of Information Packaging in Greek:

- **Phonological realisation**:
  a) Accented constituents are obligatorily interpreted as *foci*.
  b) *Ground* elements are not accented.
  c) Non-accented words may be either *focus* or *ground*.
  That is, the generalisations in (a&b) are not biconditionals. For example, the verb and the direct object below are part of *focus*:

  (4.11) [$_F$ edose ta biblia sto YANI]
  [$_F$ gave-3SG the books to-the YANI]
  'S/he gave the books to YANI'

- **Syntactic realisation**:
  d) *Links* are obligatorily realised as *fillers-dtrs*.
  e) *Foci* can be any kind of syntactic constituent (*head-dtrs, complement-dtrs, filler-dtrs, adjunct-dtrs, etc.*).
  f) *Tails* cannot be *filler-dtrs*.

- **Propagation**:
  g) Accent on the rightmost COMPS-DTR may give rise to *wide focus* (4.11).
  h) Preverbal *focus* is always narrow; it cannot give rise to *wide focus* (4.12):

  (4.12) *[$_F$ to YANI ipe oti ide o Petros]
  *[$_F$ the Yani-ACC said-3SG that saw-3SG the Petros-NOM]
  'S/he said that Petros saw Yanis'

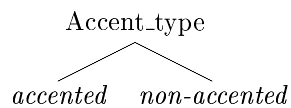
The HPSG account of the generalisations in (a-h) builds on the analysis of Engdahl & Vallduví (1996) for English and Catalan. Greek shares with English and Catalan the assignment of *wide focus* (c,g) and the fact that accented words are obligatorily interpreted as *foci* (a). However, it differs from both languages in allowing *narrow foci* and *links* to be realised as *fillers*. The account proposed here is an adaptation of the analysis of Engdahl & Vallduví (1996) to the Greek data.

Engdahl & Vallduví (1996) enrich CONTEXT with a feature INFO-STRUCT as shown in (4.13):

(4.13) $$\left[\text{context}\ \left[\text{info-struct}\ \left[\begin{array}{ll}\text{focus} & \\ \text{ground} & \left[\begin{array}{l}\text{link}\\ \text{tail}\end{array}\right]\end{array}\right]\right]\right]$$

FOCUS and GROUND take feature structures as values. Their values are structure-shared with the constituents that realise them. The various instantiation possibilities of INFO-STRUCT values are handled by constraints on their phonological and syntactic realisation.

Following Manandhar (1994), an *accent_type* hierarchy is assumed for the PHON|ACCENT attribute (for Greek):



(4.14)

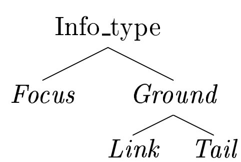
The generalisations in (a&c) are captured by two constraints on *words* [in the following, *'a'* stands for *accented* and *'u'* for *non-accented/unmarked*]:

(4.15) a. $$\textit{Word} \rightarrow \boxed{1}\left[\begin{array}{ll}\text{phon}\,|\,\text{accent} & \text{a}\\ \text{info-struct}\,|\,\text{focus} & \boxed{1}\end{array}\right]$$

b. $$\textit{Word} \rightarrow \boxed{1}\left[\begin{array}{ll}\text{phon}\,|\,\text{accent} & \text{u}\\ \text{info-struct} & []\end{array}\right]$$

According to (4.15a) any *word* with PHON|ACCENT value of sort *a*, has its FOCUS value instantiated (Engdahl & Vallduví 1996). In addition, when a *word*'s PHON|ACCENT value is *u*, its INFO-STRUCT value is not determined until it combines with other signs (4.15b).

The generalisations in (b,d-f) refer to the realisation of *foci, links and tails* (rather than *words*). These are captured by constraints of the following *info_type* hierarchy (Manandhar 1994):

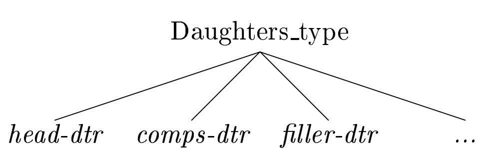


(4.16)

The phonological constraint in (b) can take the form of (4.17) which requires that the PHON|ACCENT value of *ground* elements is of sort *u*:

(4.17) $$\textit{Ground} \rightarrow \left[\text{phon}\,|\,\text{accent}\quad u\right]$$

Let us turn to the syntactic constraints. In order to state the generalisation in (d) we need to refer to *fillers*. In current HPSG, there is no straightforward way to refer to *fillers*. A tentative solution would be to introduce a sortal hierarchy of *daughters* as depicted below:



(4.18)

Links are then constrained to be of sort *filler-dtr*. The syntactic realisation of *focus* is unconstrained since, as stated in (e), *foci* can be any kind of syntactic constituent. Finally the following constraint on *filler-dtrs* ensures that *tails* are not realised as fillers (generalisation in (f)).

(4.19) *Filler-Dtr* → [info-struct *focus or link*]

Let us turn to the propagation of INFO-STRUCT values in the syntactic tree. The following two principles are assumed for Greek (adapted from Engdahl & Vallduví (1996)):

(4.20) INFORMATION STRUCTURE INSTANTIATION PRINCIPLES FOR GREEK

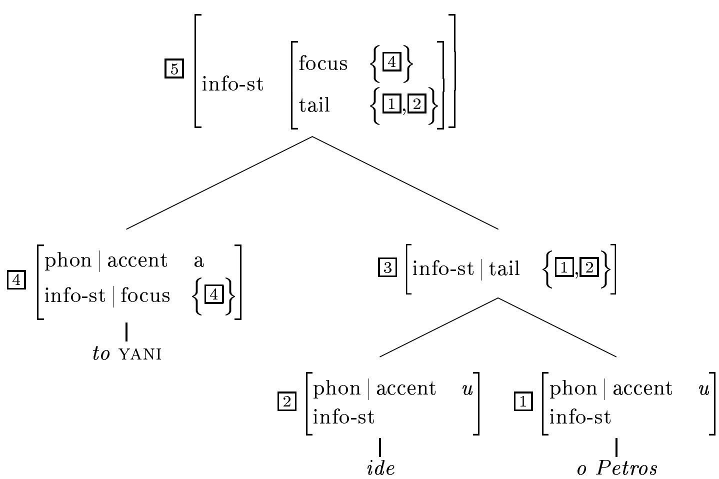
- PRINCIPLE I
  if a DAUGHTER's INFO-STRUCT is instantiated, then the MOTHER inherits this instantiation (for *narrow foci, links and tails*),
  or
- PRINCIPLE II
  the FOCUS value of the MOTHER is the sign itself (*wide focus*) just in case,

a) the FOCUS value of the most oblique COMPS-DTR is the sign itself
or

b) in a *head-marker-phrase*, the FOCUS value of the HEAD-DTR is the sign itself.

Principle I allows a MOTHER to inherit the INFO-STRUCT values of its DTRS. In this way, a *head-filler-phrase* can inherit the INFO-STRUCT value of its FILLER-DTR. Tree (4.22) illustrates example (4.21):

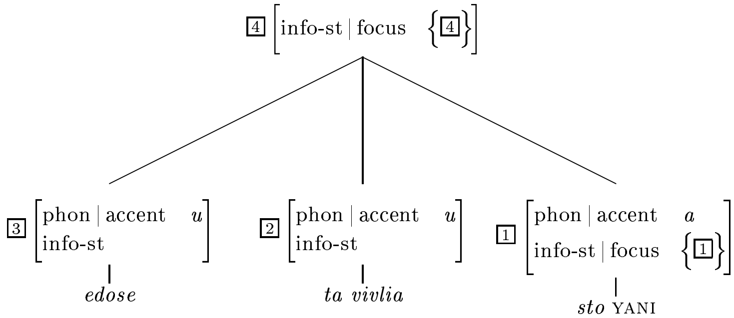
(4.21) [$_F$ to YANI] [$_G$ ide o Petros]
[$_F$ the Yani-ACC] [$_G$ saw-3SG the Petros-NOM]
'Petros saw Yanis'



(4.22)

The *filler* $\boxed{4}$ is accented and, by (4.15a), its FOCUS value $\boxed{4}$ is instantiated. Then, the *head-filler-phrase* $\boxed{5}$ inherits the FOCUS value $\boxed{4}$, by Principle I.

According to Principle II.a, *wide focus* on a MOTHER (that is the FOCUS value of the MOTHER is the sign itself) can arise from the most oblique COMPS-DTR. Consider for example the structure of (4.11) illustrated by (4.23):



(4.23)

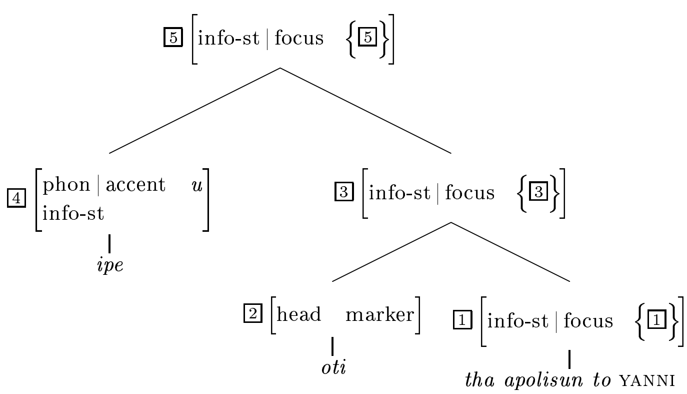
The indirect object, *sto Yani*, is the most oblique COMPS-DTR. In addition, its FOCUS value $\boxed{1}$ is the sign itself. Thus, the MOTHER $\boxed{4}$ is assigned *wide focus* (FOCUS:$\boxed{4}$).

The requirement that only COMPS-DTRS can give rise to *wide focus* blocks *wide focus* for *head-filler-phrases*. A *head-filler-phrase* (e.g. $\boxed{5}$ in (4.22)) cannot have *wide focus*, as none of its DTRS is a COMPS-DTR. In this way, the ungrammatical *wide focus* reading in (4.12) is ruled out.

The second clause of Principle II handles *all focus* examples in embedded contexts like (4.24):

(4.24)	[$_F$ ipe	oti	tha apolisoun	to	YANI]
	[$_F$ said-3SG	that	will fire-3SG	the	Yani-ACC]
	'S/he said that they'll fire Yani'				

The tree in (4.25) shows the structure of (4.24):



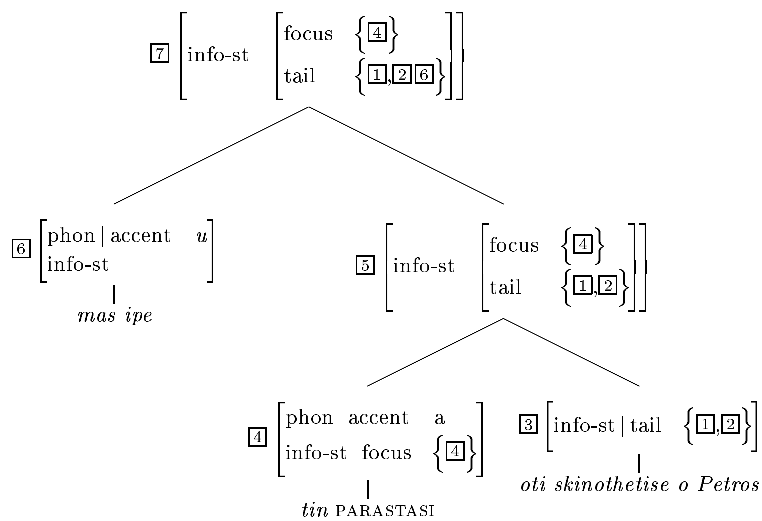
(4.25)

First, it is assumed that INFO-STRUCT is not an appropriate attribute for MARKERS. This captures the intuition that elements like *oti* do not contribute to the INFORMATION STRUCTURE of their signs. In (4.25) the HEAD-DTR $\boxed{1}$ has *wide focus* (FOCUS:$\boxed{1}$). By the second clause of Principle II the *head-marker-phrase* $\boxed{3}$ is assigned *wide focus* as well. As $\boxed{3}$ is the most oblique COMPS-DTR of the matrix verb (*ipe*) and it is *widely focused* the top node $\boxed{5}$ is assigned *wide focus*.

Finally, the requirement of Principle II that the COMPS-DTR (or the HEAD-DTR in a *head-marker-phrase*) is *widely focused* prevents a FOCUS value inherited from a FILLER-DTR from giving rise to *wide focus* once it appears on a COMPS-DTR. For example, consider the ungrammatical *wide focus* interpretation of (4.26):

(4.26) *[$_F$ mas ipe tin PARASTASI oti skinothetise o Petros]
*[$_F$ to-us said-3SG the show-ACC that directed-3SG the Petros-NOM]
'S/he said to us that Petros directed the show'

Example (4.26) can only have a *narrow focus* interpretation as illustrated in (4.27):



(4.27)

In (4.27) the most oblique COMPS-DTR of *ipe* is the *head-filler-phrase* $\boxed{5}$. However, $\boxed{5}$ is not *widely focused*. Although the FOCUS value of $\boxed{5}$ is instantiated ($\boxed{4}$), it is not the sign itself ($\boxed{5}$). Thus, Principle II cannot apply here. In effect, the ungrammatical *wide focus* interpretation of (4.26) is ruled out. In (4.27) the top node $\boxed{7}$ inherits the FOCUS value $\boxed{4}$ by Principle I.

6 Problems and potential solutions

The current account excludes examples of *wide focus* like (4.28b):

(4.28) a. Tu tilefonises;
'Did you phone him?'

b. Ne, kai [$_F$ me diaveveose oti [$_L$ tis afises] tha
Yes, and [$_F$ me-CL confirmed-3SG that [$_L$ the posters-ACC] will
tis ehi etimes stin ORA-tus]
them-CL have-3SG ready-ACC.PL on time-their]
'Yes, and he reassured me that he'll have the posters ready on time—that the posters will be ready on time'

Example (4.28b) receives a *wide focus* interpretation despite the appearence of the embedded *link* (*tis afises*). However, the analysis developed in Section 5 does not allow a *head-filler-phrase* to be *widely focused* (cf. 4.26) and, in effect, the S cannot be assigned *wide focus* either.

Further, this analysis cannot be extented to NPs. Consider the following examples:

(4.29) a. [$_F$ Agorasa ena vivlio tu CHOMSKY]
[$_F$ bought-1SG a book the-GEN Chomsky]
'I bought a book by Chomsky'

b. [$_F$ Agorasa mia kokini ZAKETA]
[$_F$ bought-1SG a red CARDIGAN]
'I bought a red cardigan'

In (4.29) the object NPs are *widely focused*. However, Principle II does not account for the assignment of *wide focus* on these NPs.

Examples (4.29) together with (4.11) indicate that the assignment of *wide focus* is not sensitive to the syntactic category of the accented constituent. Rather, it seems that, at least in Greek, *wide focus* is only sensitive to the FOCUS value of the *rightmost-daughter*. Informally, the facts about *wide focus* could be described by the following generalisation:

(4.30) If the *rightmost daughter* has *wide focus*, then the *mother* may have *wide focus* as well.

The above generalisation seems to capture the *wide focus* facts for (4.29&4.11). In addition, it allows a *wide focus* interpretation for (4.28b). In this example, the HEAD-DTR of the *head-filler-phrase* has *wide focus*. Being the *rightmost daugther*, it can give rise to *wide focus* on the *head-filler-phrase*. On the other hand, (4.26) remains excluded, since the focused FILLER-DTR is not the *rightmost daughter*. Although the alternative in (4.30) seems promising, the exact nature of this constraint as well as its expression in HPSG terms warrants further research to be pursued in future work.

7 Conclusions

In this paper I argued that Topicalisation, CLLD and Focus-movement share the same underlying syntax which is straightforwardly captured by the HPSG mechanism of Unbounded Dependencies. In languages like Greek, UDCs are employed for the syntactic realisation of Information Packaging and, in particular, for the realisation of *narrow focus* and *links*. The HPSG account captures the interactions between phonology, syntax and Information Structure in Greek.

Bibliography

ALEXOPOULOU, THEODORA. 1998a. Detaching Discourse Functions from Functional Projections. In *U. Penn Working Papers in Linguistics*, ed. by to appear. Proceedings of the 22d Annual Penn Linguistics Colloquium.

——, 1998b. *Syntactic and Discourse Constraints on word order*. University of Edinburgh dissertation. in preperation.

BOUMA, GOSSE, ROBERT MALOUF, & IVAN SAG, 1997. Satisfying Constraints on Extraction and Adjunction. ftp://csli-ftp.stanford.edu/linguistics/sag/ext-adj-draft.ps.gz.

CINQUE, GUGLIELMO. 1990. *Types of A-bar Dependencies*, volume 17. MIT Press. Linguistic Inquiry Monographs.

ENGDAHL, ELISABET, & ENRIC VALLDUVÍ. 1996. Information packaging in HPSG. In *Edinburgh Working Papers in Cognitive Science, Vol. 12: Studies in HPSG*, ed. by Claire Grover & Enric Vallduví, chapter 1, 1–32. Scotland: Centre for Cognitive Science, University of Edinburgh.

GIANNAKIDOU, ANASTASIA, 1997. *The Landscape of Polarity Items*. University of Croningen dissertation.

HEYCOCK, CAROLINE. 1993. Focus Projection in Japanese. In *Proceedings of NELS*, ed. by Merceí González, volume 24, 159–187.

IATRIDOU, SABINE. 1995. Clitics and Island Effects. *Penn Working Papers in Linguistics* 2.11–31.

KISS, KATALIN E. 1995. NP Movement, Operator Movement and Scrambling in Hungarian. In *Discourse Configurational Languages*, ed. by K.E. Kiss, Oxford Studies in Comparative Syntax, 207–243. Oxford University Press.

LASNIK, HOWARD, & TIM STOWELL. 1991. Weakest Crossover. *Linguistic Inquiry* 22.687–720.

MANANDHAR, SURESH. 1994. Encoding information packaging in HPSG. In *Integrating information structure into constraint-based and categorial approaches*, ed. by Elisabeth Engdahl. Amsterdam: ILLC. DYANA-2 Report R.1.3.B.

POLLARD, CARL, & IVAN A. SAG. 1994. *Head-Driven Phrase Structure Grammar*. University of Chicago Press, Chicago.

RIZZI, LUIGI, 1995. The Fine Structure of the Left Periphery. University of Geneva, ms.

ROOTH, MATS. 1996. Focus. In *The Handbook of Contemporary Semantic Theory*, ed. by Lappin Shalom, 271–297. Blackwell.

TSIMPLI, MARIA IANTHI. 1995. Focusing in Modern Greek. In *Discourse Configurational Languages*, ed. by K.E. Kiss, Oxford Studies in Comparative Syntax, 176–206. Oxford University Press.

VALLDUVÍ, ENRIC, & ELISABET ENGDAHL. 1996. The Linguistic Realization of Information Packaging. *Linguistics* 34.459–519.

——, & RON ZACHARSKI. 1994. Accenting phenomena, association with focus, and the recursiveness of focus-ground. In *Proceedings of the Ninth Amsterdam Colloquium*, ed. by P.Dekker & M.Stokhof, 683–702. Amsterdam:ILLC.

Chapter 5

Information Repackaging

PETR KUBOŇ

ABSTRACT. This paper proposes a modification of Vallduví's (1992) theory of information packaging. The modification consists in 1) arguing for treating the knowledge store of the hearer, where information packaging gets interpreted, as an abstract data type instead of a file, and 2) arguing against the purported need for dividing the ground into two more primitive notions of link and tail.

1 Introduction

Vallduví (1992, 1994), and Vallduví and Engdahl (1996) present a theory of *information packaging*, i.e., of the way how the speaker encodes information in a sentence to allow the hearer to extract it and use it to update her knowledge store accordingly. The theory combines two previous approaches to information packaging: 1) the topic/comment (or theme/rheme) approach of Halliday (1967), Gundel (1974), Reinhart (1982), etc., and 2) the topic/focus (open-proposition/focus, background/focus, etc.) approach of Sgall, Hajičová, and Panevová (1986), von Stechow (1981), etc., by incorporating their respective primitive notions within a single, hierarchical scheme. On the first level the sentence is partitioned into ground and focus; on the second level the ground is further divided into link and tail.

The **focus** of a sentence S encodes the (new) *information* of S (I_S), i.e., the part of the propositional content of S which (the speaker presumes) is not present in (the relevant subset of) the hearer's model of the common ground K_h at the time of utterance t_u. I_S is used by the hearer to augment or modify her model.

The **ground** is the part of the sentence which encodes what is already known and attended to in K_h. Its role is to serve as a "hook" into the hearer's model: it points to the appropriate location in K_h where (in the speaker's opinion) I_S should be entered.

The ground is further divided into link and tail. Vallduví argues that such notions are necessary because the hearer's model of the common ground is not just a set of facts; it has an internal structure which at the very least supports the notions of addressing, and local update and retrieval. With respect to such a model, the **link** indicates the address *where* I_S should be inserted, while the **tail** specifies *how* the update is to be carried out.

Vallduví follows Heim (1983) in assuming that the hearer's model of the common ground is structured as a collection of file cards in a **file**. A **file card** represents a discourse entity, a discourse referent, and it mediates between referring expressions on one hand and real-world/model entities on the other. It serves as a "storage

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bin" for attributes and relations pertaining to the entity it denotes; in accord with the file metaphor these descriptions are referred to as **record**s.

The focus is the only obligatory part of a sentence, which reflects the natural requirement on informativeness of a linguistic exchange. The ground, on the other hand, is optional—it can (and will) be omitted if (the speaker assumes that) the hearer already attends to the appropriate location or mode of update in K_h. These observations result in classifying declarative sentences into four possible types: 1) all-focus (F), 2) link-focus (L-F), 3) link-focus-tail (L-F-T), and 4) focus-tail (F-T).

The sentence types are also seen as instruction types. In this, more procedural view, a particular information packaging of a sentence is seen as an *instruction* to the hearer how to retrieve I_S and use it to update K_h. Each information-packaging primitive contributes in a distinct and specific way to the construction/interpretation of the instruction. Thus, the four possible sentence types result in four possible instruction types, i.e., four different ways how I_S can fit into K_h.

The informational contribution of the focus to K_h (realized as a file) is represented operationally as UPDATE(I_S), i.e., as an instruction for the hearer to update K_h with I_S. The link, if present, denotes a file card *fc* where the actual update takes place; it is informationally interpreted as an instruction GOTO(*fc*). Finally, the tail designates a specific record/condition on *fc* and thus further specifies the location for the update *record*(*fc*). The underlying intuition is that the hearer's attention is on a particular record if and only if the record should be *modified*—completed or altered—by I_S. And so, tail also switches the mode of update from the default ADD (sentences without tail) to REPLACE.

Under this interpretation of information-packaging primitives, the four possible instruction types associated with the four types of sentences can be summarized as:

(1)	a.	UPDATE-ADD(I_S)	(F)
	b.	GOTO(*fc*)(UPDATE-ADD(I_S))	(L–F)
	c.	GOTO(*fc*)(UPDATE-REPLACE(I_S, *record*(*fc*)))	(L–F–T)
	d.	UPDATE-REPLACE(I_S, *record*(*fc*))	(F–T)

In what follows, I propose to modify this theory of information packaging in two aspects. First, I argue that identifying the structure of the hearer's model of the common ground with a file or, indeed, *any particular representation language* is too limiting. Rather, the representation should be treated as an abstract data type in computer science, allowing for realizations in many representation languages. Second, I question the proposed motivation for dividing the ground into two more primitive notions of link and tail, and sketch a preliminary version of an alternative theory of information packaging employing only two primitive notions of ground and focus.

The rest of the paper is organized as follows. Section 2 identifies some problems of Vallduví's version of information packaging. The observations are used in Section 3 in proposing an alternative theory of information packaging. Finally, Section 4 summarizes the discussion and points out some directions for future research.

2 Problems

There are problems with Vallduví's theory as it stands, some of them already identified in the literature (cf. Hendriks and Dekker 1996). The two main points are: 1) Vallduví's arguments for organizing the hearer's knowledge by means of files and file cards are not compelling and do not preclude considering other representations for the same purpose, and 2) the informational status of links and tails is weaker than claimed. I discuss these points in turn.

2.1 Organization of K_h

Vallduví argues that the hearer's knowledge store has to have a least the internal structure of a "hypercard" file, i.e., a collection of file cards connected by pointers. He claims that this model is the *most efficient* means of organizing K_h for the purposes of information update. But this claim is not supported by any evaluation of competing models. Hendriks and Dekker (1996) show that—for the L-F instruction type—an alternative implementation of information packaging in Discourse Representation Theory (Kamp and Reyle 1993) would be more efficient.

This does not invalidate Vallduví's claim, but it clearly shows the claim needs more justification. To maintain that one representation is *optimal*, a serious study of time and space efficiency of a typical *set* of update operations encountered in discourses would have to be made. In the absence of any such study, it has to be concluded that other possible frameworks of knowledge representation (discourse representation structures, situation theoretic objects, semantic nets, etc.) are also available as potential candidates for the organization of K_h.

In addition, Hendriks and Dekker (1996) also discuss some technical problems with the proposed file representation. These are mainly due to the fact that Heim's or Vallduví's files in their present form are not suited as models of the hearer's knowledge store because they cannot represent quantified, negative, hypothetical, or disjunctive information (cf. also Heim 1983).

2.2 Problems with links and tails

As explained in Section 1, links serve to point the hearer to an "address" in her knowledge store where the update should take place. In Vallduví's model of K_h, this *locus of update* is a file card. Tails then identify a record on this file card which should be modified by the information encoded in the focus.

Links without interpretation Thus, Vallduví operates under the assumption that K_h is organized into addressable locations which contain the actual information and that *address* (file cards) *and content* (records) *are mutually incompatible.*

This view has serious implications on the structuring of the hearer's model of the common ground and even on natural language semantics. For if we claim that every link is interpreted as an address, we are in fact saying that every linguistic category which can serve as a link denotes an addressable location in the K_h—be it a file card, discourse referent, or something else.

Since Vallduví also claims that 'placement in an appropriate left-hand position (e.g., prototypical subjects and topicalized phrases) is [one of the ways] to realize linkhood (1993: 16),' it follows that not only *NPs*, but also at least *VPs*, *PPs*, and

APs are represented in K_h as file cards. But this does not agree with Heim's and Vallduví's concepts of a file. In other words, in Vallduví's approach as it stands *there are links which do not seem to have a reasonable functional interpretation.* The following two examples from Ward (1988) illustrate the problem; the link phrases are marked by bold font here:

(2) Tchaikovsky was one of the most tormented men in musical history. In fact, one wonders how he managed to produce any music at all. But **produce music** he did. (Ward 1988: 47)

(3) 'M*A*S*H' means 'mobile' and **mobile** you shall be! (Ward 1988: 60)

Tails and the REPLACE mode Vallduví's theory offers one potentially strong argument in favor of link and tails, namely the alleged one-to-one correspondence between sentence types and instruction types. In particular, the presence of a tail in the sentence switches the mode of update from ADD to REPLACE, without exceptions. Also, the tail identifies which condition(s) in K_h is (are) to be modified. But if tails are a useful information packaging primitive, then so by extension are links—as the complement of tails in the ground.

The correspondence between sentence types and instruction types is weaker than claimed, though: *the presence of tails is only a sufficient but not necessary condition for switching to the* REPLACE *mode.* For consider the following example:

(4) *A*: Egad, [$_L$ the boss] [$_F$ won AGAIN]!
B: (No,) [$_L$ the boss] [$_F$ LOST].

It is clear that *B*'s reply in (4) does not contain any tail and, thus, it should be a simple UPDATE-ADD instruction. It is equally clear, though, that the sentence should result in an UPDATE-REPLACE instruction, replacing the condition(s) derived from *9 won again* by a condition *lost*(9) on the file card #*9* for *the boss*. From an information-packaging viewpoint, there is no difference between (4) and its L-F-T variant such as

(5) *A*: Egad, [$_L$ the boss] [$_F$ won two POUNDS]!
B: (No,) [$_L$ the boss] [$_F$ LOST] [$_T$ two pounds].

It follows from these examples that (at least some) L-F sentences are ambiguous with respect to their informational interpretation between the UPDATE-ADD instruction and the UPDATE-REPLACE instruction.

Exactly when this happens is a subject for further study. Based on (4) above it can be inferred—as a first approximation—that potential candidates are simple sentences with intransitive verbs. Another suspected case is exchanges like[1]

(6) *C*: Mom, [$_L$ Macbeth] [$_F$ loves DUNCAN].
M: Oh no, dear, [$_L$ Macbeth] [$_F$ hates EVERYBODY].

[1] Granted, there is an admittedly fine line between where the role of information packaging stops and where the more powerful memory inference mechanisms take over—but that is an open question which is relevant for information packaging in general.

The discussion in this section suggests that we need to look separately at the two roles associated with information packaging. The first role, that of deciding whether the information should be added or used to modify previous knowledge in K_h, *cannot be delegated to information packaging alone.* In the general case, other sources from the context, such as discourse relations (cf. Mann and Thompson 1988; Polanyi 1985; Asher 1995), have to be taken into consideration.

The second role, that of identifying where the information should be stored in K_h, still remains in the domain of information packaging. But even this role needs to be modified because the position of tails in information packaging has been weakened by examples like (4) and (6). Since these examples do not contain tails, the task of identifying the knowledge to be modified by the UPDATE-REPLACE instruction has to be done in these cases either by the focus (since link does not operate on the level of records) or by the link (if link is also allowed to operate on records). No matter which position one takes, the alleged need for dividing the ground into two separate notions of link and tail is seriously questioned.

Status of weak pronouns Vallduví firmly maintains that weak pronouns are "invisible" to information packaging; they are treated as free variables always belonging to the focus. There are at least two problems with this approach. First, it exacerbates the problem discussed in the previous section since *sentences which should be treated as legitimate* L-F-T *types are treated as* L-F *or even* F *types* instead:

(7) G: Mom, [$_L$ Oberon] [$_F$ poked TITANIA].
N: Oh no, dear, [$_F$ he TICKLED her].
P: Oh no, dear, [$_L$ Oberon] [$_F$ TICKLED] [$_T$ Titania].

Here, N's sentence in (7), uttered as a correction to G's sentence, is treated as an all-focus (F) instruction trigerring the ADD mode of update; clearly, though, it should lead to a REPLACE mode with the same result of update as P's sentence (uttered in the same context).

Second, if weak pronouns are not treated as legitimate links, information sometimes ends in a counterintuitive location, as in the discourse below:

(8) The boss got broccoli for Christmas.
His wife had to eat it all. (F_1)
[$_F$ He HATES] [$_T$ broccoli]. (F_2)

In file F_1, before the last sentence is processed, the locus of update is on the file card *#23* for *the boss's wife.* This is problematic because the information *He hates broccoli* will get recorded on an inappropriate file card. On the other hand, if *he* were treated as a link, the locus of update would be resolved to the file card *#9* for *the boss* and the problem would disappear.

In my opinion, these two drawbacks are serious enough to require treating weak pronouns as other lexical items for the purposes of information packaging. But a move along these lines significantly changes the distribution of sentences among the four instruction types and, as such, gives us yet another argument for reevaluating Vallduví's original motivation for the notions of link and tail.

3 Modifications

Taking into account the observations made in Section 2.1, I propose that identifying the structure of the hearer's model of the common ground with a file or, indeed, *any particular representation language* is too limiting. Rather, the representation should be treated as an **abstract data type** in computer science, i.e., it should be defined only in terms of 1) its underlying structure, suitable for representation of knowledge and interpretation of information-packaging instructions, and 2) the information packaging operations it has to support. To avoid any confusion with Vallduví's account, I denote the abstract representation as AK_h, short for "abstract knowledge store."

The structure requirements are minimal: AK_h only needs to support an abstract notion of an **address** as a subset of the knowledge in AK_h; this is the part of the knowledge store affected by the current update. In addition, a **subaddress** will denote an optional, secondary address which will be modified during the update in the REPLACE mode. The subaddress can but does not have to physically form a part of the address.

The information-packaging instructions to be supported depend on how many informational primitives are truly needed for information packaging—a question which was reopened for discussion in Section 2.2. Since at this time the issue is still open, I will pursue both options in parallel.

Link, Focus, and Tail In the version of information packaging supporting Vallduví's three notions, we need to incorporate the insights from previous sections—in particular, the facts that for some L-F sentence types it is the context (C) which decides the mode of the update, and the focus[2] which determines the subaddress. Thus, we get five possible instruction types (replacing the notion of a file card with that of an *address* and the notion of a record with that of a *subaddress*). The 'X: text' notation is meant to identify that 'X' determines 'text,' where X can be any information-packaging primitive or context, and 'text' can be a mode of update or *subaddress*. Also, following the discussion in the previous section, I am assuming that weak pronouns are treated as other lexical items in information packaging.

The five instruction types are (compare with (1)):

(9) a. UPDATE-ADD(I_S) (F)
b. GOTO(*address*)(UPDATE-ADD(I_S)) (L–F; C: ADD)
c. GOTO(*address*)(UPDATE-REPLACE(I_S; F: *subaddress*))
(L–F; C: REPLACE)
d. GOTO(*address*)(UPDATE-REPLACE(I_S; T: *subaddress*))
(L–F–T; T: REPLACE)
e. UPDATE-REPLACE(I_S; T: *subaddress*) (F–T; T: REPLACE)

Ground and Focus In the version of information packaging supporting only the notions of ground and focus, the ground always determines the address; it is informationally interpreted as an instruction LOCATE(*address*). This operation is related to the GOTO operation discussed in the previous section, but it is more general in that *address* in this version is not limited to one physical location in AK_h

[2]Or the link, but that alternative is incompatible with Vallduví's assumptions about AK_h (cf. Section 2.2), so I pursue the focus variant here as the option of choice.

(an example follows shortly). The mode of the update—ADD or REPLACE—is either determined by the ground or by the context. The focus carries the information of the sentence I_S which is used to update the knowledge on the *address* according to the mode. If the mode is REPLACE, the focus together with the ground determines the *subaddress*. Below are the equivalents to the five instruction types from (9):

(10)
a. UPDATE-ADD(I_S) (F)
b. LOCATE(*address*)(UPDATE-ADD(I_S)) (G–F; C: ADD)
c. LOCATE(*address*)(UPDATE-REPLACE(I_S; G, F : *subaddress*)) (G–F; C: REPLACE)
d. LOCATE(*address*)(UPDATE-REPLACE(I_S; G, F : *subaddress*)) (G–F; G: REPLACE)
e. LOCATE(*address*)(UPDATE-REPLACE(I_S; G, F : *subadress*)) (F–G, G: REPLACE)

It is obvious that the last three instructions can be reduced to a single one, so we have only three distinct instruction types. Thus, if it can be shown that our instruction types in (10) are accurate counterparts of those in (9), the ground-focus version of information packaging will be clearly preferable as the more economical one.

So let me illustrate on examples how this could be done. Since the all-focus instruction is treated the same way in both accounts, I will concentrate on the remaining four types: the information-packaging analysis is done in terms of G-F partition; the label on the right shows the corresponding analysis in the L-F-T account. For simplicity, I assume below that AK_h is a set of simple facts and use the Prolog-like convention of denoting variables by uppercase symbols and constants by lowercase symbols. There are four cases to consider, corresponding respectively to (9b)–(9e).

(11) $[_G$ The boss $]$ $[_F$ hates BROCCOLI $]$. (L–F; C: ADD)

The *address* is resolved to the (salient) condition *the-boss*(x). Since the context marks the mode of update as ADD, no *subaddress* is needed. I_S is a set consisting of two conditions *hates*(x, y), *broccoli*(y), where y is a constant absent from AK_h. The two conditions are added to the knowledge base.

(12) *A*: The boss won.
B: (No,) $[_G$ the boss $]$ $[_F$ LOST $]$. (L–F; C: REPLACE)

The *address* is again resolved to the (salient) condition *the-boss*(x). The context marks the mode as REPLACE and so, as specified above, the ground and focus together determine the *subaddress*. Using the ideas from Jackendoff (1972) and von Stechow (1981), this can be done by replacing the focus *lost* with a variable of an appropriate semantic type to create an underspecified condition $P(x)$. This condition is matched against the content of (the salient part) of AK_h to locate the *subaddress*, in this case *won*(x). This condition is then replaced with *lost*(x).

For the sake of generality, we need to consider two subcases of the next instruction type, depending on whether the focus falls exclusively on an *NP* (13a), or not (13b):

(13) a. $[_G$ The boss hates $]$ $[_F$ BROCCOLI $]$. (L–F–T; T: REPLACE)
b. $[_G$ The boss $]$ $[_F$ HATES $]$ $[_G$ broccoli $]$. (L–F–T; T: REPLACE)

The *address* in (13a) is once again *the-boss*(x). The mode of update, REPLACE, is determined by the size and category of the ground; essentially, the mode is REPLACE if the ground is not limited to a single *NP*. The ground and focus together create an underspecified condition $hates(x, Z)$. This condition is matched against the content of AK_h; the result of the match, say $hates(x, a)$, is the *subaddress*. The update consists in adding a new condition $broccoli(y)$ into AK_h and replacing the *subaddress* with $hates(x, y)$.

In (13b) the *address* is a set of two (salient) conditions: *the-boss*(x) and $broccoli(y)$. Thus, the ground determines that the mode of update is REPLACE. As above, ground and focus create a condition $P(x, y)$. The condition is used to find the *subaddress*, say $adores(x, y)$, which is then replaced with $hates(x, y)$.

(14) C: John gave Mary a present.
D: (No,) $[_F$ FRED $]$ $[_G$ gave Mary a present $]$. (F–T; T: REPLACE)

The *address* in this case is a set of two conditions: $mary(m)$ and $present(p)$; the update mode is REPLACE. The *subaddress* is determined by the familiar process. First, the condition $gave(X, m, p)$ is created. This condition is then matched against AK_h to locate the *subaddress*, say $gave(j, m, p)$. Finally, a new condition $fred(f)$ is added to AK_h and the *subaddress* is replaced with $gave(f, m, p)$.

Thus, in all four cases we get the intended behavior with respect to information update, without having to divide the ground into link and tail parts. In addition, the examples also suggest the way to determine when the update mode is REPLACE: first, by looking at the size and category of the ground, and then, in case the ground is limited to a single *NP*, taking into account the clues from context. Therefore, the instruction scheme (10) should be reducible to only three update instructions:

(15) a. UPDATE-ADD(I_S) (F)
b. LOCATE(*address*)(UPDATE-ADD(I_S)) (G-F; C: ADD)
c. LOCATE(*address*)(UPDATE-REPLACE$(I_S;\ G{,}F: subaddress)$)
(G-F; G/C: REPLACE)

Of course, an informal treatment of four examples does not constitute a conclusive evidence, but it shows that this is a very interesting direction to pursue. Kuboň (in prep.) contains a much more detailed comparison of the two approaches. He implements the G-F version of information packaging using discourse representation structures and the L-F-T version using an extension of Vallduví's files.[3] The results show that both versions account adequately for informational partitions of simple declarative sentences with quantifiers. In addition, the file representation can also be used to support the G-F version of information packaging, thus contradicting the strong association of file cards with links assumed in Vallduví's theory. All these reasons, together with the problems analyzed in Section 2, strongly suggest that

[3]The extension consists in making the notion of a file recursive by allowing files to contain not only file cards but also (sub)files. This modification solves the technical problems mentioned in the end of Section 2.1.

the division of the ground into the link and tail parts is not only unnecessary but likely detrimental for the purposes of information packaging.

4 Conclusion

In this paper, I pointed out some problems of Vallduví's (1992) approach to information packaging and proposed to modify it in two aspects. First, I proposed to treat the hearer's knowledge store as an abstract data type rather than a file (or any other concrete representation language). This approach is more general; in particular, it allows one to clearly distinguish which aspects of the knowledge store (information state) are necessary for interpretation of information packaging and which are not.

Second, I presented data which throw doubt on the purported necessity or usefulness of dividing ground into two more primitive notions of link and tail. I showed on simple examples that an alternative theory of information packaging which uses only two primitive notions of ground and focus could capture the same intuitions as Vallduví's original theory does, while at the same time being more economical. Due to the space limitations of this paper, the alternative theory could not be developed formally, but a formal implementation of the ideas described here is currently under development. The preliminary results support the informal conclusions reached in this paper.

Bibliography

Asher, N. (1995). From discourse macro-structure to micro-structure and back again: Discourse semantics and the focus/background distinction. In H. Kamp and B. H. Partee (Eds.), *Proceedings of the workshops on Context Dependence in the Analysis of Linguistic Meaning*, Volume 1: Papers, pp. 21–51. IMS, University of Stuttgart.

Dekker, P. and H. Hendriks (1994). Files in focus. In E. Engdahl (ed.), *Integrating Information Structure into Constraint-based and Categorial Approaches*, ESPRIT Basic Research Project 6852, Dynamic Interpretation of Natural Language, DYANA-2 Deliverable R1.3.B, pp. 29–37. ILLC, University of Amsterdam.

Engdahl, E. and E. Vallduví (1994). Information packaging and grammar architecture: A constraint-based approach. In E. Engdahl (ed.), *Integrating Information Structure into Constraint-based and Categorial Approaches*, pp. 41–79. ILLC, University of Amsterdam.

Gundel, J. K. (1974). *The Role of Topic and Comment in Linguistic Theory.* Ph. D. thesis, University of Texas. Published by the Indiana University Linguistics Club, Bloomington, 1977.

Halliday, M. A. K. (1967). Notes on transitivity and theme in English, part 2. *Journal of Linguistics 3*(2), 199–244.

Heim, I. (1983). File change semantics and the familiarity theory of definiteness. In R. Bäuerle, C. Schwarze, and A. von Stechow (Eds.), *Meaning, Use and Interpretation of Language*, pp. 164–189. de Gruyter: Berlin, New York.

Hendriks, H. and P. Dekker (1996). Links without location. In P. Dekker and M. Stokhof (Eds.), *Proceedings of the Tenth Amsterdam Colloquium*, pp. 339–358. ILLC—Dept. of Philosophy, University of Amsterdam.

Jackendoff, R. S. (1972). *Semantic Interpretation in Generative Grammar*, Volume 2 of *Studies in Linguistics*. MIT Press: Cambridge, MA.

Kamp, H. and U. Reyle (1993). *From Discourse to Logic: Introduction to Modeltheoretic Semantics of Natural Language, Formal Logic and Discourse Representation Theory*, Volume 42 of *Studies in Linguistics and Philosophy*. Kluwer Academic Publishers: Dordrecht, Boston, London.

Kuboň, P. (in prep.). *Information Packaging Revisited*. Ph.D. thesis, Simon Fraser University.

Lewis, D. K. (1979). Scorekeeping in a language game. In R. Bäuerle, U. Egli, and A. von Stechow (eds.), *Semantics from Different Points of View*. Springer Verlag: Berlin.

Mann, W. C. and S. A. Thompson (1988). Rhetorical structure theory: Toward a functional theory of text organization. *Text 8*(3), 243–281.

Polanyi, L. (1985). A theory of discourse structure and discourse coherence. In W. H. Eilfort, P. D. Kroeber, and K. L. Peterson (Eds.), *Papers from the General Session at the Twenty-First Regional Meeting of the Chicago Linguistic Society*. Chicago.

Reinhart, T. (1982). *Pragmatics and Linguistics: An Analysis of Sentence Topics*. Indiana University Linguistics Club: Bloomington. Also published in *Philosophica* **27**(1): 53–94, 1981.

Sgall, P., E. Hajičová, and J. Panevová (1986). *The Meaning of the Sentence in Its Semantic and Pragmatic Aspects*. Academia: Prague, and Reidel: Dordrecht.

von Stechow, A. (1981). Topic, focus, and local relevance. In W. Klein and W. Levelt (Eds.), *Crossing the Boundaries in Linguistics*, Volume 13 of *Synthese Language Library*, pp. 95–130. D. Reidel: Dordrecht, Boston.

Steedman, M. (1991). Structure and intonation. *Language* **67**(2): 260–296.

Vallduví, E. (1992). *The Informational Component*. Outstanding Dissertations in Linguistics. Garland: New York, London.

——— (1993). Information packaging: A survey. Technical Report 44, Centre for Cognitive Science and Human Communication Research Centre, University of Edinburgh.

——— (1994). The dynamics of information packaging. In E. Engdahl (Ed.), *Integrating Information Structure into Constraint-based and Categorial Approaches*, pp. 3–26. ILLC, University of Amsterdam.

Vallduví, E. and E. Engdahl (1996). The linguistic realization of information packaging. *Linguistics 34*(3), 459–519.

Ward, G. L. (1988). *The Semantics and Pragmatics of Preposing*. Outstanding Dissertations in Linguistics. Garland: New York, London.

Chapter 6

Topic, Adverbial Quantification, and Backwards Anaphora

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Abstract.
This paper shows that backwards anaphora is possible in sentences involving A-quantification. Sentences with parallel syntactic structure, but which involve D-quantification do not generally allow backwards anaphora. These observations apply both to bound pronouns and to reflexives. The observed facts are explained in terms of the possibility of A-quantifiers, but not of quantifying non-subject noun phrases, to bind variables introduced by the subject. The freedom of the scope of A- quantifiers is related to their syntactic freedom.

This paper will analyze sentences in which a pronoun or a reflexive is construed with a noun phrase which neither precedes nor c-commands it. The sentences to be considered crucially involve adverbial quantification.

1 The Data

1.1 Pronouns

The following descriptive generalization emerges from an observation of sentences with pronouns:

1. *Weak Crossover and adverbial quantification*
   In sentences with adverbs of quantification, a pronoun contained in the subject can be bound by an indefinite non-subject. This can be observed in simple sentences as well as in the antecedent clause of conditional donkey-sentences.

The generalization in (1) is illustrated by the sentences in (2) and (3)

2. Usually, [a published story about his$_i$ private life] describes [a politician]$_i$ negatively.
3. If [an article about his$_i$ private life] describes [a politician]$_i$ negatively, hei usually tries to get it censored.

In contrast, in sentences other than those involving adverbial quantification, a pronoun contained in the subject cannot generally be bound by a quantifying non-subject. Sentence (4) below presents an instance of the so-called weak crossover effect, which disallows construal of 'his' with 'no politician':

4. *[An article about his private life] described [no politician]$_i$ negatively.

It must be noted, however, that there are exceptions to the generalization illustrated by sentence (4). These are sentences with an object DP headed by the determiner "each':

5. [Two of its$_i$ borrowers] damaged [each book]$_i$. (Comorovski (1996))

6. (?) [An article about his$_i$ leadership qualities] described [each presidential candidate]$_i$ in glowing terms.

1.2 Reflexives

Turning now to reflexives, we can put forth the following descriptive generalization:

7. *Reflexive binding and adverbial quantification*
   In sentences with adverbs of quantification, a reflexive contained in the subject can be bound by an indefinite non-subject. This can be observed in simple sentences as well as in the antecedent clause of conditional donkey-sentences.

The generalization in (7) is illustrated by the sentences below:

8. Usually, [a published picture of himself$_i$] flatters [a politician]$_i$.

9. If [a picture of himself$_i$] flatters [a politician]$_i$, he$_i$ usually tries to get it published.

In both (8) and (9), the verb 'flatter' is to be read as 'show (sb.) better looking than (s)he is', i.e. 'flatter' is not to be taken on its psych-verb meaning. The fact that none of the examples in (2)-(3) and (8)-(9) contains a psych-verb deserves mention, since the presence of a psych-verb in a sentence is known to interract with the syntax of binding relations (cf., for instance, Grimsahw (1990)).

In contrast to the sentences in (8)-(9), in sentences other than those involving adverbial quantification, a reflexive inside the subject cannot be bound by a quantifying non-subject:

10. * A published picture of himself$_i$ flattered [every politician]$_i$.

1.3 Backwards anaphora in modal contexts

As an anonymous reviewer pointed out to me, the observations about backwards in the context of adverbial quantification can be extended to sentences with modals. Examples involving backwards anaphora in modal contexts are given below:

11. [An article about his$_i$ private life] should describe [a politician]$_i$ in glowing terms.

12. [A published picture of himself$_i$] should flatter [a politician]$_i$.

1.4 Backwards anaphora and A-quantification

Based on the examples in subsections (1.1)-(1.3), the following generalization can be drawn:

12. *A-quantification, D-quantification and backwards anaphora*
    Backwards anaphora is possible in sentences involving A-quantification. Sentences with parallel syntactic structure but which involve D-quantification do not generally allow backwards anaphora. These observations apply both to bound pronouns and to reflexives.

I have borrowed the terms A-quantification and D-quantification from Bach et al. (1995), who draw a fundamental distinction between quantification by determiners and quantification by elements which are not contained in the noun phrase, such as adverbs and auxiliaries ('A' is mnemonic for Adverbs, Auxiliaries, Affixes).

The generalization in (12) unveils a striking syntax-semantics correlation: backwards anaphora is blocked in case the DP construed with the pronoun acquires its quantificational force from the determiner which projects it. In what follows, we will offer an explanation for this fact. But before that, an analysis of our sentences involving backwards anaphora is called for.

2 Analysis

2.1 Weak Crossover

Weak crossover and semantic partition Let us first consider simple sentences such as (2), repeated below for convenience:

2. Usually, [a published story about his$_i$ private life] describes [a politician]$_i$ negatively.

A remarkable fact about (2) is that it has only an object-asymmetric reading. To see this, consider the following situation: there are 20 published stories about a politician and 6 politicians; 15 stories describe negatively one and the same politician; the other 5 stories make favourable descriptions of the remaining 5 politicians. Sentence (2) is judged as false in this situation, which shows that (2) has neither a subject-asymmetric reading nor a symmetric one.

To analyze the meaning of (2), we must: 1) come up with a well-motivated semantic partition of the sentence, and 2) give a semantic analysis of the two indefinites.

Let's start by considering a factor that is crucial to the determination of the semantic partition of a sentence, namely the distribution of old and new information in that sentence. I will make the two claims below about sentence (2):

13. a) The of sentence (2) is the subject noun phrase.
    b) The object noun phrase 'a politician' is a non-novel indefinite.

Two terms used in (13) need some clarification: the term 'topic' in (13a) and the term 'non-novel indefinite' in (13b). Following Vallduví (1990) and Portner and Yabushita (1997), I use the term 'topic' as referring to a phrase which satisfies two conditions: definiteness and aboutness. As for the term 'non-novel indefinite', I have borrowed it from Krifka (1998), who suggests that some indefinites presuppose their index. According to Krifka, non-novel indefinites have defining characteristics that distinguish them from both (novel) definites and regular indefinites. Unlike regular indefnintes, non-novel indefinties introduce a new index by accommodation, not by assertion. Unlike (novel) definites, non-novel indefinites do not carry a uniqueness presupposition. Krifka points out a prosodic property of non-novel indefinites, namely the fact that they are destressed, an indication of their anaphoric nature (cf. Ladd (1980)). For lack of space, I will not go here into Krifka's arguments for the existence of non-novel indefinites. I will, however, make use of this type of indefinite for the analysis of (2).

The two claims about sentence (2) which are stated in (13) can be supported by evidence from intonation. Consider the sentences in (14)-(15), which are shorter than (2), but have parallel syntactic structure and pattern of anaphoric relations:

14. Usually, [a prolonged strike by its$_i$ employees] — rúins [a company]$_i$.

15. Usually, [a published story about his$_i$ private life] — destróys [a politician]$_i$.

A first fact to note about the intonation of the sentences above is the intonation break between the subject and the predicate. This intonation pattern is characteristic of sentences that have a topic-comment structure, with the subject functioning as the topic of the sentence (cf. Krifka et al. (1995)).

A second relevant fact about the intonation of (14)-(15) is that the object noun phrase is destressed and the nuclear stress falls instead on the verb. What could cause the destressing of the indefinite objects in (15)-(16)? Let's take (15), for example. This sentence would normally occur in a discourse about politicians; that is, a discourse about the kind 'politician'. In such a context, the speaker can quite plausibly accommodate an instantiation of the kind, i.e. an individual politician. In this case, the object indefinite picks an already existing discourse referent, namely one introduced by accommodation. Being anaphoric in nature, it cannnot carry nuclear stress and gets destressed.

Having established that the indefinite subject is the topic of the sentence and that the indefinite object is a non-novel indefinite, I will resort to some by now standard principles of semantic partition. Following proposals by Berman (1989) and Partee (1992, 1995) among others, I will assume that presuppositions of quantified sentences are accommodated in the restrictor of the quantifier. Given the notion of 'topic' that we work with, as well as Krifka's characterization of the notion of a non-novel indefinite, both the subject and the object indefinite will contribute to the content of the restrictive term.

Weak crossover and functional indefinites Going now to the second task, namely a semantic analysis of the indefinites in (2), I will note that sentence (2) is reminiscent of one class of 'reconstruction' sentences. In the case of 'reconstruction', a pronoun or a reflexive contained in a fronted constituent is bound by an antecedent which c-commands the gap associated with the fronted phrase. The kind of reconstruction sentences we are interested in are those in which the binder is a quantifying noun phrase, as, for instance, in (16):

16. [Which of his$_i$ novels] did [every author]$_i$ read from $\emptyset$?

Engdahl (1986) suggests a semantic approach to 'reconstruction' in wh-questions in which she makes use of a variable over relations in the translation of 'reconstructed' wh-phrases. Engdahl adduces independent evidence for a relational analysis of wh-phrases from question-answer pairs such as the following, in which the answer is a functional one:

17. Q: Who does every man love best ?

    A: His mother.

18. Q: [Which of his$_i$ novels] did [every author]$_i$ read from ?

    A: His latest novel.

As first observed by Groenendijk and Stokhof (1984: 196ff.), not only wh-phrases, but also indefinites, must sometimes be given a functional interpretation. This can be seen from (19b):

19. There is [a woman who every Englishman loves]

    a. namely the Queen (= 'individual continuation')

    b. namely his mother. (= 'functional continuation')

In (19b), the referent of the indefinite 'a woman who every man loves' is given by what Groenendijk and Stokhof call 'the functional continuation' of the sentence.

Given that indefinites sometimes have a functional interpretation anyway, I will resort to a functional analysis of the indefinite subject in (2) (i.e. 'a published story about his private life'), which, just like Engdahl's wh-phrases, contains a pronoun bound by a non-c-commanding antecedent.

Topic, weak crossover and scope Having an answer to both the question of the semantic partition of sentence (2) and the question of the analysis of the two indefinites in (2), we are at the point where we can propose the following semantic representation for this sentence:

20. $\exists$ f MOST$_x$ [politician (x) $\wedge$ story-about-x's life (f(x))] [describe-negatively (f(x), x)]

The representation in (20) takes into account the topichood of the subject indefinite and the presuppositional character of the object indefinite. The function variable in (20) is introduced by the subject indefinite, i.e. the indefinite which contains a bound pronoun. The variable 'f' is not of the appropriate semantic type to be bound by the unselective quantifier introduced by the adverb of quantification. What is the source of the wide scope existential quantifier that binds the function variable?

Since the function variable is introduced by the topic of the sentence and we work with a notion of topic which requires both aboutness and definiteness, the topic of (2) should be linked to an already existing discourse referent. But since the topic of (2) is an indefinite, it cannot directly satisfy the definiteness condition in the notion of a topic that we have adopted. If we want to maintain this notion and at the same time to take into account the evidence from intonation for the topicality of the indefinite subject, we will have to analyze the subject indefinite as a non-novel indefinite, i.e. an indefinite whose index is introduced by accommodation.

Just as in the case of the non-novel object indefinite, we need some previously existing discourse referent that facilitates the accommodation of 'a published story about his private life'. This discourse referent can be the kind 'published story'. By definition, any story has a theme: the thematic role 'theme' is part of the thematic grid of the noun 'story'. Thus, the already existing discourse referent represents the kind 'published story (about something)', where 'about something' is contributed by the thematic grid in the lexical entry of the noun 'story'. If there is already an established discourse referent for the kind 'published story (about something)', the speaker can accommodate an instantiation of this kind, namely 'a published story about his private life'.

In our analysis of sentence (2), 'a published story about his private life introduces two variables in the restrictor of the adverbial quantifier: the individual variable 'x', which is bound by 'MOST, and the function variable 'f', which remains free. I suggest that the function variable is bound with wide scope existential closure because it is introduced by accommodation and linked via the kind-object relation to an already existing discourse referent.

The formula in (20) is logically equivalent to (21):

21. MOSTx $\exists$ y [politician (x) $\wedge$ story-about-x's life (y)] [describe-negatively (y, x)]

Given the scope relations in (21), we can conclude that weak crossover effects do not arise if the antecedent of the pronoun is bound with wider scope than the pronoun-containing noun phrase.

A similar conclusion is reached in Comorovski (1997) concerning the possibility of backwards anaphora in the antecedent clause of conditional donkey-sentences, as exemplified in (3) above.

Weak crossover and D-quantification As we have seen in section 1, weak crossover effects do not necessarily appear in sentences in which the domain of quantification of the determiner heading a non-subject DP is already given. This fact was illustrated by sentences (5) and (6):

5. [Two of its$_i$ borrowers] damaged [each book]$_i$. (Comorovski (1996))

6. (?) [An article about his$_i$ leadership qualities] described [each presidential candidate]$_i$ in glowing terms.

Comorovski (1985, 1996) and E. Kiss (1993) note that non-subject noun phrases can take scope over the subject only if they are headed by a determiner which quantifies over an already given domain. Since the non-subject noun phrases in (5) and (6) are presuppositional, it appears again that weak crossover effects get cancelled just in case the antecedent of the pronoun scopes over the noun phrase which contains the pronoun.

Conclusion Weak crossover effects do not arise if the antecedent of the bound pronoun has wider scope than the noun phrase containing the pronoun.

2.2 Reflexive Binding

Pollard and Sag (1992) and Reinhart and Reuland (1993) note that grammatical binding conditions apply only to co-arguments of a verb. Therefore, reflexives in picture-NPs do not fall under such conditions. According to these authors, reflexives in picture-NPs are very much like pronouns, but are subject to an additional discourse constraint: they must be either emphatic or logophoric.

To take an example, the reflexive 'herself' in sentence (22) below is contained in a picture-NP and is not c-commanded by its antecedent 'Mary', whose referent is the 'subject of consciousess' in the text (to borrow Zribi-Hertz's (1989) term).

22. The picture of herselfi on the front page of the Times confirmed the allegations Maryi had been making over the years. (Pollard and Sag (1992))

Note, however, that the reflexives in our examples (8), (9), and (12) are neither emphatic nor logophoric (they do not refer to the individual whose point of view is represented in the text). We conclude that reflexives which appear in picture NPs and are bound by an A-quantifier are subject to neither grammaticality conditions nor a discourse-based condition such as logophoricity.

In sentences (8), which just like sentence (2) has only an object asymmetric reading, the antecedent of the reflexive has wider scope than the picture-NP containing the reflexive (the analysis is the same as for (2)). These scope relations allow the reflexive to be construed with a non-c-commanding antecedent.

3 Backwards anaphora and the syntax-semantics interface

Recall our generalization in (12), repeated below for convenience:

12. *A-quantification, D-quantification and backwards anaphora* Backwards anaphora is possible in sentences involving A-quantification. Sentences with parallel syntactic structure but which involve D-quantification do not generally allow backwards anaphora. These observations apply both to bound pronouns and to reflexives.

I will relate the generalization in (12) to an obvious syntactic difference between A-quantifiers and D-quantifiers. The latter have a fixed position, which is moreover inside the noun phrase (in English, at least). The former - whether they are adverbs of quantification or modal verbs - are situated outside the noun phrase. I believe that this syntactic difference is responsible for the possibility of backwards anaphora in contexts of A-quantification, but not of D-quantification.

The scope of noun phrases headed by a quantifying determiner is syntactically determined by c-command and/or precedence relations (cf. Fodor (1982)). As an exception to this generalization about scope, we have seen the case of noun phrases headed by a determiner which quantifies over an already given domain; presuppositionality and scope obviously interact. The role of existential presupposition in determining scope in the case of D-quantification is an issue I will put aside.

A-quantifiers are situated outside the noun phrase. The freedom of their scope could in principle be traced to one of the following two factors: 1) c-command, or 2) syntactic freedom. Let us briefly examine them in turn.

Adverbs of quantification, and in particular frequency adverbs, do not have a fixed position in the sentence: they can occur sentence-initially, sentence-finally, immediately before or immediately after the leftmost element of the verbal auxiliary complex. They can be argued to c- command the subject from at least some of these positions if several theoretical assumptions are made, among which are the definition of c-command and dominance. As for modal verbs, whether they do or do not c-command the subject depends on the answer to the hotly debated issue of the syntactic structure of the verbal auxiliary system. We see then that an attempt to reduce scope possibilities to c-command in the case of A-quantifiers depends both on theory- internal decisions and on syntactic analyses about which there is no wide agreement for the moment.

I will therefore take the second course and suggest that the freedom of the scope of A- quantifiers is related to the fact that they are outside the noun phrase and therefore, as different from D-quantifiers, their position does not depend on that of the noun phrases they are associated with. In the case of adverbs of quantification in particualr, it is very tempting to attribute their freedom of scope to their syntactic freedom.

Bibliography

Bach, E. et al. (1995): *Quantification in Natural Languages*, Kluwer, Dordrecht.

Berman, S. (1989): 'An Analysis of Quantificational Variability in Indirect Wh-Questions', *Proceedings of WCCFL 8.*

Comorovski, I. (1985): 'The Strong/Weak NP Distinction in File Change Semantics', ms., U. of Massachusetts/Amherst.

Comorovski, I. (1996): *Interrogative Phrases and the Syntax-Semantics Interface*, Kluwer, Dordrecht.

Comorovski, I. (1997): 'Functional Indefinites and the Proportion Problem', to appear in the Proceedings of The Second Paris Syntax and Semantics Conference.

Engdahl, E. (1986): *Constituent Questions*, Reidel, Dordrecht.

Fodor, J. D. (1982): 'The Mental Representation of Quantifiers', in S. Peters & E. Saarinen, eds., *Processes, Beliefs, and Questions*, Reidel, Dordrecht.

Grimshaw, J. (1990): *Argument Structure*, MIT Press.

Groenendijk, J. & M. Stokhof (1984): *Studies on the Semantics of Questions and the Pragmatics of Answers*, Doctoral dissertation, U. of Amsterdam.

E. Kiss, K. (1993): 'Wh-Movement and Specificity', *Natural Language and Liguistic Theory* 11.

Krifka et al. (1995): 'Introduction', in G, Carlson & F. Pelletier, eds., *The Generic Book*, University of Chicago Press.

Krifka, M. (1998): 'Topical Indefinites', paper read at the Conference on the Structure of Non-narrative Texts, University of Texas/Austin.

Ladd, R. (1980): *The Structure of Intonational Meaning: Evidence from English*, Indiana University Press, Bloomington.

Partee, B. Hall (1992): 'Topic, Focus, and Quantification', in *Proceedings from Semantics and Linguistic Theory (SALT) I.*

Partee, B. Hall (1995): 'Quantificational Structures and Compositionality', in Bach et al.

Pollard, C. & I. Sag (1992): 'Anaphors in English and the Scope of Binding Theory', *Linguistic Inquiry* 23.

Portner, P. & K. Yabushita (1997): 'The Semantics and Pragmatics of Topic Phrases', to appear in *Linguistics and Philosophy.*
Reinhart, T. & E. Reuland (1993): 'Reflexivity', *Linguistic Inquiry* 24.
Vallduví, E. (1990): *The Informational Component*, Doctoral dissertation, U. of Pennsylvania.
Zribi-Hertz, A. (1989): 'Anaphor Binding and Narrative Point of View: English Reflexive Pronouns in Sentence and Discourse', *Language* 65.

Chapter 7

Information Packaging in Japanese

JOHN FRY AND STEFAN KAUFMANN

ABSTRACT. In Sections 1 and 2 we examine the information structure of Japanese through the lens of Vallduví's theory of information packaging. Certain Japanese phenomena lead us in Sections 3 and 4 to consider two extensions to the standard filecard model that are inspired by centering theory and database design.

1 Japanese *wa* as a link marker

In Vallduví's analysis of Catalan [Val92, Val93], the overt material in the core clause is interpreted as focus; ground elements are detached from the core, with links (filecard addresses) conveniently detached to the left and tails (record pointers) to the right. If it turned out that Japanese also manifested neat grammatical distinctions for link, focus, and tail, then this fact would be a strong argument in support of Vallduví's model.

Previous authors [Wat89, Hey94, Kai98, PY98] (whose insights we build on here) take as their point of departure the assumption that the postpositional topic marker *wa* is the link marker in Japanese. This is reasonable as a first approximation; however, in this section we argue that *wa*-marking is in fact neither a necessary nor sufficient condition for linkhood.

Thematic and contrastive *wa*

It is well known that *wa*-marked phrases sometimes carry a contrastive rather than thematic reading [Kun73, Chap. 2]. A number of properties distinguish the two uses. Thematic *wa* is restricted to discourse-salient referents, while contrastive *wa* can mark new information. A thematic *wa*-phrase goes unstressed, while a contrastive *wa*-phrase receives prominent intonation. A sentence is restricted to at most one thematic phrase, which if present appears in sentence-initial position; however, multiple elements within the sentence can be marked *in situ* with contrastive *wa*. And while the topic generally falls outside of the scope of negation, phrases marked by contrastive *wa* are interpreted as the target of negation [McG87]. Thus the properties of thematic *wa* match up nicely with Vallduví's characterization of the link. Contrastive *wa*-phrases which contain new information and receive prominent intonation should be considered focus elements.

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Gosse Bouma, Geert-Jan Kruijff & Richard Oehrle (editors).

Two thematic *wa*'s

Presumably, the claim that *wa* marks linkhood is a claim about the thematic *wa* and not the contrastive one. However, some instances of thematic *wa* cannot be interpreted as link instructions. Shibatani [Shi90, Sec. 11.2] makes a distinction between two types of preposed *wa* sentences. The first represents a true categorical judgment [Kur72] about the entity which is the *wa*-marked topic. An example is sentence (7.1a), in which the topicalized element *kyou* ('today') denotes an entity about which a property is asserted.

(7.1) a. *Kyou-wa* [*tenki-ga* *ii*].
today weather-SUBJ is good
'Today is such that the weather is good.'

b. *Kyou-wa* [*boku-ga* [e] *ryouri-siyou*].
today I-SUBJ cook-do-VOL
'Today, I will cook.'

The second type, exemplified by (7.1b), Shibatani calls the 'stylistic' topic construction. Here an element is *wa*-marked and fronted, but the effect is of mild emphasis rather than true topicalization. Shibatani suggests that a true topic construction like (7.1a) is base-generated, while the stylistic topic results from movement of the fronted element out of the predicate, as indicated in (7.1b). In any case, the phenomenon includes examples like the *wa*-marked PPs in (7.2) and (7.3).

(7.2) *Hatizi-made-wa* *matu*
8 o'clock-until wait
'(I will) wait until eight o'clock.'

(7.3) *Tookyoo-kara-wa* *John-ga* *kita.*
Tokyo-from John-SUBJ came
'From Tokyo, John came.'

Whatever the *wa*-marked phrases in (7.1b)-(7.3) denote, clearly they are not links. Heycock [Hey94], who takes the function of *wa* to be link-marking, notes that one could perhaps argue instead that Japanese has a particular syntactic position (e.g. SpecCP) that is specialized for links, as in Catalan. A Japanese sentence is restricted to at most one thematic *wa* phrase, including the 'stylistic' one. It follows that if the thematic *wa* phrase in fact occupies a particular syntactic position, then this slot may well be specialized for links, but not exclusively, since it can sometimes host nonlinks as well.

The particle *ga*

The Japanese postpositional particle *ga* is often viewed as a nominative case marker; it marks the grammatical subject of a sentence.[1] Whether the subject of a sentence is marked by *wa* or *ga* conveys a variety of information about it, and this contrast has received much attention [Kur72, Kun73, HMI87, Wat89]. One difference is that *ga* is often used to introduce new discourse entities. Thus *ga* is often a focus marker, analogous to the A accent [Jac72] in English. Heycock [Hey94] also gives

[1]For a restricted class of transitive predicates *ga* marks the object.

an example where a *ga*-phrase acts as a tail rather than a focus element. However, she takes *wa*-marking to be a necessary condition for linkhood and therefore rules out the possibility of *ga*-phrases behaving as links.

Under Vallduví's analysis, all preverbal subjects of Catalan are interpreted as links. In English, subjects with B accent are links. It seems to us that despite the association of *ga* with new information, Japanese subjects marked with *ga* are sometimes links too.[2] For example, a request for information about John is naturally answered with *John-wa kaetta* ('John left'), but could also be answered with *John-ga kaetta* ('What John did was leave'). The latter response might be used when leaving is seen as a surprising or unlikely activity for John. Shibatani [Shi90, Sec. 11.2] gives other examples where *ga* is used instead of *wa* in a discourse to present the events as discrete scenes, as if each event were witnessed afresh. In cases like these, *ga*-marked phrases are sentence-initial ground elements whose corresponding filecards are the only plausible destinations for the propositions expressed by the sentences in which they occur. We conclude then that not all tokens of *wa* are link markers, and not all links are marked by *wa*.

2 Other facets of Japanese information structure

Prosody

In Japanese, intonational prominence (like word accent) is realized mainly through pitch. The locus of Japanese sentence accent falls on the leftmost accentable constituent of the accent phrase. The sentence accent generally marks the point of information focus or contrastive prominence in the utterance. In the unmarked case, the location of the accent is determined by the syntax; a sentence whose sentence accent deviates from the unmarked pattern generally receives a contrastive or narrow focus reading.

The examples in (7.4) illustrate the effect of sentence accent falling on different constituents in the sentence. Here we use boldface to mark morae that are slightly above the intonation baseline (e.g. word accents), and upper-case to mark the higher-pitch sentence accent, corresponding roughly to the A accent in English.

(7.4)	a.	KEsa	o**ka**si-o	**tabete-ima**sita.
		this morning	cakes-OBJ	eating-was

'I was eating cakes THIS MORNING.'

b. **ke**sa oKAsi-o **tabete ima**sita.
'I was eating CAKES this morning.'

c. **ke**sa o**ka**si-o TABETE IMAsita.
'I was EATING cakes this morning.'

Utterance (7.4b) bears unmarked sentence accent and hence allows both broad and narrow focus readings. That is, it can be interpreted as an answer to the general query "What were you doing this morning?" as well as "What were you eating this morning?" On the other hand, (7.4a) and (7.4c) can only be interpreted as narrow-focus answers to specific queries. All three examples in (7.4) can also receive contrastive focus interpretations.

[2]This is not a contradiction, since it is sometimes possible for the link to point to a new address, thereby simultaneously creating and pointing to that filecard [Val92].

Most accentable		$\Longleftrightarrow$		Least accentable
ga-phrases/wh-words	nouns	adverbs	*wa*-phrases	verbs/particles

Table 7.1: Scale of accentability [Mat84]

Japanese exhibits what Vallduví calls 'plastic' intonational structure—the prosodic structure of the sentence is fairly malleable to the information packaging needs of the speaker. Matsunaga [Mat84] observes however that certain syntactic categories are more likely to receive sentence accent than others, as illustrated in Table 7.1.[3] Not surprisingly, the focus-accentability of thematic *wa* phrases, which refer anaphorically to already salient entities, is lower than that of *ga* phrases which usually refer to new information.

Constituent ordering

The ordering of constituents within a Japanese sentence is another parameter that conveys aspects of its information structure. In Japanese (as in many 'free' word order languages), given information tends to precede new information within the sentence. Prague school approaches [SHP86] assume that elements exhibit a fine gradation of 'communicative dynamism' from left to right across the sentence. Many approaches assume explicit syntactic slots for topic and focus—topic is assumed to occupy a leftmost position detached from the rest of the sentence, with the default focus position just to the left of the verb (cf. Hungarian, Basque, Turkish).

Japanese enjoys freer word order than English, although SOV is the preferred, unmarked configuration and the verb must be sentence-final. Grammatical functions are identified by overt, postpositional case particles such as *ga* (subject) and *o* (object). Although an object may precede the subject, the presence of more than one object in front of the subject sounds unnatural—thus Japanese "scrambling" phenomena are sometimes characterized as "fronting" (implying less freedom). The fronting of a constituent tends to mildly emphasize it and increase its salience.

The post-verbal construction

As noted above, the verb must come at the end of a sentence and cannot be scrambled. However, in colloquial speech certain constituents can sometimes appear after the main verb, as illustrated in (7.5).

(7.5)	*Mou*	*yonda,*	*kono*	*hon.*
	already	read,	this	book

'I've already read this book.'

The pragmatic effect is that the postposed phrase seems to suggest some kind of afterthought. The intonation pattern also implies this, since the verb is uttered with the usual sentence-final falling intonation, and the postposed element is added quickly with low, flat intonation.

Kaiser suggests that Japanese uses this construction as a means of overtly marking tails [Kai98]. Her analysis is attractive in that it meshes with Vallduví's

[3] Note that prosodic focus can be so narrow that even individual particles receive sentence accent (Table 7.1).

	English	**Catalan**	**Japanese**
Intonation	plastic	nonplastic	plastic
Word order	links optionally front	ground detached	flexible, given→new
Focus	A-accent	A-accent, core clause	A-accent, default preverbal slot
Link	B-accent, often initial	left-detached, unaccented	*wa*-marked, sentence-initial, unaccented
Tail	non-link	right-detached	non-link, optionally right-detached

Table 7.2: Crosslinguistic comparison

identification of right-detached elements in Catalan with tails. Furthermore, the characterization of the postposed phrases as afterthoughts implies that they would be good candidates for helpful *update-replace* instructions, i.e. tails. Unfortunately, however, the comparison with Catalan again falls somewhat short. First, as Kaiser acknowledges, the postposed elements are not always hearer-old. Secondly, *wa*-marked topics, ostensibly links, can be postposed. Kaiser excludes the possibility of non-initial links in principle; however, examples of non-sentence-initial links are found in many languages [EV94, p. 50], so this assumption might be questioned.

Conclusion

Having surveyed the major information packaging phenomena of Japanese, we compare them to the corresponding features of English and Catalan in Table 7.2. This table is intended to complement similar crosslinguistic charts in [EV94]. As we argued, however, the fit of the Japanese entries in Table 7.2 is not always a comfortable one. While the particle *wa* is generally associated with the link, the association is not exclusive in either direction; similarly, while the postverbal construction often hosts tails, nontails can be postposed as well.

In the next two sections we consider some extensions to the standard filecard model which are motivated by certain facts about Japanese as well as theory-internal considerations. We warn that this subsequent material is somewhat speculative and is not intended to provide a full account of the material covered in Sections 1 and 2.

3 Information packaging and centering

Weak pronominals, including English unaccented pronouns as well as clitic pronominals and zero pronouns in Catalan, are "inert as far as information packaging is concerned" [EV94]. For example, in the focus-tail utterance [[(*But he's*) NOT_F] $dead_T$], the weak pronoun *he* appears within the focus phrase by default, but in fact is not associated with any instruction type. For link-less utterances it is assumed that the locus of update is either inherited from earlier in the discourse or is somehow recoverable from context.

In Japanese, the ubiquity of zero pronouns means that constituents that would be part of the ground if expressed overtly are frequently omitted, resulting in a large percentage of utterances that are mostly or entirely focus. This raises a question about how the information in highly underspecified Japanese utterances is in fact 'unpackaged' by the hearer: given impoverished instructions, how is the locus of update to be selected?[4]

One approach to this "missing link" problem is suggested by the centering discourse processing model [GJW95]. Centering and information packaging are inherently compatible: both models keep track of the entities mentioned in a discourse, and both view the sentence as providing a function from an input information state to an output state. We propose a natural point at which to integrate these two compatible models: the identification of the locus of update of an utterance U_i with U_i's preferred center Cp.[5] Note that for sentences with *wa*-marked links, one would expect the link to become the preferred center anyway, since topic takes the highest position in the Japanese Cf ranking hierarchy [Kam85, WIC94]. For linkless utterances, the Cp would provide the file clerk with a useful (but defeasible) heuristic about which card to select.

As Dekker and Hendriks [DH94] point out, given Vallduví's notion of the current locus of update, the tools are in place for determining pronominal reference within the information packaging system. An integrated approach would seem to offer an enriched model in which both information update and pronoun resolution are accounted for.[6]

4 A closer look at the file system

What the file clerk points to

A problem arises in Vallduví's system when the link represents a property or a relation, as in (7.6).

(7.6) a. *Dare-ga siawase desu-ka*
Who-SUB happy COP-Q
'Who is happy?'

b. *Noriko-da.*
Noriko-COP
'Noriko.'

c. *Siawase-nano-wa Noriko da.*
happy-NOMIN Noriko-COP
'It is Noriko who is happy.'

[4]Heycock [Hey94] proposes that for sentences with stage-level predicates, an implicit Davidsonian event argument could be interpreted as the link. Portner and Yabushita [PY98] also consider this approach but note some problems with it.

[5]Due to lack of space we must assume familiarity with centering concepts like the backward-looking (Cb), forward-looking (Cf) and preferred (Cp) centers, and the basic discourse transition relations. Hoffman [Hof98] also considers the packaging/centering interface, but seems to identify the locus of update with the Cb, not the Cp. The distinction becomes important during a RETAIN transition between utterances U_i and U_{i+1}, where $Cb_{i+1} = Cb_i$ but $Cb_{i+1} \neq Cp_{i+1}$. If an element e is introduced via a link in U_{i+1}, then e becomes the new Cp (sentence topic), but not the Cb (discourse topic).

[6]The first author and his colleagues are working on an implementation of this approach in the form of a Japanese spoken dialogue system [FAM98].

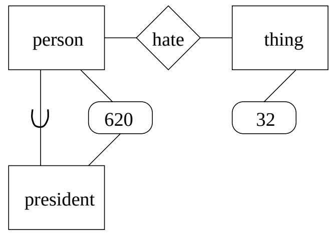

Figure 7.1: The president hates the Delft china set

An alternative to the all-focus response (7.6b) is (7.6c), whose information structure can be preserved in the English rendering by it-clefting. In either case, what filecard did the hearer's file clerk select after the utterance of (7.6a) for the addition of this information, and how was the update performed? The only active card involved seems to be the one standing for Noriko.

In order to account for such cases, a system is needed in which the clerk can point to properties. To provide this, we suggest a modification of Vallduví's metaphor of the filecard system to one closer to a *relational database* [Ull82]. Here we will use only a common high-level description language of such databases, viz. the ER (Entities and Relationships) model introduced in [Che76].

Figure 7.1 illustrates some of the basic conventions of the ER model: Names of sets of individuals (*entities*) are enclosed in rectangles, *relationships* between entity sets in diamonds. The connecting lines indicate that the *hate* relationship holds between certain *persons* and *objects*. *Attributes*, written in ovals, associate values from some domain directly with single entities or relationships. Where the mapping from the values to the entities or relations is a function, the attribute is a *key*. Each entity is assigned its *primary key* (PK), which uniquely identifies it (this role is played by arbitrary, but unique numbers in the figure). In this way, an individual's primary key is "scattered" throughout the objects representing its properties and the relationships it participates in.[7]

For the discourse in (7.6), then, suppose that *happy* is an entity set, standing for a set of (1-tuples of primary keys of) persons. Then (7.6b) is felicitous only if the file clerk already holds the address of this entity set. When encountering (7.6b), it adds the key belonging to *Noriko* to the set. If the file clerk had been pointing to a different location, incompatibility or miscommunication would have resulted. (7.6c) is slightly more robust in this last respect. It can lead to a successful update even if the file clerk is pointing to some other location than that of *happy*. Here the *wa*-marked phrase (link) directs the file clerk to the *happy* table, where Noriko's primary key is added.

What the file clerk is

The file clerk is often depicted as something that moves about in the file system and points to cards. For example, consider (7.7).

[7]Instances of entities or relationships can then be represented as *tuples* of PK values, i.e. sequences of length n for n-ary relations. The tuples are encoded as rows in tables (whose columns correspond to *roles*), which make up the database.

(7.7) a. *Katyou-wa osusi-o dou sita?*
boss-TOP sushi-OBJ how did-DO-Q
'What did the boss do to the sushi?'

b. *Tabetano.*
ate
'He ate it.'

Here the file clerk is sent to a record for sushi on the card for the boss, and the information that the former ate the latter is added. But this is not the end of the update: a hypercard-style pointer to the boss card must be added to the sushi card as well [Val94]. Thus the record, though entered on only one filecard,[8] ends up equally visible from both locations. This system is claimed to be more "efficient" than one where the record is written on all the filecards. This is true with respect to the number of times the information is written; however, as Hendriks and Dekker note [HD96], in Vallduví's model the file clerk still has to make new moves as the number of arguments grows.

From another (equivalent) perspective, the file clerk can be viewed as a variable holding addresses. Moving around then corresponds to changing its value. In (7.8b) this variable seems to keep track of more than one location:

(7.8) a. *Katyou-wa kinou kaetta.*
boss yesterday left
'The boss left yesterday.'

b. *Kyou-wa nokoru.*
today stay
'Today he's going to stay.'

c. *Kyou-wa kayoubi-da.*
today Tuesday-COP
'Today is Tuesday.'

In (7.8b), *kyou-wa* is used contrastively (against *kinou*). In filecard terms, *katyou* remains the locus of update, but a new record is indicated on that filecard. Contrast this with (7.8c), a true topic construction, where *katyou* is replaced by *kyou* as the locus of update. In both cases, *kyou-wa* is instructing the clerk to point to the location of *today*; however, in (7.8b), *katyou* remains the locus of update (and the *Cp* of the centering theory discussed in Section 3). It appears that (7.8b) somehow involves two addresses; that is, the clerk points to both *katyou* and *kyou* (replacing *kinou*) simultaneously.

Here we illustrate how a single database update can produce the same result as in the traditional filecard model. We identify the stage at which information packaging is relevant with the *interface* where database operations are prepared. In the case of example (7.8), the file clerk values on the left are used to build the database instructions on the right (here using SQL syntax):

(7.9) a. $\langle \mathit{Leave}, b, y\rangle \mapsto$ `insert into L values b, y`
b_1. $\langle \mathit{Leave}, b, t\rangle$
b_2. $\langle \mathit{Stay}, b, t\rangle \mapsto$ `insert into S values b, t`

[8]Portner and Yabushita [PY98, p. 120–7] suggest that there is in fact a real asymmetry that Vallduví's system accounts for. They note that a discourse entity e is more readily picked out with information that was previously attributed to e when e was a *wa*-marked topic, i.e. when this information was updated on e's filecard specifically. Presumably symmetrical update systems like Heim's and DRT (and the one we propose here) cannot capture this asymmetry. We cannot discuss their data here; while they are interesting, they involve very subtle judgments in which the information packaging account must be carefully weighed against competing pragmatic explanations.

Line (7.9b_1) shows the result of processing *kyou-wa* in (7.8b). The argument y is replaced with t in the file clerk settings (recall that changing this value amounts to moving the file clerk to the location of *kyou*). The key b corresponding to *katyou* remains the underlying topic and is reused from the clerk for this instruction. Finally, the focused element *nokoru* is inserted into the SQL expression, producing the final instruction in (7.9b_2).[9]

Conclusion

To sum up the ideas in this section: The file clerk variable is a tuple holding addresses of both entities and relationships. As the interface to the knowledge store (seen here as a relational database), the clerk, equipped with centering-style heuristics, is charged with keeping track of the discourse context while generating database update instructions.

This picture is not incompatible with proposals for replacing the filecard metaphor with DRSs [DH94]. As Engdahl and Vallduví observe [EV94], filecards play a role similar to that of DRT's discourse referents, although the former have no equivalent to the latter's semantics of embedding. In addition, the file system has the clerk variable, which can assist in what in expositions of DRT is usually called "finding a suitable antecedent."[10] An integrated discourse model might use something akin to a DRS which objectifies properties and relations similarly to the ER formalism and has an additional layer of structure to represent the file clerk.

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Bibliography

[Che76] Peter Pin-Shan Chen. The entity-relationship model—toward a unified view of data. *ACM Transactions on Database Systems*, 1(1):9–36, 1976.

[DH94] Paul Dekker and Herman Hendriks. Files in focus. In Elisabet Engdahl, editor, *Integrating Information Structures into Constraint-based and Categorial Approaches*. ILLC-Department of Philosophy, University of Amsterdam, 1994. DYANA-2 Deliverable R1.3.B.

[EV94] Elisabeth Engdahl and Enric Vallduví. Information packaging and grammar architecture: A constraint-based approach. In Elisabeth Engdahl, editor, *Integrating Information Structure into Constraint-based and Categorial Approaches*, pages 39–79. ILLC, Amsterdam, 1994. DYANA-2 Report R.1.3.B.

[9] The reader may have noticed that file clerk values of the form $\langle R, x, y\rangle$ are reminiscent of the *infons* of situation semantics. This connection might be a promising object for further study.

[10] To be sure, the analogy has its limits: Besides making discourse referents available, a major aim of DRT is to predict when they are *inaccessible*. Vallduví's theory makes no attempt to explain the same set of data.

[FAM98] John Fry, Hideki Asoh, and Toshihiro Matsui. Natural dialogue with the Jijo-2 office robot. In *Proceedings of IEEE/RSJ International Conference on Intelligent Robotic Systems, IROS-98*, Victoria, B.C., Canada, 1998.

[GJW95] Barbara J. Grosz, Aravind K. Joshi, and Scott Weinstein. Centering: A framework for modelling the local coherence of discourse. *Computational Linguistics*, 21(2):203–225, June 1995.

[HD96] Herman Hendriks and Paul Dekker. Links without locations. In Paul Dekker and Martin Stokhof, editors, *Proceedings of the Tenth Amsterdam Colloquium*, pages 339–358. ILLC-Department of Philosophy, University of Amsterdam, 1996.

[Hey94] Caroline Heycock. Focus projection in Japanese. In *Proceedings of NELS 24*, Amherst, MA, 1994. Graduate Linguistics Students Association.

[HMI87] John Hinds, Senko K. Maynard, and Shoichi Iwasaki, editors. *Perspectives on Topicalization: the Case of Japanese* wa, volume 14 of *Typological Studies in Language*. Benjamins, Amsterdam and Philadelphia, 1987.

[Hof98] Beryl Hoffman. Word order, information structure, and centering in Turkish. In Marilyn A. Walker, Aravind K. Joshi, and Ellen F. Prince, editors, *Centering Theory in Discourse*, pages 253–271. Clarendon Press, Oxford, 1998.

[Jac72] Ray Jackendoff. *Semantic Interpretation in Generative Grammar*. MIT Press, Cambridge, MA, 1972.

[Kai98] Lizanne Kaiser. Representing the structure-discourse iconicity of the Japanese post-verbal construction. In Michael Darnell et al., editor, *Functionalism & Formalism in Linguistics*, Amsterdam, 1998. Benjamins.

[Kam85] Megumi Kameyama. *Zero Anaphora: The Case of Japanese*. PhD thesis, Stanford University, August 1985.

[Kun73] Susumu Kuno. *The Structure of the Japanese Language*. MIT Press, Cambridge, MA, 1973.

[Kur72] Sige-Yuki Kuroda. The categorical and thetic judgement: evidence from Japanese. *Foundations of Language*, 9:153–185, 1972.

[Mat84] Takashi Matsunaga. *Prosodic Systems of Japanese: Parametric Approach to the Analysis of Intonation*. PhD thesis, Georgetown University, 1984.

[McG87] Naomi Hanaoka McGloin. The role of *wa* in negation. In John Hinds, Senko K. Maynard, and Shoichi Iwasaki, editors, *Perspectives on Topicalization: the Case of Japanese* wa, volume 14 of *Typological Studies in Language*, pages 165–183. Benjamins, Amsterdam and Philadelphia, 1987.

[PY98] Paul Portner and Katsuhiko Yabushita. The semantics and pragmatics of topic phrases. *Linguistics and Philosophy*, 21(2):117–157, 1998.

[Shi90] Masayoshi Shibatani. *The Languages of Japan*. Cambridge University Press, Cambridge, 1990.

[SHP86] Petr Sgall, Eva Hajičová, and Jarmila Panevová. *The Meaning of the Sentence in its Semantic and Pragmatic Aspects*. Reidel, Dordrecht, 1986.

[Ull82] Jeffrey D. Ullman. *Principles of Database Systems.* Computer Science Press, second edition, 1982.

[Val92] Enric Vallduví. *The Informational Component.* Garland, New York, 1992.

[Val93] Enric Vallduví. Information packaging: A survey. Report prepared for *Word Order, Prosody, and Information Structure.* Centre for Cognitive Science and Human Communication Research, University of Edinburgh, 1993.

[Val94] Enric Vallduví. Updates, files, and focus-ground. Appeared in proceedings: P. Bosch and R. v.d. Sandt (eds.): *Workshop on Focus and Natural Language Processing.* IBM Deutschland, 649–658, 1994.

[Wat89] Yasuko Watanabe. *The Function of* wa *and* ga *in Japanese Discourse.* PhD thesis, University of Oregon, 1989.

[WIC94] Marilyn Walker, Masayo Iida, and Sharon Cote. Japanese discourse and the process of centering. *Computational Linguistics*, 20(2):193–233, 1994.

Chapter 8

Topic and Focus Structures

The Dynamics of Tree Growth[1]

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ABSTRACT. This paper deals with the syntactic realization of topic and focus as represented by Clitic Left Dislocation, Topicalization and Scrambling in a left-right parsing model which incrementally constructs a logical form while processing a natural language string from left to right. The aim is to provide a unifying cross-language typology for such dislocation structures, distinguishing them solely in terms of different growth strategies and their interaction with a process of anaphora resolution without requiring a grammar internal concept of anaphoric binding. This paper contributes to the LDS_{NL} framework which advocates a shift in the concept of a grammar formalism for natural language to a grammar as a schematic left-right parser.

1 Introduction

Despite a considerable amount of work on the semantics of focus, the relation between topic and focus is not often addressed in formal terms.[2] In this paper, we address the relatively modest goal of modelling the on-line process of interpreting the family of 'dislocation' structures known variously as Clitic Left-Dislocation (CLLD), Topicalization and Scrambling, presenting a typology across different language types. From a syntactic perspective, these structures are associated with different restrictions, and hence need to be given quite different characterisations. Pragmatically, despite widespread assumption to the contrary, as Prince [Prince, 1995] demonstrates in detail, none of the structures corresponds to but a single form of processing and constructing structural explanations for each form leads to multiplication of structural possibilities well beyond what is realised in any natural language. We shall argue that these structures are nevertheless to be explained in terms of the dynamics of language processing, by showing how the different cross-language effects arising from the interaction of long-distance dependency and anaphora resolution can be explained in terms of a model based on the step by step, left to right, processing of the structures in question. The explanation is in terms of an entirely general characterisation of pronoun construal, without a grammar-specific characterisation of resumptive (or any other sub-type of) pronouns. We shall take this to be indicative of the general perspective adopted - that a natural language grammar *is* a schematic parser integrating the articulation of

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[2]cf. [Porter & Yabushita, 1998] for a model-theoretic account of topic, and [Erteschik-Shir, 1997] for an account of topic and focus structures in terms of 'files'.

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the structural basis of natural language with pragmatic processes such as anaphora resolution.

The background framework is a formal model of the incremental process of natural language (NL) parsing, where this is defined as the progressive building up of a logical form corresponding to a possible interpretation of the string. The centrepin of the interpretation process is the concept of tree growth. Using a modal tree-description language (LOFT - [Blackburn & Meyer-Viol, 1994], we model the interpretation process for a sentence as the successive setting up of nodes in a tree representation of a logical form for that string. Each node comes into being with some set of *requirements* (for annotations on that node), which must then be progressively satisfied by annotations supplied by the string. Only those trees in which the requirements associated with all nodes are satisfied the moment the string has been completely traversed, can correspond to logical forms for a given string. We propose that the interpretive effects associated with CLLD and Topicalisation structures result from discrete ways of building up a logical form from the various strings, an explanation which (partly) turns on this requirement/annotation distinction. In dislocation structures lacking a resumptive pronoun, a tree description is constructed in which the focussed constituent projects a logical term as an *annotation* on a node that is as yet unfixed, (its position in the representational tree having to be subsequently defined). This reflects the fact that that term does not yet have a definite role in the (partial) logical form:

(1) The woman I met in London, John interviewed at length.

In structures with a resumptive pronoun, the focussed constituent projects the same logical term on an unfixed node, but now as a *requirement*. This will force every *grammatical* continuation of the string to contain a constituent projecting the necessary annotation:[3]

(2) As for the woman I met in London, John interviewed her at length.

The variation across languages according to whether dislocated constituents are sensitive to island constraints turns on the possible relations between the unfixed node and the root of the tree in which that node is created.

All strings displaying some dislocated expression will on this account project a propositional structure identical to that projected by the 'basic' string without dislocated constituents:

(3) John interviewed the woman I met in London at length.

As a consequence of our analysis simple and dislocated variants - (1) and (3) - will be assigned an identical propositional structure, and left-dislocated expressions with a resumptive pronominal in the main clause - (2) - will differ from these two only in projecting in addition a copy of some term from that propositional structure.

2 The LDS_{NL} Framework

The overall process of interpretation is modelled as a goal-driven, incremental, structure-building operation: the goal is to establish a logical formula of type t by setting up an annotated tree structure reflecting its combinatorial structure: the

[3]Such examples are only available in English with the *as for* construction.

formulae annotating the daughters of a node are combined (through, for instance, function application) to give the formula annotating the mother node. The annotations at a node of the tree are formulated in $LOFT$, a propositional modal *l*anguage *o*f *f*inite *t*rees (cf. [Blackburn & Meyer-Viol, 1994]).
— The atomic propositions of the language express that certain *label*- and *formula*-predicates have some value. The values of the Fo (*Fo*rmula) predicate are expressions of a lambda calculus with variable-binding-term operators. The set of label predicates includes the type predicate Ty, and other syntactic features. NPs are taken to project variable-binding term-operator expressions of type e which bind an open variable in formulae of type cn, projected by nominal expressions.
— The modalities of the language $LOFT$ for describing tree relations include $\langle 0 \rangle$ (interpreted over the left daughter relation $\prec_0$), $\langle 1 \rangle$ (over right daughter $\prec_1$), $\langle \downarrow \rangle$ (over the immediate dominance relation $\prec_\downarrow$), and $\langle * \rangle$ (over the dominance relation $\prec_*$). We extend $LOFT$ with a link modality $\langle L \rangle$ interpreted over the *link* relation $\prec_L$ connecting an arbitrary node of a tree and the root of a new tree. This relation will connect (representations of) linguistic 'islands'. Finally, we introduce the modality $\langle D \rangle$ interpreted over the relation $\prec_D$ which holds between node a and b respectively if a is connected to b by a finite composition of any of the $\prec$ relations (cf. [**?**]). Note that in a set of linked binary trees we have,

$$\prec_0, \prec_1 \subseteq \prec_\downarrow \subseteq \prec_* \subseteq \prec_D .$$

The *local* tree of a node a consists of the set of all nodes b connected to a by a sequence of $\prec_{i_j}$ transitions, where for all j, $i_j \neq L$ and $i_j \neq D$. By the *global* tree of a we will mean all nodes b connected to a by a sequence of $\prec_{i_j}$ transitions where for each j, $\prec_{i_j}$ is an arbitrary $LOFT$ tree relation.
By means of tree descriptions with operators '$*$' and 'D' we define tree relations such as dominance which underspecify a given sequence of node relations. These weakly specified tree relations we use to characterise long-distance dependencies.

2.1 The Dynamics of Tree Growth

The growth of information accumulated during the parsing process is defined by a set of inference rules licensing transitions between descriptions of partial trees. A partial tree is a structure that can be embedded in a complete binary tree. (So, for instance, in a partial tree $a \prec_* b$ need not (yet) imply that there is a finite $\prec_\downarrow$ sequence connecting a and b.) Each node in such a partial tree is associated with two finite lists of LOFT formulae: a finite list of *requirements*, the $TODO$ list, and a finite list of *annotations*, the $DONE$ list. Individual transitions developing tree structure may move formulae from the $TODO$ to the $DONE$ list. The emphasis of our parsing model is on the partial nature of information available at any point in the tree development, where tree nodes may yet have non-empty $TODO$ lists and may as yet have merely $\prec_\downarrow, \prec_*$, or $\prec_D$ predecessors. Wellformedness for a sentence-string is defined as the availability of a set of transitions from the *axiom* (a single (root) node with $TODO$ list $\{Ty(t)\}$ and first word of the string), to the *goal* (a tree representation of a logical formula where the root node has $Ty(t)$ among its annotations, no words remain and all $TODO$ lists empty). The partial tree structures arising succesively by processing the string left to right starting from the axiom are $LOFT$-*homomorphically* related, that is, if $a \prec_i b$ holds at a certain partial tree, then this will also hold at its successor. Notice that this may involve narrowing down of $a \prec_D b$ to $a \prec_0 b$ via $a \prec_* b$ and $a \prec_\downarrow b$.

Transition Rules
Tree nodes are represented by ordered pairs of $DONE/TODO$ lists for a given node identifier x:

$$[_x DONE \bullet TODO].$$

A finite partial linked tree is represented by a *nested* set of node representations where the node identifier gives the relation of the embedded to the embedding node. Node identifiers consist of finite sequences of the constants 0 (left daughter), 1 (right daughter), $\downarrow$ (daughter, immediate dominance), $*$ (dominance), L (Link), D (any combination of dominance and/or Link relations), and the variables n, m standing for finite sequences over $\{0, 1\}$. The transition rules are defined over finite partial linked trees formulated in terms of nested node representations.
Transitions between partial trees are (essentially) induced by the words in an NL string and may involve, for instance, creation of tree structure and compilation of annotations. No transition removes tree structure or elements from the $DONE$ list of a node. A rule called *Scanning* extends a partial linked tree in a way determined by the word presently under observation if the $DONE, TODO$ pair associated with the node currently in focus 'satisfies the trigger' of that word; and a rule called *Thinning* removes a formula from the $TODO$ list of the node currently in focus if that formula also is a member of the $DONE$ list.
The process of anaphora resolution is one of copying some suitable antecedent formula into the current $DONE$ list, a process which is free apart from locality restrictions differentiating the morphologically distinguished anaphoric expressions.
In this paper we will only explicitly formulate the rules dealing with dislocation in its various guises. [4] The first pair of rules deals with the introduction of a dislocated NP starting from the axiom ($[_n \bullet Ty(t)]$) and its subsequent fixation at a definite position in the tree.

Star Adjunction

$$\frac{[_n \ \bullet Ty(t)]}{[_n \ \bullet Ty(t), [_* \ \bullet Ty(e)]]}$$

Star Resolution

$$\frac{[_m \ [_* \ Fo(\alpha), Ty(e) \bullet] \ \ldots [_n \ X \ \bullet \ Y]]}{[_m \ \ldots [_n \ Fo(\alpha), Ty(e), X \ \bullet \ Y]]}$$

This pair of rules licenses the adjunction of an unfixed node — a node which is only constrained to occur somewhere in the local the tree under construction, and the subsequent identification of that unfixed node with a fixed tree position (cf. [Meyer-Viol, 1997]). Star Resolution maps a $\prec_*$ connection to an $\prec_n$ one. This is a

[4] For a full set of rules, see [Meyer-Viol, 1997],[Kempson, Meyer-Viol, & Gabbay 1997], [Kempson & Meyer-Viol forthcoming].

LOFT homomorphism because $\prec_n \subseteq \prec_*$. Depending on the instantiations of X and Y different cases are covered by this rule. If $X = 0$ and $Y = Ty(e)$ star resolution has the form

$$\frac{[_m\, [_*\, Fo(\alpha), Ty(e) \bullet\,]\ \ldots [_n\ \bullet Ty(e)]]}{[_m\ \ \ldots [_n\, Fo(\alpha), Ty(e)\ \bullet\ Ty(e)]]}$$

where $Ty(e)$ may then be removed from the $TODO$ list by the thinning rule. This covers the cases where a *gap* occurs in an NL string: a constituent of type e is required, but the NL string does not supply it (at the right moment). The unfixed node then provides what the string does not.
For $X = Fo(\alpha), Ty(e)$ and $Y = 0$, star resolution looks like

$$\frac{[_m\, [_*\, Fo(\alpha), Ty(e) \bullet\,]\ \ldots [_n\, Fo(\alpha), Ty(e) \bullet\,]]}{[_m\ \ \ldots [_n\, Fo(\alpha), Ty(e) \bullet\,]]}$$

This covers the cases where the dislocated constituent is identified with a coreferring pronominal.
For arbitrary X, Y, the star resolution rule may result in an unsuccessfull parse sequence by producing tree nodes with a $TODO$ list that cannot be emptied or an inconsistent $DONE$ list.

A Link Adjunction rule adjoins a fresh (partial) tree to a 'head' node and ensures the transfer of the formula from the head, to an unfixed node in that tree.

Link Adjunction

$$\frac{[_n\, Fo(\alpha), Ty(X) \bullet\,]}{[_n\, Fo(\alpha), Ty(X) \bullet [_L\ \bullet Ty(t), [_*\ \bullet Fo(\alpha), Ty(X)]]]}$$

The effect of this rule is to ensure that linked trees[5] share a common formula. The rule applies to a node with empty $TODO$ list of any type giving rise to an ordered pairs of trees. There is also a rule of $LINK$ completion which applies only when all $TODO$ lists of the linked structure are empty, and which has the effect of absorbing the formula established in the linked structure into the head to which the linked tree is adjoined. ([Kempson & Meyer-Viol forthcoming]).

3 The Analysis

There are three primary distinctions in the model developed which the analysis will make use of. Annotations of nodes may occur on the $TODO$- or on the $DONE$-list. Trees may or may not be linked, the first case involving transfer of information from one tree to another, the transferred information constraining the subsequent tree development. Finally, unfixed nodes may be restricted to finding a fixed location either in the local tree, the tree in which it has been created, or somewhere in the subsequent global tree. This gives us a number of options for expressing the relation between a dislocated structure and its environment, as displayed by $CLLD$, scrambling, and topicalisation structures. Our claim in detail is this. Regular left

[5]with all $TODO$ lists empty

dislocation (“wh movement”) is the projection within a tree structure of a node annotated with a formula and lacking only a fixed tree position. Once this internal tree relation has been identified, an interpretation of the whole string can be built up which is identical to that of the normal form. The explanation thus ensures that the following have the same resulting interpretation:

(4) John, Nadia ignores.

(5) Nadia ignores John.

Clitic left dislocation on the other hand, involves the linkage of a tree to (the representation of) the dislocated constituent; and within this tree the constituent imposes its projection as a requirement on some yet unfixed node. Consequently, not only does the position of the unfixed node have to be identified in the new tree, but the presence of the appropriate formula in that tree has to be ensured also. This is the (twofold) task of the pronoun. The result is that a clitic left dislocation structure will share with simple clausal sequences and with left dislocation structures the projection of a propositional structure, differing from them both in that the dislocated constituent is projected also separately.

A further potential for variation lies in the restriction as to where in the subsequent tree development the unfixed node should be identified. As defined, the process of Star Resolution applies across a chain of daughter relations, restricted to applying within the local tree. But we might impose a weaker restriction, that the node in question be identified merely somewhere in the global tree under construction (replacing the node identifier * in the rule of Star Resolution with D). Indeed, the prepositional adjunct *as for* X seems precisely of this weak sort. It imposes the presence in the following structure of some copy of the expression X, but it places no restriction on whether this copy be constructed within the local or within the global tree:

(6) As for John, I haven’t yet met the woman who befriended him.

The significance of constructing an explanation of these structures in terms of the dynamics of how nodes of a tree are created and subsequently annotated, is that this enables the process of anaphora resolution to remain quite free (limited only by whatever locality restrictions are particular to the individual anaphor), with no special articulation of a grammar-internal process specific to CLLD, or Clitic Copying, etc ([Cinque, 1990]). For it is the force of the constraints on the unfolding tree structure which guarantees that what is an intrinsically unrestricted process turns out in the event to allow only the interpretation in which the pronoun is identified with the head of the clause to which it is adjoined.

Our account turns on the interaction between the projection of unfixed nodes in a tree, the building of linked structure, and anaphora resolution. We shall now show how interaction between these processes might give rise to variation across languages. First we have the Romance case, which like English has left dislocation with no resumptive pronoun, but which has in addition a process of clitic left dislocation, in which fronted noun phrases are paired with resumptive pronominals:

(7) GIANNI ho cercato, non piero.

Gianni I looked for, not Piero.

(8) Gianni l’ho cercato.

As for Gianni, I looked for him.

Unlike many languages with a clitic left-dislocation structure, CLLD in Italian is restricted. The pairing of clitic and dislocated constituent can be separated across the so-called "weak" islands, *eg* involving an intervening wh expression, but cannot be used across strong islands such as a relative clause barrier.

(9) Mario, no perche lo abbiano invitato.

Mario, I don't know why they invited him.

(10) *A Carlo$_i$ ti parlero solo delle persone che gli$_i$ piacciono .. (Italian)

to Carlo I will talk to you only about the people that to him appeal.

This variation suggests two alternative rules for interpreting initial dislocated expressions - the projection of an unfixed node where the dislocated constituent projects information in the $DONE$ list, as in English, and the projection of a linked tree structure in which a copy of the information from the head is projected into the $TODO$-list of an unfixed node which must find its location in the local tree, that is, along a chain of daughter relations:

$$\text{“}Focus\text{”} \quad [_n[_* \, Fo(\alpha), Ty(e) \;\bullet\;] \bullet \; Ty(t)\,]$$

$$\text{“}Topic\text{”} \quad [_n \; Fo(\alpha), Ty(e) \;\; \bullet [_L \bullet Ty(t)\,[_* \bullet Fo(\alpha), Ty(e)\,]]]$$

These match the processes of Left Dislocation and Clitic Left Dislocation argued for by Cinque ([Cinque, 1990]). Notice that Clitic Dislocation here is not characterised by any process of operator-binding: there is merely a dislocated constituent constraining the development of the linked tree (and in Italian the constraint is that the unfixed node must be fixed within that local tree).

If we weaken just this parameter on the development of the structure within which the imposed requirement is met, we have a characterisation for a regular resumptive pronoun language such as Arabic. Arabic differentiates between wh structures (in questions) and other dislocation structures (including referentially construed wh forms), in that while the former are associated with a gap in the clausal sequence, the latter are invariably (except in subject position) associated with a resumptive pronoun, without any restriction as to where in the subsequent string that pronoun should occur:[6]

(11) hal-kteeb sme9t ?enno l-wallad 9alee

this-the-book I heard that the boy wrote on-it

'I heard that the boy wrote on this book'

(12) hal-kteeb hkiit ma9 l-wallad yalli katab 9alee

this-the-book talked-2S with the-boy who wrote on-it (Lebanese Arabic)

I heard that you talked with the boy who wrote on this book'

Furthermore, no additional statement is needed for subject positions, where no resumptive pronoun normally occurs, since Arabic projects a pronominal-type formula for the subject position in the tree directly from the predicate, which is then

[6]Some forms of Arabic dialects allow the full range of NPs in the initial dislocated position without any subsequent resumptive pronoun, eg some dialects of Moroccan Arabic, presumably under the influence of French.

identified anaphorically as though the pronoun had been morphologically expressed. As with non-subject pronouns, this identification is a free anaphoric process: the constraint that the projection of the induced subject be identified with that of the dislocated constituent is a mere consequence of the need to finish the parsing process with empty $TODO$ lists:

(13) hal-wallad sme9t ?enno 9alee l-kteeb

this-the-boy I heard that wrote on the book

I heard that this boy wrote on the book

The pattern in this case (with variation across the different forms of Arabic as to the need of any additional specification distinguishing nonreferential wh question forms) is:

"$Focus$" $[_n[_* \; Fo(\alpha), Ty(e) \; \bullet \;] \;\; \bullet Ty(t) \;]$

"$Topic$" $[_n \; Fo(\alpha), Ty(e) \;\; \bullet \;\; [_L \;\; \bullet Ty(t) \; , [_D \bullet Fo(\alpha), Ty(e) \;]]]$

In this case, there is no restriction on the development of the local linked tree - the copy of the formula projected by the head may occur at any point in the global tree structure. Finally, we have the possibility of projecting the information of a dislocated constituent in the $DONE$-list of an unfixed node in a linked tree structure, without specifying (in the initial description of that node) as to where in the global structure it is to occur. This is arguably required for Japanese topic constructions, as expressed by the suffix wa:

(14) Ano hon-wa$_i$ Hanako-ga e_j t_i katta hito$_j$ sagasite iru rasii

That book-ACC Hanako-NOM bought person-ACC looking-for seem

It seems that John is looking for the person who bought that book

Such a weak characterisation allows for projection of the information of the dislocated constituent somewhere in the global tree under construction:

"$Focus$" $[_n[_* \; Fo(\alpha), Ty(e) \;\;] \bullet Ty(t) \;]$

"$Topic$" $[_n \; Fo(\alpha), Ty(e), [_L[_D \;\; Fo(\alpha), Ty(e)] \;\; \bullet Ty(t) \;]]$

The wa structure is assigned the second of these characterisations.[7] Scrambling, which is more restricted in its occurrence, debarring reconstruction into relative clauses and adjunct clauses, we assign the first characterisation, following the English pattern.

4 Crossover and Related Phenomena

We have set these parameters of variation distinguishing discrete language types. In all types there are two dislocation structures available; they vary as to how unfixed constituents and linked structures can combine in interpreting some initial (sequence of) word(s) in a string. Up to this point anaphora resolution merely fulfills some requirement on a fixed tree node, and plays no part in fixing a tree position for some unfixed node. There are good reasons to consider two generalisations. Firstly, the Star Resolution rule allows for pronominals to fix projections of dislocated constituents. This we will use in our account of strong Crossover. Secondly there is no reason to disallow pronominals from fulfilling requirement at *unfixed* nodes. Allowing this will supply an account of the surprising phenomenon in Hebrew of resumptive pronouns "moving" to a higher clause.

Strong crossover is a universal restriction debarring the sequence of a dislocated constituent of type e, a pronominal construed as identical to it, followed by a gap:

(15) *(As for)Sue$_i$, I know even she$_i$'s worrying e_i is sick, because she keeps talking about it.

In our account, it is the pronoun *she*$_i$, realised by $[_x\ Fo(\texttt{Sue}), Ty(e)\bullet\ ]$, and not the gap e_i, realised by $[_y\ \bullet Ty(e)]$, that unifies with the (projection of the) dislocated constituent $[_*\ Fo(\texttt{Sue}), Ty(e)\bullet\ ]$ through Star Resolution. Consequently, no subject is assigned to the predicate 'is sick' (and there is no possibility, English not being a "pro-drop" language, of projecting a subject directly from the predicate). Thus the formula $Ty(e)$ on the $TODO$-list of the node associated with the gap will not be removed by information supplied by the string and thus the parse cannot finish successfully. [8] The Star Resolution rule shows the problem clearly:

[7] Though there are cases in which the topic-marked -wa constituent is not explicitly associated with any internal clausal position, all such constructions involve an 'aboutness' relation between the expressions constituting the clause and the wa-marked epxression, suggesting that the wa marked expression does project a sub-formula of the whole in the resulting logical form, the presence of which may be guaranteed through an intervening step of inference, much as with anaphora resolution:

(i) sono sakura -no ki -wa hana -ga tittta.
the cherry tree-Gen tree-Top flower-Nom has fallen

(ii)sono itiba -wa, sakana-ga warui.
the market-Top fish -Nom bad

(iii) hana -wa sakura -ga ii.
flower-Top cherry blossoms-Nom good.
'As for flowers, cherry blossoms are good.'

[8] In *pro*-drop constructions, crossover phenomena may not be visible. Cf. [Demirdache, 1991] for discussion.

$$\cfrac{\cfrac{[_m\ [_*\ Fo(\texttt{Sue}_i), Ty(e)\bullet\ ]\quad [_n\ Fo(\texttt{she}_i), Ty(e)\bullet\ ]]}{[_m\ [_n\ Fo(\texttt{Sue})\bullet\ ]\quad [_l\ \bullet\ Ty(e)]]}}{\Leftrightarrow\Leftrightarrow\Leftrightarrow}$$

Here no continuation is possible without $Ty(e)$ projected from the string (at the right moment) to fulfill the requirement of node l. Indeed, any subsequent attempt to pick out the individual in the dislocated expression must be through a process of anaphora resolution - hence the much increased acceptability if pronouns are used throughout the string:[9]

(16) (As for) Sue$_i$, I know even she$_i$'s worrying she$_i$ is sick, because she$_i$ keeps talking about it. But not Ruth. She seems to be refusing to recognise the problem.

The Star resolution rule again shows why the acceptable order: antecedent ... gap ... pronominal may lead to successful parses:

$$\cfrac{\cfrac{[_m\ [_*\ Fo(\texttt{Sue}_i), Ty(e)\bullet\ ]\quad [_n\ \bullet\ Ty(e)]\ldots]}{[_m\ [_n\ Fo(\texttt{Sue}_i)\bullet\ ]\quad [_l\ Fo(\texttt{she}_i), Ty(e)\bullet\ ]]}}{[_m\ [_n\ Fo(\texttt{Sue}_i)\bullet\ ]\quad [_l\ Fo(\texttt{Sue}_i), Ty(e)\bullet\ ]]}$$

The assumption that anaphora resolution succeeds both in fixing the position and supplying the formula of the node in question, can also be generalised. When a linked structure requires a copy of the formula projected by the head merely as part of the global tree under construction and not necesarily as part of local tree, anaphora resolution may fulfill that requirement, supply the formula, while merely restricting the area in which this node can be fixed form the global to a local tree. This is a monotonic update - a requirement is satisfied, a tree relation becomes more specific. Such a process allows us to explain the surprising phenomenon whereby a resumptive pronoun can be"moved" to a higher clause yielding the order antecedent .... pronominal .... gap, all construed identically, without inducing a crossover violation (cf. [Demirdache, 1991]):

(17) Shalom, ?ani xošev še ?amarta še ?alav sara katva šir
Shalom, I think that said-you that about him sara wrote poem

(18) Shalom, ?ani xošev še ?alav ?amarta še sara katva šir
Shalom, I think that about-him said-you that sara wrote poem

(19) shalom, ?alav ?ani xošev še ?amarta
vse sara katva šir
Shalom, about him I think that said-you that sara wrote poem.

Our explanation turns on the status of the intervening pronominal. The initial transfer of information from the host node to the new linked structure has the weakest of all characterisations: the information is imposed as a requirement on an unfixed node that must find its location in the global tree under construction. Now, this requirement can be satisfied in one of two ways.

[9]cf. [Edwards & Kempson, 1998] for justification of this account of strong crossover.

— In one step, by a pronoun providing a fixed tree node whose value is identified as the formula which inhabits the head node - resolving both aspects of underspecification. This is the case in (17).
— In two steps, in case a pronoun occurs in a position which is itself unfixed (examples (18) and (19)). The first step is the provision of a value for the formula projected by the pronoun: the second is to resolve the tree-node identification. Two applications of Star Resolution can take care of that:

$$\frac{\dfrac{[_L\ [_D \bullet Fo(\texttt{Shalom}_i), Ty(e)\ ]\ \ldots [_* \ Fo(\texttt{him}_i), Ty(e) \bullet\ ] \ldots [_n \bullet Ty(e)]]}{[_L\ [_* \ Fo(\texttt{Shalom}), Ty(e) \bullet\ ]\ \ldots [_n \ \bullet Ty(e)]]}}{[_L \quad \ldots [_n \ Fo(\texttt{Shalom}), Ty(e) \bullet\ ]].}$$

Note that, again, the mapping of $\prec_D$ to $\prec_*$ and of $\prec_*$ to $\prec_n$ is a LOFT-homomorphism (for $\prec_n \subseteq \prec_* \subseteq \prec_D$).
This is far from an exhaustive listing of the various ways in which anaphora and long-distance dependency resolution can interact, but it is striking that in each case we have preserved the generality both of anaphora resolution and of the characterisation of how initially unfixed nodes come to be assigned a fixed position in the resultant tree. And in all cases, the step-wise process of interpretation supplies an increasingly richer annotated tree structure providing in the end a propositional formula for the sentence-string.

5 Conclusion

This paper has introduced an analysis of long-distance dependency in terms of a process of tree update, in which 'dislocated' constituents are assigned initially weak tree descriptions which are subsequently updated. The account has been set within a model of language understanding in which interpretation is defined as a process of progressively building up a logical form on a left-right basis. The advantage of the account is that it provides a natural basis for describing the interaction between anaphora resolution and long-distance dependency. From this interaction, a typology of long-distance dependency effects has been shown to emerge without proliferation of discrete syntactic processes, while nevertheless retaining an entirely general process of anaphora resolution.

The significance of the analysis is that it formally differentiates syntactically identifiable topic and focus structures while preserving the insight that the semantic content of both types of structure is identical to that of their counterpart in which each constituent expression is in its expected position.It also respects Prince's observations, by leaving open the possibility of there being different pragmatic uses to which these structures might be put, depending on other forms of contrast available in the individual languages.

The success in capturing the semantic property of dislocation structures and their diversity across a broad range of language types confirms the LDS_{NL} perspective on natural language - that a natural-language grammar should be defined in intrinsically dynamic terms, as a schematic left-to-right parser.

Bibliography

[Blackburn & Meyer-Viol, 1994] Blackburn, P. and Meyer-Viol, W. 1994. Linguistics, logic and finite trees, *Bulletin of IGPL*2: 2-39.

[Cinque, 1990] Cinque, G. 1990. *Types of A' Dependencies.* MIT Press.

[Demirdache, 1991] Demirdache, H. 1991. *Resumptive Chains in Restrictive Relatives, Appositives and Dislocation Structures.* MIT. Ph.D.

[Edwards & Kempson, 1998] Edwards, M. and Kempson, R. (forthcoming) Resumptive Pronouns in English and Arabic. In Ouhalla,J. and Perrett,D. (eds.)*Proceedings of 1998 Afro-Asiatic Conference.*

[Erteschik-Shir, 1997] Erteschik-Shir, N. 1997. *The Dynamics of Focus Structure.* Cambridge University Press.

[Kempson & Meyer-Viol forthcoming] Kempson, R. and Meyer-Viol, W. forthcoming. Syntactic Computation as Labelled Deduction: WH a case study. in Borsley, R. and Roberts, I. (eds.) *Syntactic Categories.* Academic Press.

[Kempson, Meyer-Viol, & Gabbay 1997] Kempson, R, Meyer-Viol, W. and Gabbay,D. On representationalism in semantics: a dynamic account of WH. Dekker, P. et al (eds.), *Proceedings of 11th Amsterdam colloquium* 193-8.

[Meyer-Viol, 1997] Meyer-Viol, W. 1997. Parsing as tree construction. Dekker, P. et al (eds.), *Proceedings of 11th Amsterdam Colloquium* 229-34.

[Porter & Yabushita, 1998] Portner, P and Yabushita, K. 1998. The semantics and pragmatics of topic phrases. *Linguistics and Philosophy* 21, 117-57.

[Prince, 1995] Prince, E. 1995. On the limits of syntax, with reference to Left-Dislocation and Topicalization. ms.

[Saito, 1985] Saito, M. 1985. *Some Asymmetries in Japanese and their Theoretical Implications.* Ph.D. MIT.

Part II

Symposium on Unbounded Dependencies

Chapter 9

Unbounded dependencies: logic and structure

Michael Moortgat

Within current linguistic frameworks a variety of principles has been put forward to account for the properties of local and unbounded dependencies. (On the local side: subcategorization principles in HPSG, principles of coherence and completeness in LFG, the theta criterion in GB; supplemented by principles for non-local dependencies: movement and empty category principles, slash feature percolation principles, etc.)

It is tempting to consider the formulation of such principles as the ultimate goal of grammatical theorizing. But we could also see them as the starting point for a more far-reaching enterprise. Suppose, following the slogan 'Cognition=Computation', we model the cognitive abilities underlying knowledge and use of language as a 'logic of grammar' — a specialized deductive system, attuned to the task of reasoning about the composition of grammatical form and meaning. The logic of grammar, so conceived, would provide the deductive *raison d'être* for the grammaticality principles mentioned above, thus removing the need to state them as irreducible primitives.

To work out this concept of a logic of grammar, the following issues have to be addressed.

- What are the CONSTANTS of grammatical reasoning? Can we provide an explanation for the *uniformity* of the form/meaning relationship across languages in terms of this vocabulary of logical constants, together with the deductive principles governing their use?
- How can we reconcile the idea of 'constants of grammatical reasoning' with the differences between languages, that is, with STRUCTURAL VARIATION in the realization of the form/meaning correspondence?

Some progress has been made on these questions recently, through a combination of categorial and resource-logical themes. A carefully separation of logical and structural components of the 'computational system' leads to the identification of a grammatical *base logic*. At the level of the base logic, we address the uniformity theme above: the composition of grammatical form and meaning is read off from the dynamic process of constructing a derivation/proof in terms of the introduction and elimination rules for the grammatical constants. Cross-linguistic *variation* in

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the realization of the form-meaning correspondence is captured in terms of *structural* inference packages, acting as plug-ins with respect to the base logic of the grammatical constants. Structural inferences are under the explicit control of lexically anchored licensing features. These features have the status of logical constants in their own right.

We illustrate the approach with a contrastive study of extraction in English and Dutch. At the level of grammatical 'multiplicity', we provide a unified account of local (lexical) and unbounded dependencies, based on the duality between elimination ('modus ponens') and introduction ('hypothetical reasoning') of the constants capturing grammatical (in)completeness. On the structural level, we show that clusterings of empirical phenomena that differentiate between these two languages arise naturally from logical choices in the fine-tuning of grammatical resource management.

Bibliography

[Moortgat,1997] Moortgat, M. (1997), 'Categorial Type Logics'. Chapter 2 in J. van Benthem and A. ter Meulen (eds.) *Handbook of Logic and Language*. Elsevier, Amsterdam and MIT Press, Cambridge MA, 1997, 93–177.

[Moortgat,1998] Moortgat, M. (1998), 'Constants of grammatical reasoning'. In H. Bennis (ed) *Interface Strategies*. Proceedings KNAW Conference. (www-uilots.let.uu.nl/staff/moortgat/ICG/knaw.pdf)

Chapter 10

A Unified Theory of Complement, Adjunct, and Subject Extraction

GOSSE BOUMA, ROB MALOUF AND IVAN SAG

ABSTRACT. This paper outlines an HPSG theory of filler-gap ('extraction') dependencies that unifies the treatment of extracted complements, adjuncts and subjects.[1] The theory is 'head-driven' in that information about extracted constituents is propagated from the head daughter only. The theory is 'constraint-based' in that a single lexical entry is associated with a family of structures – only some of which terminate an extraction dependency. Constraints take the place of the Complement Extraction and Adverb Addition Lexical Rules of earlier proposals. The analysis presented here accounts for numerous English and cross-linguistic data that are inconsistent with other proposals.

1 Introduction

In this paper, we develop a novel approach to extraction. It differs from previous feature-based accounts in that it is traceless, head-driven, and involves no lexical rule of the sort proposed in PS-94, Sag and Fodor (1994), or Sag (1997). By 'head-driven' we mean that a phrase inherits SLASH information from only one of its daughters (the head daughter), rather than from all of its daughters, as in analyses that include the Foot Feature Principle of Gazdar et al. (1985) or the Nonlocal Feature Principle of PS-94.

The approach to extraction developed here has considerable overlap with the proposal made in Sag (1997), but it makes one minor and one major modification. The minor change is that in order to allow for the account of adjunction presented in section 4, SLASH amalgamation is defined for DEPS rather than ARG-ST. The major modification is that the Complement Extraction Lexical Rule is eliminated, as

[1]This paper excerpts material presented in Bouma, Malouf and Sag (1998), which should be consulted for further details. Special thanks to Bob Levine, Carl Pollard, Bob Kasper and Mike Calcagno, who have been skeptical of many of the ideas that led up to the proposals made here. This paper is much improved thanks to our interactions with them. In addition, we thank Georgia Green, Carl Pollard, and Peter Sells for their reactions to an earlier version of this paper, and Ann Copestake, Dan Flickinger, Jeff Smith and Gertjan van Noord for helpful suggestions. This research was conducted in part as part of CSLI's English Resource Grammar Online (LINGO) project, in conjunction with the **Verbmobil** project. In that connection, we gratefully acknowledge the support of the Bundesministerium für Bildung, Wissenschaft, Forschung, und Technologie (BMBF).

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are the lexical rules which have been proposed for subject and adjunct extraction. Instead, Dependent Realization will account for the lexical variation required for a traceless account of extraction. This has at least one highly significant consequence: it provides an entirely uniform account of complement, subject, and adjunct extraction. In addition, it eliminates a lexical rule whose status has always been dubious and whose interaction with other analyses has been highly controversial.

Our proposal follows a tradition within nontransformational grammar (including, among others, Gazdar et al. (1984), Steedman (1996), Morrill (1994), and Kaplan and Zaenen (1989)) demonstrating the feasibility of traceless accounts of extraction. Sag (1998) in fact demonstrates numerous difficulties facing any analysis that appeals to *wh*-trace.

2 Constraint-based Head-driven Extraction

HPSG analyses of extraction, building on earlier work in GSPG, involve feature specifications for the feature SLASH that are projected upward in a syntactic structure. A non-empty SLASH value on a phrasal node signals that an elements is 'missing' from the corresponding phrase. The distribution of SLASH normally follows from its interpretation as a placeholder for missing elements: if a node dominates a daughter containing a non-empty SLASH value, the SLASH value of the node itself must also be nonempty. Two kinds of exceptions to this rule are possible: in head-filler constructions (i.e. the top of a *wh*-question or of a relative clause) a filler combines with a head whose SLASH value unifies with the filler. The 'missing element' is 'found' at this point, and thus the SLASH of the resulting phrase is empty. A second type of exception may occur if a lexical head selects an incomplete complement (*easy*-constructions).

The distribution of SLASH is normally accounted for by the Nonlocal (or Foot) Feature Principle, which constrains the SLASH value on phrasal nodes to be the union of the SLASH values on its daughters. This approach is configurational in that it defines SLASH in terms of mothers and daughters in a phrase structure tree. Also, it implements a strict bottom-up flow of information: nonempty SLASH values are introduced by traces and these values are consistently passed up to nodes higher in the tree. This scheme is satisfactory in the majority of cases, but, as discussed below, there is at least some data which is hard to reconcile with it. In particular, the adjective *easy* and related words 'bind' a SLASH value which arises on one of its dependents.

In our lexicalist alternative to configurational theories of SLASH, the Nonlocal Feature Principle is replaced by a simpler constraint on phrases and a lexical constraint on heads. More precisely, we propose that the SLASH value of a lexical item is defined in terms of the SLASH values of its dependents. Lexical binding of SLASH is accounted for by the feature BIND, which has the empty set as value for all words except SLASH binders like *tough*:

(1) **SLASH Amalgamation Constraint (SLAC)**:

$$
\textit{word} \Rightarrow \begin{bmatrix} \text{loc} & \begin{bmatrix} \text{cat} & \begin{bmatrix} \text{deps} & \left\langle \begin{bmatrix} \text{slash} & \boxed{1} \end{bmatrix}, \ldots, \begin{bmatrix} \text{slash} & \boxed{n} \end{bmatrix} \right\rangle \\ \text{bind} & \boxed{0} \end{bmatrix} \end{bmatrix} \\ \text{nonloc} & \begin{bmatrix} \text{slash} & \left(\boxed{1} \cup \ldots \cup \boxed{n} \right) \Leftrightarrow \boxed{0} \end{bmatrix} \end{bmatrix}
$$

SLASH amalgamation ensures that, if a dependent is slashed, the head which selects it will also be slashed. So, by SLASH amalgamation, the verb *know* in (2) is slashed if its subject or S complement is.

(2)
$$
\begin{bmatrix} \text{i-form} & \text{know} \\ \text{subj} & \langle \boxed{3} \rangle \\ \text{comps} & \langle \boxed{4} \rangle \\ \text{deps} & \left\langle \boxed{3}\begin{bmatrix} \text{loc} & \text{NP} \\ \text{slash} & \boxed{1} \end{bmatrix}, \boxed{4}\begin{bmatrix} \text{loc} & \text{S}[\textit{fin}] \\ \text{slash} & \boxed{2} \end{bmatrix} \right\rangle \\ \text{bind} & \{\ \} \\ \text{slash} & \boxed{1} \cup \boxed{2} \end{bmatrix}
$$

The configurational passing of SLASH features can now be simplified to a constraint which only mentions the head daughter:

(3) **SLASH Inheritance Principle (SLIP)**:

$$
\textit{hd-val-ph} \Rightarrow \begin{bmatrix} \text{nonloc} & \begin{bmatrix} \text{slash} & \boxed{1} \end{bmatrix} \\ \text{hd-dtr} & \begin{bmatrix} \text{slash} & \boxed{1} \end{bmatrix} \end{bmatrix}
$$

SLIP is defined as a constraint on *head-val-phrases*, which is the type of phrases involving only head, complement, or subject daughters, but, crucially, no filler daughters (see Sag 1997). For the latter type of phrase, we assume the following:[2]

(4)
$$
\textit{hd-filler-ph} \Rightarrow \begin{bmatrix} \text{nonloc} \mid \text{slash} & \boxed{2} \uplus \boxed{3} \\ \text{hd-dtr} \mid \text{slash} & \boxed{2} \uplus \{\boxed{1}\} \\ \text{non-hd-dtrs} & \left\langle \begin{bmatrix} \text{loc} & \boxed{1} \\ \text{nonloc} \mid \text{slash} & \boxed{3} \end{bmatrix} \right\rangle \end{bmatrix}
$$

The SLASH value of a head/filler phrase is the SLASH value of the head daughter minus the filler plus the SLASH value of the filler. Thus, we obtain structures such as (5).

What remains to be explained is the question how the bottom of the extraction path, i.e. the verb *hates* in (4), may introduce a non-empty value for SLASH. Traceless accounts of extraction within HPSG have posited a lexical rule to account for this fact. The Complement Extraction Lexical Rules of PS-94, Sag and Fodor (1994) or Sag (1997), for instance, all remove an element from COMPS, and at the same time ensure (either directly or indirectly) that the value of SLASH on the output of the rule will include the local features of the removed complement. Such a rule is awkward, as it uses a tool (the lexical rule) which is primarily intended

[2]Here '⊎' designates the operation of disjoint set union, which is just like familiar set union, except that the disjoint union of two sets with a nonempty intersection is undefined.

to account for processes that are clearly lexical in nature. The usual diagnostic for distinguishing lexical from syntactic rules is the fact that only the former have exceptions which are triggered by the lexical material involved. Many languages lexically mark words with a non-empty SLASH value, but for complement extraction per se, this is never the case, to the best of our knowledge. Apart from this, the formal status of the Complement Extraction Lexical Rule has been the matter of some debate (Hinrichs and Nakazawa, 1996; Höhle, 1995; Müller, 1996).

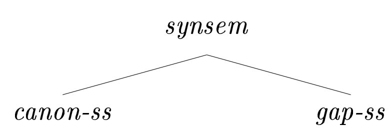
The solution adopted in this paper employs neither traces nor lexical rules. The key insight to our solution is that given a constraint-based lexical architecture in which DEPENDENTS are mapped onto valence features such as SUBJ and COMPS, there is no need for rules that remove elements from COMPS (or SUBJ): one can simply avoid putting them there in the first place. Thus extraction is located on the interface between the lexicon and the syntax rather than in either one of these components individually.

Our analysis follows Sag (1997) in defining *gap-ss* as a new subtype of *synsem*. The LOC value of a *gap-ss* element corresponds to its SLASH value:

(5)
$$\textit{gap-ss} \Rightarrow \begin{bmatrix} \text{loc} & \boxed{1} \\ \text{nonloc} & \begin{bmatrix} \text{slash} & \left\{ \boxed{1} \right\} \end{bmatrix} \end{bmatrix}$$

*Gap-ss*s in this theory play a role similar to that of traces in a movement theory, with an important difference. Unlike traces, *gap-ss*s exist only on the list of dependents of the lexical head which selects them. They play no independent role in the phrase structure, linear order, or phonology of phrasal signs.

The proper distinction between gaps and other, canonical, *synsem* types can be embodied in terms of the following type hierarchy:

(6)


The question of whether a dependent of a lexical head is to be realized as a local dependent (i.e. on one of the valence features SUBJ or COMPS) or a nonlocal dependent, is a consequence of the Dependent Realization constraint in (7).

(7) **Dependent Realization**:
$$\textit{word} \Rightarrow \begin{bmatrix} \text{subj} & \boxed{1} \\ \text{comps} & \boxed{2} \ominus \text{list(gap-ss)} \\ \text{deps} & \boxed{1} \oplus \boxed{2} \end{bmatrix}$$

Dependent Realization, together with the Principle of Canonicality in (8), ensures that none of the *gap-ss*'s on DEPS appears on COMPS.

(8) **Canonicality**:
$$\textit{sign} \Rightarrow \begin{bmatrix} \text{synsem} & \textit{canon} \end{bmatrix}$$

As lexemes will typically specify their arguments as being of type *synsem*, and not as being of either type *canon-ss* or *gap-ss*, Dependent Realization opens the possibility of realizing a non-subject dependent either as a complement or as a gap.

For instance, the feature structure in (9) can satisfy Dependent Realization either as shown in (10a) or as shown in (10b).

(9)
$$\begin{bmatrix} \text{i-form} & \text{hates} \\ \text{subj} & \langle \textit{synsem} \rangle \\ \text{deps} & \left\langle \begin{bmatrix} \text{loc} & \textit{NP} \\ \text{slash} & \boxed{1} \end{bmatrix}, \begin{bmatrix} \text{loc} & \textit{NP}\begin{bmatrix}\textit{acc}\end{bmatrix} \\ \text{slash} & \boxed{2} \end{bmatrix} \right\rangle \\ \text{slash} & \boxed{1} \cup \boxed{2} \end{bmatrix}$$

(10) a.
$$\begin{bmatrix} \text{i-form} & \text{hates} \\ \text{subj} & \left\langle \boxed{3}\begin{bmatrix} \text{loc} & \textit{NP} \\ \text{slash} & \boxed{1} \end{bmatrix} \right\rangle \\ \text{comps} & \left\langle \boxed{4}\begin{bmatrix} \textit{canon-ss} & \\ \text{loc} & \textit{NP}\begin{bmatrix}\textit{acc}\end{bmatrix} \\ \text{slash} & \boxed{2} \end{bmatrix} \right\rangle \\ \text{deps} & \langle \boxed{3}, \boxed{4} \rangle \\ \text{slash} & \boxed{1} \cup \boxed{2} \end{bmatrix}$$

b.
$$\begin{bmatrix} \text{i-form} & \text{hates} \\ \text{subj} & \left\langle \boxed{3}\begin{bmatrix} \text{loc} & \textit{NP} \\ \text{slash} & \boxed{1} \end{bmatrix} \right\rangle \\ \text{comps} & \langle\ \rangle \\ \text{deps} & \left\langle \boxed{3}, \begin{bmatrix} \textit{gap-ss} & \\ \text{loc} & \boxed{2} \\ \text{slash} & \{\boxed{2}\} \end{bmatrix} \right\rangle \\ \text{slash} & \boxed{1} \cup \left\{ \boxed{2}\text{NP}[\textit{acc}] \right\} \end{bmatrix}$$

In (10a), the complement is realized on COMPS. This is the kind of structure which occurs in sentences without extraction (e.g. (11a)), but also in sentences where the extracted element is inside the object complement (11b). Note that because the SYNSEM value of any overt element (i.e. any sign) is of type *canon-ss*, it follows without lexical stipulation that the complement in (10a) is of type *canon*. In (10b), the object dependent is realized as a gap, and thus is extracted, as in (**??**) or (11c).

(11) a. She hates every inch of this school.

b. Which school does Dana say she hates [every inch of __]?

c. Which school does Kim think she hates __?

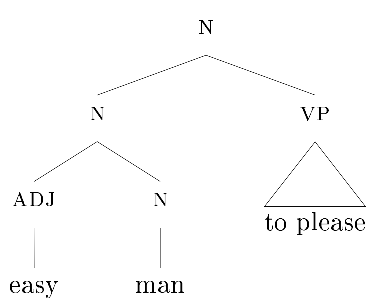
3 Subbinding

The analysis just presented also provides an account of more complicated cases, such as those noted in Flickinger and Nerbonne (1992):

(12) an easy man to please __

Flickinger and Nerbonne argue for the following constituent structure:

(13)



The adjective *easy* is not the head of this structure, nor is it the head of the substructure *easy man*. Under a configurational approach, such as that presented in PS-94, the BIND feature on *easy* can therefore not be used to ensure that the phrase as a whole must bear an empty SLASH-specification. The lexicalized SLASH-amalgamation approach, on the other hand, faces no such problem, as the SLASH value of the VP is bound lexically by the adjective *easy*. Of course, this leaves an important puzzle concerning the construction in (13) unexplained, namely the fact that a complement of *easy* appears in a position which suggests it is a complement of *man*. Flickinger and Nerbonne suggest a principle of *subcategorization transfer* to account for this. We suspect an account in terms of a more general treatment of extraposition is preferable. Exploration of this idea would take us too far afield, however.

Another puzzling construction is *en*-clitization in French. Miller and Sag (1997) argue for a theory of cliticization in which *affix-synsems* may be realized as clitics of the verb on whose argument structure they appear. Clitic-climbing is accounted for by an appeal to argument composition: verbs which allow clitics corresponding to arguments of an embedded verb are actually argument composition verbs which inherit the arguments of their verbal complements, this opening up the possibility of clitic climbing. *En*-clitization, illustrated in (14) below, is different, however.

(14) a. Marie en connaît la fin.
'Marie knows the end of it.'

b. La fin en est désagréable.
'The end of it is unpleasant.'

The *en*-clitic corresponds to a *de*-phrase which is a semantic argument of a noun, and the phenomenon is far more restricted than other types of clitization (it is restricted to a formal register and occurs only with arguments of the right semantic type). On the other hand, the construction does share properties with extraction of *de*-phrases:

(15) a. J'ai écouté le garçon avec la clef.
'I heard the boy with the key.'

b. *la clef$_j$, avec laquelle$_j$ j'ai écouté le garçon ...
'the key with which I heard the boy ... '

(16) a. Marie lit la fin du livre.
'Marie is reading the end of the book.'

b. le livre dont Marie lit la fin ...
'the book of which Marie is reading the end ... '

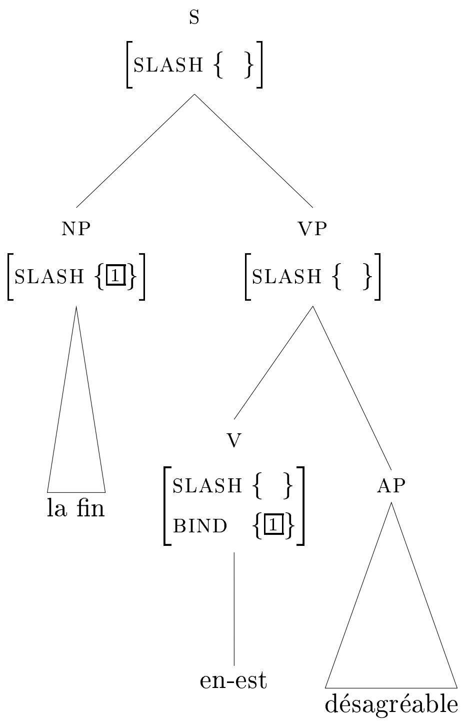
c. La fin du livre est désagréable.
'The end of the book is unpleasant.'

d. le livre dont la fin est désagréable ...
'the book of which the end is unpleasant ... '

Extraction out of NPs in general is excluded in French (15), the only exception being extraction of (certain) *de*-phrases.

The similarity between *en*-cliticization and extraction of *de*-phrases leads Miller and Sag to propose a lexical rule. An output of this rule is a verb that selects for a subject whose SLASH value contains an NP[*de*] that the verb binds. These verbs thus effect SLASH binding by a verb that is lower in the syntactic structure than the phrase whose SLASH value it binds, as sketched in (17):

(17)



Phenomena such as these appear extremely problematic for previous theories of SLASH inheritance and binding, where the SLASH binder must always be in a syntactically superior position to the extraction site.[3] Indeed, these facts stand as a challenge to all theories whose constraints require binders to be structurally superior to (c-command, etc.) the traces that they bind.

4 The Analysis of Adjuncts

The idea that adjuncts combine syntactically with the phrases that they modify semantically in terms of modifier-head structures is firmly entrenched in modern grammatical theory. In HPSG terms, adjuncts are endowed with a specification for the feature MOD, whose value must be identified with (the SYNSEM of) the head daughter in a Head-Adjunct Structure. In this way, the fact that adjectives modify nominal expressions, adverbials modify verbal expressions, etc. can all be reduced to lexical specifications associated with particular kinds of modifiers. This type of analysis is adequate for a wide range of cases to which it is standardly applied. In particular, we will assume that preverbal adverbs in English are selected by means of the HEAD-ADJUNCT schema.

However, in many languages, there are examples of adverbials that defy any simple analysis in terms of modifier-head syntactic combination. In particular,

[3]But see Chae (1992).

it has been argued that cliticization (Miller, 1992), word order (van Noord and Bouma, 1994; Abeillé and Godard, to appear), scope (Manning, 1996; van Noord and Bouma, 1994; Kim and Sag, 1995; Przepiórkowski, 1997b), and case marking (Przepiórkowski, in press; Przepiórkowski1997) suggest that certain adverbial phrases must be selected by means of the same mechanism which accounts for the selection of complements. Another challenge for the standard view of adverbial modifiers comes from the behavior of case marking in languages like Finnish, Korean, and Polish (Maling, 1989; Maling, 1993; Przepiórkowski, in press; Przepiórkowski1997).

In the constraint-based set-up introduced in section 2, there is no need for a lexical rule to add an adverbial to a verb's ARG-ST or DEPS list, as the mapping between argument structure and dependents already accounts for the fact that the DEPS-list, and thus COMPS, may contain an adverbial *synsem*. The relevant argument realization constraint is given in (18).

(18) **Argument Realization**:

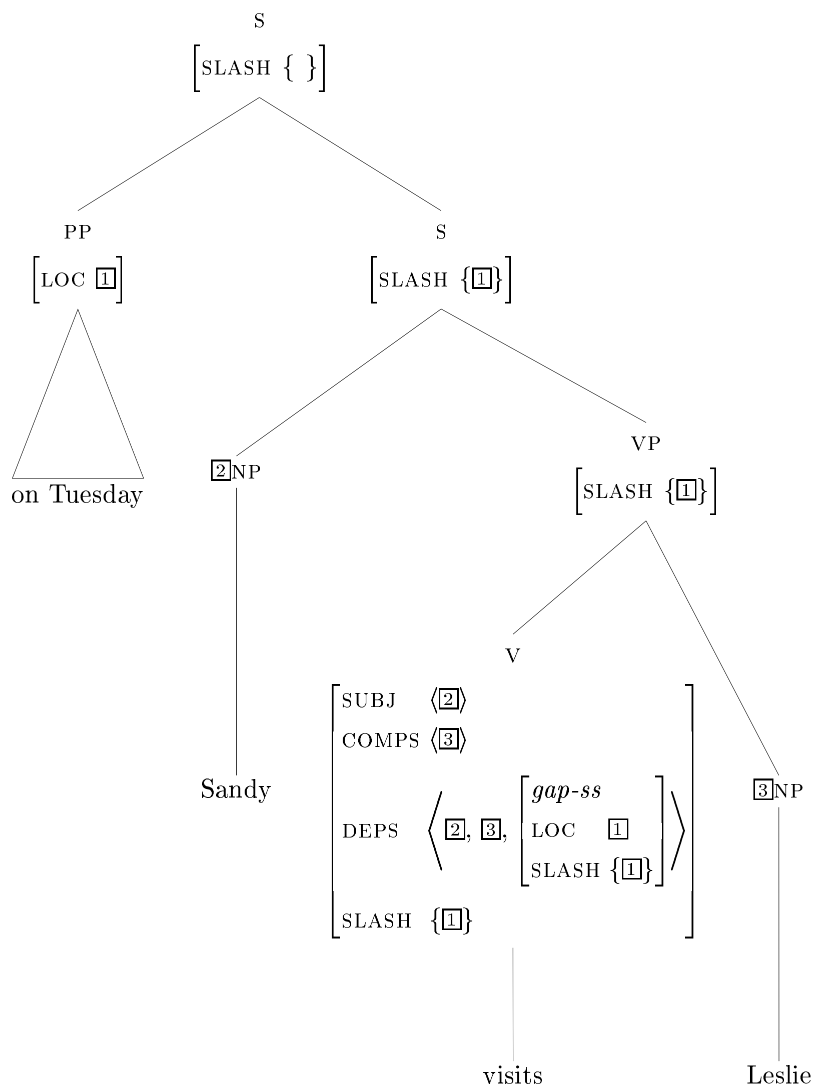
$$verb \Rightarrow \begin{bmatrix} \text{head} & \boxed{3} \\ \text{deps} & \boxed{1} \oplus \text{list}\left(\begin{bmatrix}\text{mod}\begin{bmatrix}\text{head} & \boxed{3} \\ \text{cont}\,|\,\text{key}\,|\,\text{arg} & \boxed{2}\end{bmatrix}\end{bmatrix}\right) \\ \text{arg-st} & \boxed{1} \\ \text{cont}\,|\,\text{key} & \boxed{2} \end{bmatrix}$$

This guarantees that a verb's DEPS list may contain, in addition to the verb's arguments, any number of adverbials. Moreover, the MOD|HEAD value of the adverbial is identified with those of the verb on whose DEPS list the adverbial appears. We have imposed minimal restrictions on the adverbial elements that can be included in the verb's DEPS list, allowing adverbs, PPs, and the like (subject to certain further constraints). The semantics can be accounted for by simply unifying the argument of the adverbial with the KEY-relation introduced by the verb. The combined effect of Argument Realization and the Dependent Realization constraint introduced earlier, is that adverbials may appear as complements of the verb in a HEAD-COMPLEMENT structure.

As argued in PS-94 and extensively in Hukari and Levine (1995), there is strong evidence that unbounded dependencies may involve adjuncts. Hukari and Levine point out, for instance, that adjuncts not only occur in topicalizations and *wh*-questions, but also in all other constructions involving unbounded dependencies, such as indirect questions, relatives, and clefts. Hukari and Levine (1995) further demonstrate that there is strong, cross-linguistic, evidence for the claim that dislocated adjuncts involve true extraction. Their argument rests on the observation that in all those cases where a language registers unbounded dependencies in some way, the registration occurs consistently with both arguments and adjuncts.

The possibility of adjunct extraction as well as extraction out of adjuncts follows from the assumptions introduced so far, without appeal to a lexical rule or any other additional device for adjunct extraction. By incorporating adjuncts into the list of dependents of the verb, and by defining both SLASH-amalgamation and the introduction of *gap-ss*'s on this level as well, we provide a uniform account for both complement and adjunct extraction. That is, we may assume that *visits* may appear in a structure like (19), with the indicated lexical instantiation.

(19)



The structure in (19) arises when DEPS contains an adverbial element in addition to the arguments of the verb (as a consequence of Argument Realization), and that this adverbial *synsem* is further specified as a *gap-ss* by Dependent Realization. The SLASH value of the *gap-ss* is incorporated into the SLASH value of the verb because SLASH-amalgamation is defined in terms of the DEPS list. The example thus involves three constraints applying in conjunction with the same lexical entry. We believe that this type of example, which does not involve derivational devices of any kind, provides considerable evidence for the constraint-based approach we have been pursuing. Further evidence for relating extractibility of adjuncts to their status of complements comes from the fact that adverbials that only occur as preverbal modifiers do not extract, precisely as predicted by our unified extraction analysis.

Our lexicalized approach to adjunct extraction also provides a natural account, we believe, of the known facts about extraction in Chamorro (Chung, 1982; Chung, 1995), Palauan (Georgopolous, 1985), and Thompson River Salish (Kroeber, 1997), all of which register adjunct extraction lexically and hence present a serious challenge to previous GPSG and HPSG accounts that rely on traces and the traditional distinction between complements and adjuncts. Our account of these data also unifies what are treated as disparate phenomena in other frameworks, e.g. the stipulative distinction between types of government in much work in Principles and Parameters or Government and Binding approaches.

5 Subject Extraction

The constraint-based analysis of extraction we have presented allows subject arguments to be realized as *gap-ss*'s, and thus offers an interesting alternative to the account of PS-94, one which does need to posit lexical rules or new types of grammatical constructions.

To see this, consider the constraints we have imposed on verbs: these guarantee that verbs always have one element on their SUBJ list and that the SLASH values of a verb's dependents are amalgamated as the verb's SLASH value. Since SUBJ is a singleton list, and since SUBJ is also required to be a prefix of the DEPS list (as a consequence of Dependents Realization), the first element of DEPS is always the same as the subject, but nothing prevents this element from being of type *gap-ss*. That is, (20b) is completely consistent with the lexemic information in (20a) and all of the constraints introduced in the previous sections.

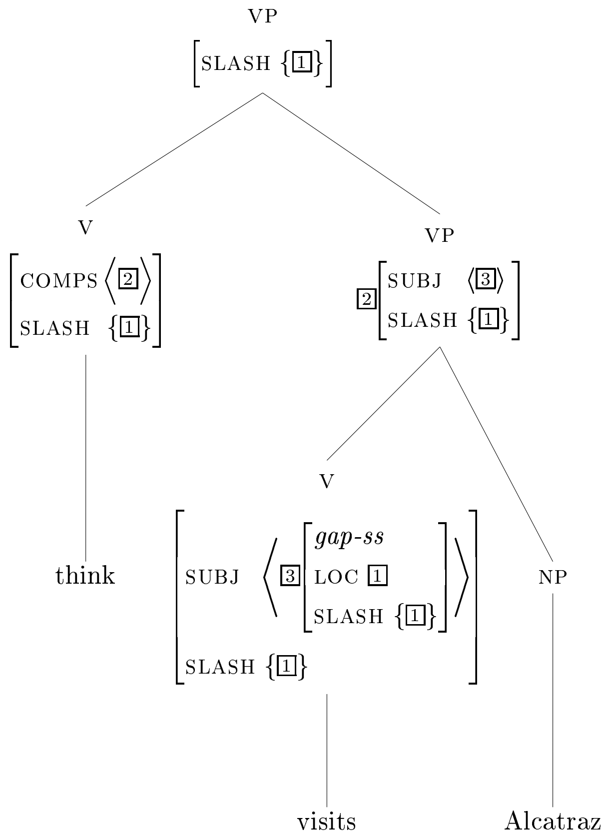
(20) a. $\begin{bmatrix} \text{root} & \text{visit} \\ \text{arg-st} & \langle NP,\ NP \rangle \end{bmatrix}$

b. $\begin{bmatrix} \textit{word} & \\ \text{i-form} & \text{visits} \\ \text{subj} & \left\langle \boxed{8} \begin{bmatrix} \textit{gap-ss} & \\ \text{loc} & \boxed{7}\text{NP}[\textit{nom}]_{3sg} \\ \text{slash} & \{\boxed{7}\} \end{bmatrix} \right\rangle \\ \text{comps} & \langle \boxed{9}\text{NP}[\textit{acc}] \rangle \\ \text{deps} & \langle \boxed{8}, \boxed{9} \rangle \\ \text{arg-st} & \langle \boxed{8}, \boxed{9} \rangle \\ \text{slash} & \{\boxed{7}\} \end{bmatrix}$

Furthermore, if verbs like *think* select not a saturated complement, but rather one whose SUBJ value is a possibly empty list of *gap-ss*s, as shown in (21), then a phrase like *visits Alcatraz* will be a possible complement of *think*. The SLASH-value of *visits* will thus be passed up and amalgamated into the SLASH value of *think*, which will pass it up to the mother of the phrase *think visits Alcatraz*, as shown in (22).

(21) $\begin{bmatrix} \text{root} & \text{think} \\ \text{arg-st} & \left\langle \text{np}\ ,\ \begin{bmatrix} \text{head} & \text{v} \\ \text{subj} & \text{list(gap-ss)} \\ \text{comps} & \langle\ \rangle \end{bmatrix} \right\rangle \end{bmatrix}$

(22)



That-trace violations like **Who do you think that visits Alcatraz?* can now be ruled out as a simple matter of local subcategorization. If complementizers are markers selecting a [SUBJ ⟨ ⟩] sentential complement through their SPEC features, as shown in (23), then there will be no way for a structure like (21) to cooccur with *that*. The same result can be achieved if complementizers are treated as (CP-projecting) heads that select for a [SUBJ ⟨ ⟩] complement.

Note that this analysis provides no account of the 'adverb amelioration' effect discussed by Culicover (1993) (among others), i.e. the fact that examples like (23) seem grammatical, or nearly so:[4]

(23) (?)This is the kind of person who I doubt that, under normal circumstances, would have anything to do with such a scheme.

But in fact, the adverb amelioration effect is absent with most adverbials. Similar examples involving temporal, manner and locative adverbials, for example, are unacceptable, as shown in (24).

(24) a. *This is the kind of person who I doubt that last year had anything to do with such a scheme.

b. *Who do you think that happily visited museums?

[4]This phenomenon was apparently first observed by Bresnan (1977).

c. *Which people at the conference did they think that in Paris visited museums?

Thus whatever is responsible for the acceptability of examples like (23) (parentheticality may be a factor) is not something that should be incorporated into the treatment of adjuncts in general.

French exhibits a much-discussed contrast of complementizers that in certain respects mirrors the *that*-trace facts just discussed. The complementizer *que* is the rough equivalent of English *that*. The complementizer *qui* is not in general available as an alternative:

(25) Tu a dit *que*/**qui* cet homme est heureux.
you said that that man is happy
'You said that this man is happy.'

Yet neither *que* nor its prevocalic alternant *qu'* can combine with a clause whose subject is extracted.

(26) *L'homme que tu a dit *que*/*qu'* est heureux ...
the-man that you said that is happy ...
'the man that you said is happy ... '

In this case, the complementizer *qui* must be used:

(27) L'homme que tu a dit *qui* est heureux ...
'the man that you said that is happy ... '

These contrasts receive a simple treatment in the analysis we have developed. *Que*, like English *that*, selects a phrase that is [SUBJ $\langle\ \rangle$] and *qui* selects a phrase that is [SUBJ $\langle$*gap-ss*$\rangle$]. It follows that the two forms are in complementary distribution. The key to the analysis is making the information about subject extraction locally accessible on the VP selected by the complementizer.

6 Conclusion

The SLASH-based analysis of long-distance dependency constructions pioneered by Gazdar (1981) has proven to be highly resilient. The HPSG version of this analysis presented in chapter 4 of PS-94 replaces some of the mechanisms of the original theory by principles that are more readily compatible with modern feature-based approaches to grammar, but does not change the essentials of the original proposal. The ultimate version of their analysis, however, presented in the final chapter of that book, and explored further in Sag and Fodor (1994) and Sag (1997), does deviate from earlier proposals, in that it locates much of the theory of unbounded dependencies in the lexicon. While the elimination of traces, which provides part of the motivation for this innovation, may appeal to many linguists, it remained to be shown that the traceless account of extraction is indeed a solid alternative to trace-based accounts.

In particular, previous traceless theories of extraction had two major weaknesses. Traces were only eliminated at the cost of introducing one or more lexical rules, the status of which has raised considerable controversy. Hukari and Levine (1996) draw attention to a second problematic aspect of previous proposals. They observe that traceless accounts fail to provide a uniform treatment of the full range of data. Given the HPSG architecture of PS-94, in which complements and subjects are represented by two different valence features, and where adjuncts and arguments are selected by widely different mechanisms, no traceless, lexicalist, account appeared competitive in terms of providing a single, simple, mechanism responsible for extraction. The theory of extraction we have presented here, shows that this initial assessment is ultimately incorrect. A single constraint on words, Dependent Realization, covers complement, subject, and argument extraction. Obviously, this constraint-based approach to extraction remedies the first problem (the obscure status of lexical rules) as well, in that it renders otiose the use of lexical rules in the grammar of extraction.

References

Abeillé, Anne and Danièle Godard. to appear. The syntax of French negative adverbs. In Paul Hirschbühler and F. Marineau, editors, *Negation: Syntax and Semantics*. John Benjamins, Amsterdam.

Bouma, Gosse, Robert Malouf, and Ivan A. Sag. 1998. Satsifying constraints on extraction and adjunction. Ms., University of Groningen and Stanford University.

Bresnan, Joan W. 1977. Variables in the theory of transformations. In Adrian Akmajian, Peter Culicover, and Thomas Wasow, editors, *Formal Syntax*. Academic Press, New York.

Chae, Hee-Rahk. 1992. *Lexically Triggered Unbounded Discontinuities in English*. Ph.D. thesis, The Ohio State University, Columbus.

Chung, Sandra. 1982. Unbounded dependencies in Chamorro grammar. *Linguistic Inquiry*, 13:39–77.

Chung, Sandra. 1995. *Wh*-agreement and "referentiality" in Chamorro. *Linguistic Inquiry*, 25:1–44.

Culicover, Peter. 1993. Evidence against ECP accounts of the that-*t* effect. *Linguistic Inquiry*, 24:557–561.

Flickinger, Daniel and John Nerbonne. 1992. Inheritance and complementation: A case study of *easy* adjectives and related nouns. *Computational Linguistics*, 18(3):269–309.

Gazdar, Gerald. 1981. Unbounded dependencies and coordinate structure. *Linguistic Inquiry*, 12:155–184.

Gazdar, Gerald, Ewan Klein, Geoffrey Pullum, and Ivan A. Sag. 1985. *Generalized Phrase Structure Grammar*. Blackwell.

Gazdar, Gerald, Ewan Klein, Geoffrey K. Pullum, and Ivan A. Sag. 1984. Foot features and parasitic gaps. In W. Geest and Y. Putseys, editors, *Sentential Complementation*. Foris, Dordrecht.

Georgopolous, Carol. 1985. Variables in Palauan syntax. *Natural Language and Linguistic Theory*, 3:59–94.

Hinrichs, Erhard and Tsuneko Nakazawa. 1996. Applying lexical rules under subsumption. In *Proceedings of the 16th International Conference on Computational Linguistics (COLING)*, pages 543–549, Copenhagen.

Höhle, Tilman. 1995. The Complement Extraction Lexical Rule and variable argument raising. Paper presented at HPSG Workshop. Universität Tübingen.

Hukari, Thomas E. and Robert D. Levine. 1995. Adjunct extraction. *Journal of Linguistics*, 31(2):195–226.

Hukari, Thomas E. and Robert D. Levine. 1996. Phrase structure grammar: the next generation. *Journal of Linguistics*, 32:465–496.

Kaplan, Ronald M. and Annie Zaenen. 1989. Long-distance dependencies, constituent structure and functional uncertainty. In Mark R. Baltin and Anthony S. Kroch, editors, *Alternative Conceptions of Phrase Structure*. University of Chicago Press.

Kim, Jong-Bok and Ivan A. Sag. 1995. The parametric variation of English and French negation. In *Proceedings of the West Coast Conference on Formal Linguistics*.

Kroeber, Paul. 1997. Relativization in Thompson River Salish. *Anthropological Linguistics*, 39:376–422.

Maling, Joan. 1989. Adverbials and structural case in Korean. In S. Kuno, I.-H. Lee, J. Whitman, S.-Y. Bak, Y.-S. Kang, and Y.-J. Kim, editors, *Harvard Studies in Korean Linguistics III*. Harvard University, Cambridge, MA, pages 297–308.

Maling, Joan. 1993. Of nominative and accusative: the hierarchical assignment of grammatical case in Finnish. In A. Holmberg and U. Nikanne, editors, *Case and other functional categories in Finnish syntax*. Mouton de Gruyter, Dordrecht, pages 51–76.

Manning, Christopher, Ivan A. Sag, and Masayo Iida. in press. The lexical integrity of Japanese causatives. In Robert Levine and Georgia Green, editors, *Readings in HPSG*. Cambridge University Press, Cambridge.

Miller, Philip. 1992. *Clitics and Constituents in Phrase Structure Grammar*. New York: Garland.

Miller, Philip and Ivan A. Sag. 1997. French clitic movement without clitics or movement. *Natural Language and Linguistic Theory*, 15:573–639.

Morrill, Glyn. 1994. *Type Logical Grammar: Categorial Logic of Signs*. Dordrecht: Kluwer Academic Publishers.

Müller, Stefan. 1996. Complement extraction lexical rules and argument attraction. In Dafydd Gibbon, editor, *Natural Language Processing and Speech Technology. Results of the 3rd KONVENS Conference, Bielefeld, October 1996*, pages 223–236, Berlin, New York. Mouton de Gruyter.

Przepiórkowski, Adam. 1997a. On complements and adjuncts in polish. unpublished draft.

Przepiórkowski, Adam. 1997b. Quantifiers, adjuncts as complements, and scope ambiguities. unpublished draft.

Przepiórkowski, Adam. in press. Adjuncts as complements: Evidence from case assignment. In Andreas Kathol, Jean-Pierre Koenig, and Gert Webelhuth, editors, *Lexical and Constructional Aspects of Linguistic Explanation*. CSLI Publications.

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

Sag, Ivan A. 1998. Not a trace. Unpublished manuscript, Stanford University.

Sag, Ivan A. and Janet Dean Fodor. 1994. Extraction without traces. In *West Coast Conference on Formal Linguistics 13*, Stanford. CSLI Publications.

Steedman, Mark. 1996. *Surface Structure and Interpretation*. Cambridge, MA: MIT Press.

van Noord, Gertjan and Gosse Bouma. 1994. Adjuncts and the processing of lexical rules. In *Proceedings of the 15th International Conference on Computational Linguistics (COLING)*, pages 250–256, Kyoto.

Chapter 11

Functional Uncertainty and Long-distance Dependencies in LFG

with special attention to the relevant facts in West-Germanic

ANNIE ZAENEN

1 Introduction

In LFG long distance dependencies are handled in teh f-structure and require no empty categories in the phrase structure representation. After summarising some of the arguments for this view, I will present the technical aspects of Functional Uncertainty, the LFG device that handles long distance dependencies and illustrate it with an analysis of Dutch and German topicalisation structures.

The discussion will center around the following topics:

- what are good arguments for surface phrase structure representations?
- what is an adequate representation for island constraints given how variable these constraints are across languages?
- what are the main generalisations about topicalisation and long distance scrambling in Dutch and German?
- what is the right division of labour between the f-structure and information structure?

Proceedings of FHCG'98
Gosse Bouma, Geert-Jan Kruijff & Richard Oehrle (editors).

Part III

Regular Session

Chapter 12

French subject inversion in extraction contexts

Olivier Bonami, Danièle Godard and Jean-Marie Marandin

Abstract. Subject NP inversion in extraction contexts in French raises difficulty for standard phrase structure approaches. We present an analysis which relies both on domain union and lexical types for verbs. This analysis extends to French locative inversion whose properties have never been examined. Having unified the syntax of LI with that of other extractions, we reexamine the relation between NP inversion and information packaging in constructions with main clause assertive force.

1 Introduction

In this paper, we study subject inversion in extraction contexts with three goals in mind. First we present a novel analysis of extraction-triggered inversion (ETI) in a linearization-based HPSG framework, crucially relying on previously unexplored data. Second, we show that French locative inversion, whose properties have not yet been investigated, is best analyzed as an instance of ETI from a syntactic point of view. Finally, we explore the interaction of inversion with information packaging, showing that inverted subjects cannot be topics.

2 Inverted subjects in extraction contexts

Subject NP inversion is possible in all recognized extraction contexts in French: relatives, *wh-* interrogatives or exclamatives, clefts, PP topicalizations. In this section we illustrate the general properties of ETI with relatives.[1]

The inverted NP is a subject A number of properties are known to differentiate a preverbal subject from a postverbal object in French (for a summary, see [Marandin,1997] and references therein). Since the inverted NP in extraction contexts shares properties with both, the question of its functional status is not trivial. The relevant observations are summarized in FIG 12.1.

[1] Our analysis naturally extends to quotative inversion. There are other cases of NP inversion which are not triggered by extraction [Le Bidois,1950], such as inversion in certain subjunctive embedded clauses. Note that NP subject inversion differs sharply from clitic (subject) inversion [Kayne,1972].

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	inverted NP	subject	object
1. binding of *se*	+	+	−
2. quantitative *en* construction	−	−	+
3. bare Q's *tous*, *beaucoup*	−	+	−
4. *de N* in negative context	+	−	+
5. floating *beaucoup (... de N)*	−	−	+
6. *combien* extraction	+	−	+
7. number agreement with finite V	+	+	−
8. person agreement with finite V	-	+	−

Figure 12.1: Properties of subjects, objects and inverted NPs

These observations offer two arguments in favor of analyzing the inverted NP as a subject. First, simple generalizations concerning subjects and objects can be kept: (a) all and only subjects can bind the anaphor *se* (*L'endroit où Paul se rend / où se rend Paul* 'The place where Paul goes'); (b) all and only objects allow for the quantitative *en* construction. Examples (12.1) contrast an object with a time NP modifier, a subject and an inverted NP (with *en* the pronominal equivalent of 'weeks'):

(12.1) a. *Paul en passera plusieurs à Paris.*
Paul of-them spend-fut several in Paris

b. * *Paul en restera plusieurs à Paris.*
Paul of-them stay-fut several in Paris

c. * *Plusieurs en passeront avant la décision.*
Several of-them pass-fut before the decision

d. * *La décision avant laquelle en passeront plusieurs*
The decision before which of-them pass-fut several

(c) Objects allow for a floating *Q ... de N* construction (*Il a beaucoup lu de livres* 'He read many books'). Inverted NPs do not allow it (**L'anné où sont beaucoup parus de best-sellers* 'The year during which many best sellers were published'). Note that this cannot be due to the form *de N* of the NP, since inverted *de N*'s are possible in other contexts (observations 4 and 6).

Second, the restriction on bare Qs unexpectedly favors a subject analysis of the inverted NP. Bare Qs in general are acceptable in all NP functions. However, some of them (*tous*, *beaucoup*, *un*) cannot be objects, while others can (e.g. *tout*, *rien*). Since neither group forms a syntactic or semantic natural class, the restrictions must be encoded on the lexical items themselves: some bare Qs simply fail to have an accusative form [Abeillé & Godard, 1998]. Going back to ETI contexts, only those bare Qs that can be objects can be inverted NPs. This follows if inverted NPs are accusative, and is unexpected if they are nominative. However, inverted NPs cannot be accusative complements, or there would be no way to distinguish them from objects. Thus they are accusative subjects. This analysis also accounts for their differences with preverbal subjects (see observations 3,4,5,8).

Phrase structure-based analyses It has long been observed that the inverted subject (IS) can be linearized not only after the VP, but also between the verb and one of its complements:

(12.2) a. *La lettre qu' enverra [$_{PP}$à la direction] [$_{NP}$ le patron]*
'The letter that the boss will send to the management'

b. *La lettre qu'enverra [$_{NP}$ le patron] [$_{PP}$ à la direction]*

In phrase-structural terms, this fact can be accounted for by assuming that ETI sentences have a flat structure, the inverted subject being a sister of the lexical verb and its complements. Since the order between NP and PP is unconstrained in French, the two orders in (12.2) are directly accounted for.[2]

However, this analysis cannot account for the occurrence of the subject to the left of an embedded complement, as in (12.3b), a piece of data which has been overlooked in previous studies:

(12.3) a. *Le livre que le patron du labo [croyait [pouvoir [recommander à cet étudiant]]]*
'The book that the head of the lab thought he could recommend to this student'

b. *Le livre que croyait pouvoir recommander le patron du labo à cet étudiant*

In order to account for (12.3b), the only available phrase-structural solution[3] is to assume that the higher verb (*croyait*) may inherit complements of the infinitival V via argument composition (e.g. [Hinrichs & Nakazawa,1994]), thus allowing the subject of the higher verb to be followed by complements of an embedded verb.

Note first that the flat structures which have been argued for French (e.g. [Abeillé et al. to appear]) and which rely on argument composition do not provide evidence in favor of this analysis. For instance, as is well known, in causative constructions, pronominal clitics subcategorized for by the infinitival complement occur on the causative verb (12.4a); in ETI constructions this is never the case (12.4b). An argument composition analysis would have to say that the higher verb in ETI can only inherit the canonical complements from the V[inf].

(12.4) a. Paul it make-fut read-inf to-the students / make-fut it read to-the students *Paul le fera lire aux étudiants / * fera* le lire aux étudiants.
'Paul will make the students read it'

b. *Un message que veut lui envoyer Paul / * lui*
A message which wants to-him send-inf Paul / to-him
veut envoyer Paul.
wants send-inf Paul
'A message which Paul wants to send to him'

[2]Transformational analyses differ as regards the position of the inverted NP; it is assumed to be right adjoined to the VP, or in its base position to the left or to the right of the VP; see [de Wind,1997] and references therein for discussion. All transformational approaches assume that extraposition is responsible for the order variation in (12.2).

[3]Note that in a transformational analysis, extraposition is of no help in (12.3b): there would be a long-distance dependency between the V and the PP (see (12.3a)), which (rightwards) extraposition doesn't allow in French any more than in English.

Second, since the inverted NP is a subject, the analysis requires positing a new phrase type *head-subj-comps-ph*, which would require independent justification. Third and most importantly, binding data present a serious challenge for argument composition. Assuming that an anaphor such as *l'un ... l'autre* has to be bound in every ARG-ST list where it occurs,[4] we would not expect an ETI such as (12.5) to be acceptable :

(12.5) *Le jour où voulait les présenter Paul l'un à l'autre*
The day when wanted them introduce-inf Paul to-each other
'The day Paul wanted to introduce them to each other'

The binder is the clitic *les*, which doesn't belong to the ARG-ST of *voulait.* If *l'un ... l'autre*, as an inherited argument, belongs to the ARG-ST of *voulait*, it is not bound.

The proposed analysis Since purely phrase-structural analyses fail, we propose that subject inversion be analyzed as an effect of domain union. Adopting [Reape,1994]'s formalization, a DOMain feature and a boolean feature [UN±] are associated with every phrase. The value of DOM for a phrase is the list of its daughters in the unmarked case; if some daughter is [UN+], its own DOM value is shuffled into the mother's DOM. ETI sentences have the same phrase structure as sentences with a preverbal subject, the difference being that the VP is domain unioned into the S domain, as exemplified in FIG. 12.2. Thus, an inverted sentence has in its order domain the subject and the immediate constituents of the VP, allowing the ordinary (V≺NP) rule to order the inverted subject after the verb. Just as in a VP, the relative order of NP and PP is unconstrained (see (12.2)). In the case of (12.3), the VPs are sequentially domain-unioned, yielding at the S level a domain containing the lexical Vs, all their complements, and the subject.

The detail of the data is intricate:[5] while a verb with a gapped argument may always have an IS, there are constraints on inversion triggered by long-distance extractions. First, extraction out of a finite complement never licenses inversion of an upstairs subject (contra [Kayne & Pollock,1978]), although the embedded subject can be inverted (12.6). Extraction out of a VP[inf] allows inversion of the upstairs subject (see 12.3b).

(12.6) ** Le livre qu'a cru que Jean écrirait mon éditeur*
'The book that my publisher thought that John would write'

[4]This hypothesis is supported by the binding constraints on *l'un ... l'autre* in causatives:

(i) Sa rigueur le fera s' occuper [des patients]$_i$ [l' un après l' autre]$_i$
'His orderliness will make him take care of the patients one after the other'

(ii) * Sa rigueur le fera s' en$_i$ occuper [l' un après l' autre]$_i$
His orderliness will make him take care of them one after the other

According to [Abeillé et al. to appear]'s analysis, composition-*faire* can take a cliticized verb complement if it has inherent clitics, like *s'occuper* in (i-ii). *Des patients* is inherited by *faire* in (i), while the corresponding clitic *en* is not in (ii). Thus *l'un après l'autre*, which is on both ARG-ST lists, is upstairs bound in (i) but not in (ii).

[5]See [Bonami & Godard, to appear] for a more complete presentation of the data and of the analysis.

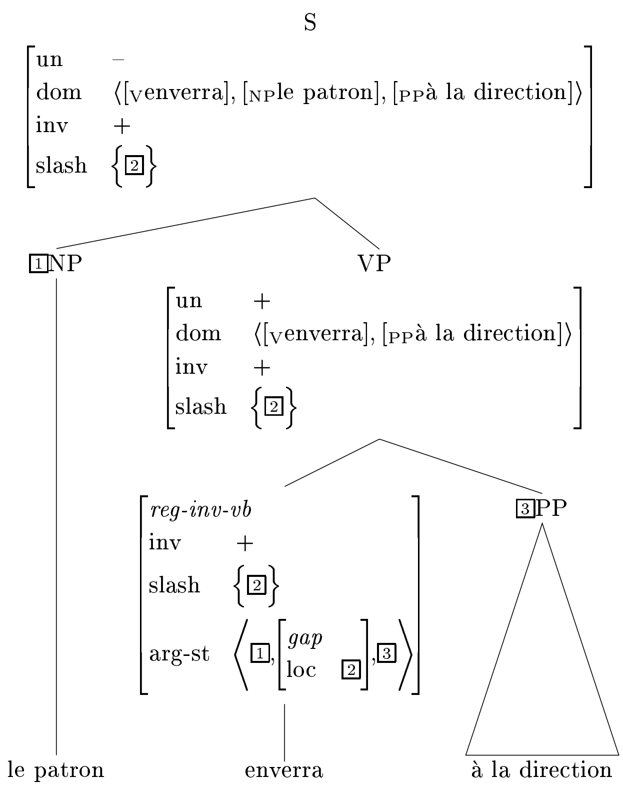

Figure 12.2: HD-DTR of the relative clause in (12.2b)

Second, object control verbs contrast with subject control verbs in not allowing the problematic order of (12.3b): the inverted subject must follow the embedded complements. In our analysis, the embedded VP in (12.8) is [UN⇔], contrasting with the [UN+] VPs in (12.3b).

(12.7) *Le livre que m' a convaincu d' offrir à ma sœur un libraire*
'The book that a bookseller convinced me to offer to my sister'

(12.8) ** Le livre que m' a convaincu d' offrir un libraire à ma sœur*

To account for this array of data, we introduce the head feature [INV±] in addition to [UN±].[6] As in [Sag,to appear], the sharing of SLASH values between a phrase and its daughters is mediated by the lexical head. Only verbs with a nonempty SLASH value can be [INV+]. The relation between the two features is as follows:

(12.9)

a. $\begin{bmatrix} \textit{phrase} \\ \text{inv} \quad - \end{bmatrix} \Rightarrow [\text{UN} -]$

b. $\begin{bmatrix} \textit{phrase} \\ \text{inv} \quad + \end{bmatrix} \Rightarrow [\text{UN} \ /+]$

c. $\begin{bmatrix} \textit{phrase} & \\ \text{head—vform} & \textit{finite} \\ \text{subj} & \textit{list(gap)} \end{bmatrix} \Rightarrow [\text{UN} -]$

Accordingly, infinitival VPs are unioned depending on the INV value, finite clauses are never unioned although they may be [INV+].

We then propose the hierarchy of verbs in FIG. 12.3. The distinction between *non-inv-vb* and *inv-vb* encodes the constraints discussed above. *long-inv-vb* are subject control/raising verbs which constrain the complement from which they inherit the SLASH to be itself inverted, and hence unioned. *reg-inv-vb* cover all other cases of ETI. The $\boxed{1}$ argument can be a gap (12.2), the slashed VP[inf] complement of an object control/raising verb (12.8), or even an NP (*Combien sont venus de clients?* 'How many customers came?'); but not a finite complement (12.6).[7]

3 Locative inversion is triggered by extraction

The question must be raised whether French locative inversion (LI), whose syntax has not been studied previously, is another instance of ETI.

The inverted NP is a subject The inverted NP in LI has the very same distribution of subject-like and object-like properties as the inverted NPs in ETI; thus if the inverted NP in ETI is a subject, so is the inverted NP in LI.

Long-distance inversion LI is possible in a context where a raising or even a control verb intervenes between the preposed PP and the verb selecting it.[8] The subject is then realized on the right of the embedded verb:[9]

[6]We assume that the INV feature is present on all major categories.

[7]Another constraint is necessary if [Bonami & Godard, to appear] are right in that inverted subject control verbs force their complement to be [INV+].

[8]The semantic requirements of the LI construction forbid the presence of raising to object and object-control verbs.

[9]English sentences parallel to (12.10a) have been taken as evidence that the initial PP in English LI is a subject (e.g. [Bresnan,1994]). This argument does not hold for French,

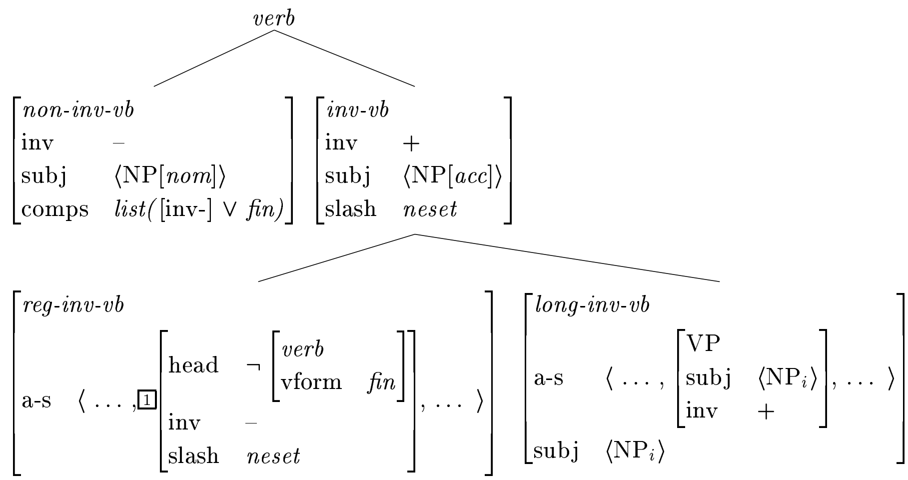

Figure 12.3: A fragment of the hierarchy of verbs

(12.10) a. *Dans le jardin semblaient danser des statues de pierre.*
'In the garden seemed to be dancing statues of stone'

b. *Du piano semblait vouloir s'échapper un son métallique.*
(lit.) 'From the piano seemed to want to escape a metallic sound'

Moreover, as in ETI, the inverted subject of the main verb can be linearized between the constituents of an embedded VP, as (12.11) shows:

(12.11) *Sur la place semblait se dresser une cathédrale avec majesté.*
(*lit.*) 'On the square seemed to stand a cathedral in its majesty'

Since *se dresser* and *avec majesté* form a constituent (the complement of *sembler*), the only possible analysis is that the embedded VP is unioned into the matrix VP domain, which in turn is unioned into the S domain.

We conclude that the position of the subject in ETI and in LI have the same source: in each case, the position of the subject is an effect of domain union. Since domain union in ETI is licensed by extraction, the next question is whether the same is true in LI.

The preposed PP is extracted Turning now to the analysis of the initial PP, we are faced with two possibilities: either the PP is a filler, or the PP is not extracted. Rather, it is a constituent of the VP, realized in initial position as an effect of domain union ([Kathol & Levine,1993] provide a similar analysis for English LI). We argue in favor of the first alternative.[10]

Consider the initial PP in (12.12a): *a priori*, it can be analyzed as a frame adverbial, an extracted ('topicalized') PP, or the initial PP in a locative inversion.

given the possible occurrence of control verbs between the PP and the verb selecting it (12.10b). In addition, there is no case for subject PPs in French.

[10] The fact that the initial PP can be semantically either an argument (12.10–12.11) or a modifier (as in *Devant la gare bavardait un groupe d'enfants* 'In front of the station discussed a group of children') is not a counter-argument against an extraction analysis. In French both kinds of locative PPs behave in the same way in the VP with respect to extraction. In particular, both allow subject inversion (see [Hukari & Levine, 1995]).

The inversion in (12.12a) cannot be due to the *wh-* word *pourquoi*, which does not license inversion (12.12b). Hence it is due to the initial PP.

(12.12) a. *[$_{PP}$ Dans le salon], pourquoi [$_{V}$ se soûlaient] [$_{NP}$ des soldats]?*
'Why were soldiers getting drunk in the lounge?'

b. ** Pourquoi se soûlaient les soldats dans le salon ?*

First, the initial PP is not a frame adverbial, since such adverbials do not license inversion either (*A Paris, Paul va au cinéma / *A Paris va Paul au cinema* 'In Paris, Paul goes to the movies'). Second, it is not a topicalized PP, since locatives such as *dans*+NP are never good topicalized PPs in French (**Dans le jardin, Paul ira / *Dans le jardin ira Paul* 'Into the lounge, Paul will go'). Thus (12.12a) as an instance of LI.

Given the analysis of (12.12a), we now have an argument against a domain-union analysis for the position of the PP: since finite Ss never union, the PP in (12.12a) would not be able to linearize outside the *pourquoi* clause. We conclude that the initial PP in LI is extracted.[11]

In addition, a linearization approach to the initial position of the PP would recquire an otherwise unmotivated difference between preposed and in-situ PPs (PPs never precede a lexical V in French).

Since subject inversion in LI is a result of domain union on the one hand, and the PP is extracted on the other hand, we conclude that LI is just another case of extraction-triggered domain union. In spite of their similarity, LI and PP topicalization must be distinguished: (a) the set of admissible PPs is not the same; (b) inversion is obligatory in LI, and rare in PP topicalization; hence the unacceptability of **Dans le jardin, Paul ira* above. We thus consider that LI is a specific construction. Syntactically, it is a subtype of *head-filler-phrase* specified as [HEAD *verb*[VFORM *fin*,INV +].

4 Subject inversion and information packaging

The number of ETI constructions in French offers an opportunity to reexamine a traditional question with respect to NP inversion in general: is there an information-packaging [Lambrecht,1994, Vallduví & Engdahl,1996] effect associated with inversion *per se*? Adopting [Vallduví & Engdahl,1996]'s partition of information into focus and ground and of ground into topic (link) and tail, we briefly show that inverted subjects are indeed constrained in that they cannot be topics. However there is no single information packaging instruction associated with subject inversion.

Inverted subjects are never topic French has a test for topichood: a parenthetical tonic pronoun (PTP) only cooccurs with subject NPs and clitic pronouns ([Ronat,1979]): the very elements which can be topics (12.13). Coindexation with a PTP forces a (contrastive) topic interpretation. We can easily show that an IS cannot be a topic since coindexation with a PTP is ill-formed as (12.14) shows :[12]

[11] Note that extraction of PPs out of finite *wh-* clauses is possible in French.

[12] Following [Vallduví & Vilkuna,1997], we we assume that contrast is orthogonal to the focus/ground partition. The following sentence with a contrastive IS shows that contrast is not responsible for the ill-formedness of (12.14):
Une chambre où ne dormait que Paul
'A room where only Paul slept'

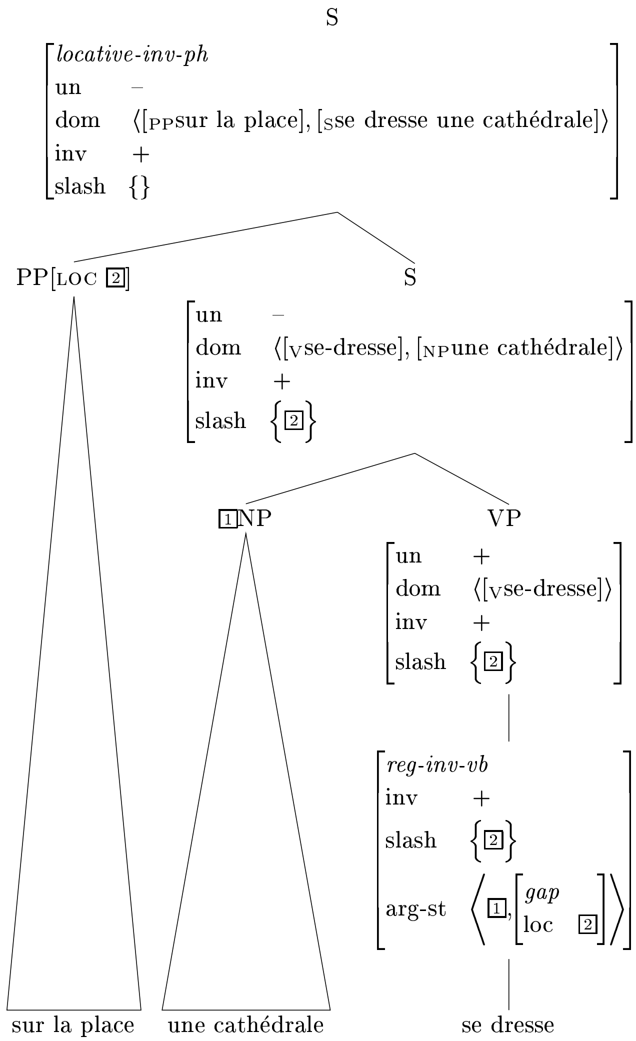

Figure 12.4: Analysis of *Sur la place se dresse une cathédrale*

(12.13) *Marie$_i$ aime véritablement Paul, elle$_i$.*
‘MARY loves Paul’ (lit: Mary loves Paul, her)

(12.14) a. * Dans le faubourg se dresse la nouvelle cathédrale, elle.
‘In the suburb stands the NEW cathedral’

b. * La maison où habite Paul, lui, est immense.
‘The house where PAUL lives is huge’

IS can belong to the focus or the ground An IS in LI is not assigned to either focus or ground. An LI sentence can be a felicitous answer in the three following contexts: the question in (12.15) calls for an all-focus answer; that in (12.16) for a narrow focus on the inverted NP and that in (12.17) for a narrow focus on PP (hence the IS is in the ground):

(12.15) [What’s happening?]

De la cheminée sort une fumée inquiétante.
'From the chimney comes out a worrying smoke'

(12.16) [And in Paul's room, what is postered on the walls?]
Sur un des murs est affichée une photo de Marie.
'On one of-the walls is postered a picture of Mary.'

(12.17) [What about John? Where are his pictures shown?]
Au Louvre sont exposés ses monochromes.
'In the Louvre are shown his monochromes'

Constraints on IS There are two *it*-cleft constructions in French.[13] The coda clause of *it*-cleft-1 is assigned to the ground, while *it*-cleft-2 is a presentational all-focus construction with the coda-clause part of focus [Lambrecht,1994]. The unacceptability of (12.19) is unexpected, given that subject inversion is compatible with an all focus packaging (see (12.15) above).

(12.18) [Who did John speak to?]
C'est à Marie que Jean a parlé / qu'a parlé Jean.
'It is to MARY that John spoke'

(12.19) [What's happening?]
C'est mon voisin que la police arrête / # qu'arrête la police.
'Here is my neighbor arrested by the police'

Since this contrast and similar ones (for instance, an IS can be a focus in LI while it cannot be in PP-topicalization) cannot be attributed to subject inversion by itself, it means that each construction specifies whether it allows subject inversion as well as which information packaging is associated with it. The presence of the boolean INV feature on the head of the construction is sufficient to account for the presence or absence of IS. Although the integration of subject inversion in a general picture of information packaging remains for future research, we have arrived at a partial conclusion. While subject inversion has nothing to say in the focus/ground partition (IS may belong to either), it does play a role in the organization of the ground (IS may be part of the tail, but cannot be topic). This shows, in contrast with [Lambrecht & Polinsky,1997]'s proposal for inversion in Italian, that detopicalization does not imply focalization.

5 Conclusions

Having shown that inverted NPs were subjects in ETI constructions, we propose that inversion is an effect of an extraction-triggered domain union. This analysis accounts in particular for difficult data where the inverted main subject precedes an embedded complement. Moreover, we rely on lexical typing of verbs occurring on extraction paths to account for the intricate constraints on long distance inversion. Finally, we show that the syntactic commonality of the inversion contexts we have explored is partially reflected in the information packaging dimension: inverted subjects may not be topics.

[13] The two it-clefts are associated with different intonational patterns, see [Clech-Darbon et al., 1998]).

Bibliography

[Abeillé & Godard, 1998] Anne Abeillé and Danièle Godard 1998. A lexical account of quantifier floating. In G. Webelhuth, J.-P. Kœnig and A. Kathol, *Lexical and constructional aspects of linguistic explanation*. Stanford: CSLI Publications.

[Abeillé et al. to appear] Anne Abeillé, Danièle Godard and Ivan A. Sag 1998. Two kinds of argument composition. In E. Hinrichs, A. Kathol and T.Nakazawa (eds), *Complex predicates*, New York: Academic Press.

[Bonami & Godard, to appear] Olivier Bonami and Danièle Godard to appear. Inversion du sujet, constituance et ordre des mots. In G. Lardreau (ed), *Cahier Jean-Claude Milner*, Paris: Verdier.

[Bresnan,1994] Joan Bresnan 1994. Locative inversion and the architecture of universal grammar. *Language* 70. 72–131.

[Clech-Darbon et al., 1998] Anne Clech-Darbon, Georges Rebuschi and Annie Rialland 1998. Are there Cleft-sentences in French? Ms, Université Paris 3.

[de Wind,1997] Marteen de Wind 1995. *Inversion in French.* PhD dissertation, Groningen University.

[Hinrichs & Nakazawa,1994] Erhard Hinrichs and Tsuneko Nakazawa 1994. Linearizing AUXs in German verbal complexes. In J. Nerbonne, K. Netter and C. Pollard (eds), *German in HPSG*, Stanford: CSLI Publications. 11–37.

[Hukari & Levine, 1995] Tom Hukari and Robert D. Levine 1995. Adjunct extraction. *Journal of linguistics* 31. 195–226.

[Kathol & Levine,1993] Andreas Kathol. and Robert D. Levine 1993. Inversion as a linearization effect. *Proceedings of NELS 23*.

[Kayne,1972] Richard S. Kayne 1972. Subject inversion in French interrogatives. In Casagrande *et al.* (eds), *Generative studies in Romance languages*, Rowley, Mass: Newbury House. 70–126.

[Kayne & Pollock,1978] Richard S. Kayne and Jean-Yves Pollock 1978. Stylistic inversion, successive cyclicity and move NP in French. *Linguistic Inquiry* 9. 595–621.

[Lambrecht,1994] Knud Lambrecht 1994. *Information structure and sentence form.* Cambridge : CUP.

[Lambrecht & Polinsky,1997] Knud Lambrecht and Maria Polinsky 1997. Typological variation in sentence-focus constructions. *CLS* 33.

[Le Bidois,1950] Robert Le Bidois 1950. *L'inversion du sujet dans la prose contemporaine.* Paris : Editions d'Artey.

[Marandin,1997] Jean-Marie Marandin 1997. *Dans le titre se trouve le sujet.* Mémoire d'habilitation. Université Paris 7.

[Reape,1994] Mike Reape 1994. Domain union and word order variation in German. In J. Nerbonne, K. Netter and C. Pollard (eds), *German in HPSG*, Stanford: CSLI Publications. 151–197.

[Ronat,1979] Mitsou Ronat 1979. Pronoms topiques et pronoms distinctifs. *Langue française* 44, 106–128.

[Sag,to appear] Ivan A. Sag *to appear*. English relative clause constructions. *Journal of Linguistics*.

[Vallduví & Engdahl,1996] Enric Vallduví and Elisabet Engdahl 1996. The linguistic realization of information packaging. *Linguistics* 34. 459–519.

[Vallduví & Vilkuna,1997] Enric Vallduví and Maria Vilkuna 1997. On rheme and kontrast. In P. Culicover and L. McNally (eds), *The limits of syntax*, New York: Academic Press.

Chapter 13

Towards a General Theory of Partial Constituent Fronting in German

Kordula De Kuthy and Walt Detmar Meurers

1 The issue

The topicalization of partial constituents in German has received much attention in the literature since the phenomenon is a serious challenge to the theory of constituency. In the HPSG paradigm, the attention has focussed on the topicalization of partial verb phrases.[1] But G. Müller (1993, 1996) and others discussed that partial constituent fronting in German also occurs with nominal and adjectival phrases. A simple example for each of the categories is shown in (1).

(1) a. [Verkaufen] wird er *das Pferd.*
sell will he the horse

b. [Ein Buch] hat Hans *über Syntax* ausgeliehen.
a book has Hans about Syntax borrowed

c. [Stolz] ist er *auf seine Kinder* gewesen.
proud is he of his children been

In (1a), the transitive verb *verkaufen* has been fronted, leaving its complement, the NP *das Pferd*, behind. In (1b), the NP *ein Buch* is topicalized without its PP complement *über Syntax*. And in (1c), the AP *stolz* has been fronted, leaving its PP argument *auf seine Kinder* behind.

Looking at the theoretical consequences drawn from such data, two ideas pursued in the principles and parameters paradigm are that i. the constructions involve remnant movement of a constituent containing a trace (Thiersch 1985, Webelhuth and den Besten 1987, G. Müller 1996), or ii. "smaller" constituents can be topicalized which are licensed with the help of special processes like "reanalysis" (Fanselow 1987, for partial NPs). Parallel to these two ideas, HPSG approaches to PVP topicalization proposed a remnant movement-like analysis (Hinrichs and Nakazawa 1994) or used an extended notion of valence, argument raising, which supports partial structures like those resulting from "reanalysis" (the other publications cited

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[1]Pollard (1996), Hinrichs and Nakazawa (1994), Nerbonne (1994), Kathol (1995, sec. 7.7), Meurers (1998), St. Müller (1997), Bouma and van Noord (1998, sec. 3.4)

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in fn. 1). Since one of the arguments against reanalysis fielded by G. Müller (1991, p. 175) is that a reanalysis rule cannot properly be expressed in the GB framework, an interesting aspect of the parallel development in the two frameworks is that the argument-raising approaches in HPSG give a formally precise rendering to a notion of reanalysis.

In this paper, we want to discuss and compare the partial constituents of the three different categories and develop an HPSG theory which accounts for the observable similarities and differences in the three sets of data. We show that a generalized argument raising account makes the correct predictions, in particular regarding the observable word order and the interaction in complex fronting phenomena involving topicalized (P)VPs with partial complements. With respect to the theoretical consequences of the partial fronting data, we believe that the reanalysis-like theory we propose provides a concrete basis for a reevaluation of the choice between remnant movement and reanalysis.

2 The data

2.1 Partial VPs

It is known since Bech (1955) that the possibility of partial VP topicalization depends on the class of the governing verb. Obligatorily coherent verbs like *werden* (will) in (1a) and optionally coherent verbs like *versuchen* (try) in (2a) allow PVP topicalization, while obligatorily incoherent ones as *empfehlen* (recommend) in (2b) do not.[2]

(2) a. [Zu verkaufen] versuchte er *das Pferd*.
to sell tried he the horse

b. * [Zu verkaufen] empfahl er ihr *das Pferd*.
to sell recommended he her the horse

The examples in (3) show that if a topicalized verbal head coherently selects a verbal complement, that complement has to be included in the fronted constituent.[3]

(3) a. [Verkaufen$_3$ müssen$_2$] wird$_1$ er *das Pferd*.
sell have-to will he the horse

b. * [Müssen$_2$] wird$_1$ er *das Pferd verkaufen$_3$*.
have-to will he the horse sell

c. * [Das Pferd müssen$_2$] wird$_1$ er *verkaufen$_3$*.
the horse have-to will he sell

[2] A discussion of Bech's proposal in the context of HPSG is provided in Kiss (1992).

[3] Examples like the ones shown in (3) are a notorious problem case. For G. Müller (1993, p. 447, fn. 22) the ungrammaticality of a sentence like (3b) "can be made to follow from the general prohibition against predicate scrambling", but he never actually provides such a constraint explicitly. The restrictions proposed in Hinrichs and Nakazawa (1994) and Nerbonne (1994) are shown by Kathol (1995, pp. 260f.) to be too restrictive. Kathol and St. Müller (1997) then propose something similar to the generalization we state above; but see fn. 5 for a difference between the proposed formalizations.

In HPSG, Pollard (1996) showed that the lexical argument raising specification of Hinrichs and Nakazawa (1989) can be employed to supply the variable subcategorization requirements required to license the full range of (partial) verbal constituents occurring as complements of coherently constructing verbs. Subsequently, a number of authors argued that the partial constituents should only be licensed in topicalized position (Hinrichs and Nakazawa 1994, Nerbonne 1994, Meurers 1998, St. Müller 1997), which was motivated by the theoretical desideratum of excluding spuriously ambiguous structures in the Mittelfeld.

Interestingly, one can actually find empirical support for excluding the spurious structures, which in the HPSG discussion on PVP topicalization has gone unnoticed. The examples in (4) show that the partial verbal constituent can never be linearized at the beginning of the Mittelfeld. Complete infinitival complements, on the other hand, can occur there when selected by obligatorily incoherent (5c) and optionally coherent verbs (5b), but not obligatorily coherent ones (5a).

(4) a. * Er wird [verkaufen] *das Pferd* noch heute.
he will sell the horse still today

b. * Er versuchte [zu verkaufen] *das Pferd* verzweifelt.
he tried to sell the horse desperately

c. * Er empfahl [zu verkaufen] ihr *das Pferd*.
he recommended to sell her the horse

(5) a. * Er wird [das Pferd verkaufen] noch heute wollen.
he will the horse sell still today want-to

b. Er wird [das Pferd zu verkaufen] noch heute versuchen.
he will the horse to sell still today try-to

c. Er wird [das Pferd zu verkaufen] ihr noch heute empfehlen.
he will the horse to sell her still today recommend

In addition to being theoretically attractive, it thus is also empirically motivated to license partial verbal constituents for topicalization only, and we will assume such an approach as the background of our proposal.

2.2 Partial APs

After this sketch of the main properties of partial VPs on the basis of Bech's distinction between three classes of verbal complement taking verbs, partial APs can now straightforwardly be characterized as behaving like the partial verbal complements of obligatorily coherent verbs (cf. G. Müller 1993, St. Müller 1997). Firstly, a partial AP can be topicalized as shown in (1c), and with a different kind of AP in (6).

(6) [Treu] will er *seiner Frau* für immer bleiben.
faithful wants-to he his wife for ever remain

Secondly, neither a partial (7a) nor a complete (7b) AP can be linearized at the beginning of the Mittelfeld.

(7) a. * Er ist [stolz] immer *auf seine Kinder* gewesen.
he is proud always of his children been

b. * Er ist [stolz auf seine Kinder] immer gewesen.
he is proud of his children always been

Finally, the complement of the AP can occur at the beginning of the Mittelfeld (8), just like the complement of the verbal argument of a coherently constructing verb (9).

(8) Er ist *auf seine Kinder* immer [stolz] gewesen.
he is on his children always proud been

(9) Noch heute wird *es* der Mann [verkaufen] wollen.
Still today will it the man sell want

All of these facts make it plausible to analyze APs analogous to the verbal complements of coherently constructing verbs in that the arguments of the adjectival head are obligatorily raised.

2.3 Partial NPs

The third kind of partially occurring constituents we are interested in, nominal complements selecting a PP argument, in some respects behave like verbal complements of optionally coherent verbs.

Such a nominal complement can be partially topicalized, as was shown in (1b), and the complete NP can be linearized at the beginning of the Mittelfeld as exemplified in (10).

(10) Er hat [ein Buch über Syntax] heute ausgeliehen.
he has a book about syntax today borrowed

Furthermore, the complement of the NP can be linearized at the beginning of the Mittelfeld (11).

(11) Er hat *über Syntax* während seines Studiums [kein einziges Buch] ausgeliehen.
he has about syntax during his studies not a single book borrowed

But, different from all the other partial constituents discussed above, even a partial NP can occur at the beginning of the Mittelfeld (12).

(12) Er hat [keine einziges Buch] während seines Studiums *über Syntax* ausgeliehen.
he has not a single book during his studies about syntax borrowed

The conclusion we want to draw from these facts is that a partial NP and its PP argument should be analyzed as two independent sister constituents. Thus, when a PP argument is raised from an NP, the remaining partial NP complement needs to be treated by its verbal head like any other saturated complement.

There are two related aspects which we have no space to discuss here: Firstly, the occurrence of partial NPs is subject to certain lexical restrictions. A discussion of these restrictions and how they can be integrated into our account is provided in De Kuthy (1998). That paper also situates the empirical phenomenon discussed here in the context of other phenomena involving partial NPs, such as the so-called Split NPs and *Was-für* Split. Secondly, G. Müller (1996) argued that there is empirical evidence for the existence of a trace in a partially fronted NP. In De Kuthy and Meurers (1998) we provide examples which show that his conclusion is not convincing.

2.4 Interactions

Interesting empirical evidence arises from the fact that the topicalization of (P)VPs can interact with the occurrence of partial APs and NPs. An example for a fronted VP including a partial NP is shown in (13a) and the parallel case with a partial AP in (13b).

(13) a. [Ein Buch ausleihen] will er *über Syntax*.
a book borrow wants-to he about syntax

b. [Treu bleiben] will er *seiner Frau*.
faithful remain wants-to he his wife

The example in (14) illustrates that such interaction is also possible with a partially fronted VP, in this case including a partial NP complement.

(14) [Ein Buch ausleihen] will er *ihr hierzu* aber nicht.
a book lend wants-to he her on-this but not

In proposing to analyze all three kinds of partial constituents and coherent constructions with an argument raising mechanism parameterized for the different categories, the theory we formalize below predicts this behavior.

Finally, one can observe that fronting of the complement of an NP or an AP together with the embedding verb is ungrammatical, as shown in (15).

(15) a. * [Über Syntax ausleihen] will er *ihr ein Buch*.
about syntax lend wants-to he her a book

b. * [Auf seine Kinder gewesen] ist er *stolz*.
about his children been he is proud

This is parallel to the example (3c), which showed that the raised complements of a verb cannot be fronted without that verbal head. Our theory therefore explains these facts by requiring raised arguments to be saturated (or more specifically *independent*, a notion introduced below).

3 An HPSG analysis

We propose to generalize the argument raising approach to partial VP fronting of Pollard (1996) to partial constituent fronting in general. The idea is to introduce argument raising as a general option for different kinds of complements. To formalize this option, we define a lexical principle in the style of Meurers (1997a, 1997b) which introduces argument raising as a generalization in the mapping between the argument structure and the valence specifications of verbs.

In the lexicon, the argument structure is specified under the ARG-ST attribute, as shown in the lexical entries below.[4]

(16) a. $\begin{bmatrix} \text{PHON} & \langle \text{wollen} \rangle \\ \text{ARG-ST} & \left\langle NP, \begin{bmatrix} \text{L} \mid \text{C} \mid \text{HEAD} & \textit{verb} \\ \text{LEX} & + \end{bmatrix} \right\rangle \end{bmatrix}$ b. $\begin{bmatrix} \text{PHON} & \langle \text{empfehlen} \rangle \\ \text{ARG-ST} & \left\langle NP, \begin{bmatrix} \text{L} \mid \text{C} \mid \text{HEAD} & \textit{verb} \\ \text{LEX} & - \end{bmatrix} \right\rangle \end{bmatrix}$

c. $\begin{bmatrix} \text{PHON} & \langle \text{hoffen} \rangle \\ \text{ARG-ST} & \left\langle NP, \begin{bmatrix} \text{L} \mid \text{C} \mid \text{HEAD} & \textit{verb} \end{bmatrix} \right\rangle \end{bmatrix}$

In addition to the specification of the argument structure, the lexical entries also show that obligatorily coherent verbs verbs like *wollen* (want-to) in (16 a) mark their verbal complement as [LEX +], whereas obligatorily incoherent verbs like *empfehlen* (recommend) in (16 b) require it to be [LEX –]. The lexical entry of an optionally coherent verb like *hoffen* (hope) in (16 c) is underspecified and enforces no LEX restrictions on its complement.[5] Basically, marking a complement as [LEX –] corresponds to the X-bar schema condition that non-heads have to be completed projections. But while the X-bar schema is a condition on structures, the LEX attribute lexicalizes this restriction, which makes it possible to relax the [LEX –]-complement requirement for heads of a specific lexical class to account for cluster formation in coherent constructions.

The lexical principle shown in figure 13.1 expresses how the argument structure specified in the ARG-ST list of the lexical entries of base form verbs[6] determines the values of the valence attributes (SUBJ and COMPS). The first element ($\boxed{1}$) of

$$\begin{bmatrix} \textit{word} \\ \text{S} \mid \text{L} \mid \text{C} \mid \text{HEAD} \begin{bmatrix} \textit{verb} \\ \text{VFORM} & \textit{bse} \end{bmatrix} \end{bmatrix} \rightarrow \begin{bmatrix} \text{S} \mid \text{L} \mid \text{C} \mid \text{V} & \begin{bmatrix} \text{SUBJ} & \langle \boxed{1} \rangle \\ \text{COMPS} & \boxed{2} \oplus \Big(\textit{raised}\big(\boxed{3}\big) \wedge \textit{indep} \Big) \end{bmatrix} \\ \text{ARG-ST} & \langle \boxed{1} \mid \boxed{2} \rangle \;\wedge\; \big(\boxed{3} \bigcirc \textit{indep} \big) \end{bmatrix}$$

Figure 13.1: The lexical argument-raising principle

the argument structure is assigned to be the subject and the rest of the arguments ($\boxed{2}$) are specified to surface on the COMPS list.[7] Appended ($\oplus$) to that COMPS list are the arguments raised from $\boxed{3}$. These raised arguments are required to be

[4]The ARG-ST attribute is specified explicitly or derived by some kind of a linking theory. We assume argument raising to take place only with respect to the valence attributes, not on ARG-ST. The intuition behind this is that the argument structure should be a direct syntactic reflection of the semantic roles of a predicate.

[5] Kathol (1995) and Müller (1997) employ a special selection attribute (GOV or VCOMP) for complements of coherent verbs. This, however, results in two lexical entries for each optionally coherent verb instead of the underspecified single entry we propose here. Apart from this, regarding PVP topicalization their analyses make the same predictions as the one we propose here.

[6]Finite verbs are assumed to be derived from their base forms by a lexical rule which among other things removes the subject from SUBJ and encodes it together with the complements on COMPS in the tradition of Pollard (1996).

[7]To concentrate on the relevant issues, we here ignore subjectless and subject raising verbs, the integration of which is possible but requires a principle with a more complex mapping for subjects.

indep(endent)[8], i.e., saturated with respect to their complements and $\left[\textsc{lex}\ -\right]$. This is also required of all arguments on ARG-ST except for the argument raising source $\boxed{3}$, which is shuffled ($\bigcirc$) into this list.

The relation *raised* defined in figure 13.2 specifies that the argument raising

$$
\begin{array}{l}
\textit{raised}\big(\langle\rangle\big) := \langle\rangle. \\[6pt]
\textit{raised}\left(\left\langle\begin{bmatrix}\textsc{lex} & + \\ \textsc{l}\,|\,\textsc{c} & \begin{bmatrix}\textsc{head} & \textit{verb} \vee \textit{adj} \\ \textsc{v}\,|\,\textsc{comps} & \boxed{1}\end{bmatrix}\end{bmatrix}\right\rangle\right) := \boxed{1}. \\[6pt]
\textit{raised}\left(\left\langle\begin{bmatrix}\textsc{l}\,|\,\textsc{c} & \begin{bmatrix}\textsc{head} & \textit{noun} \\ \textsc{v}\,|\,\textsc{comps} & \boxed{1}\end{bmatrix}\end{bmatrix}\right\rangle\right) := \boxed{1}.
\end{array}
$$

Figure 13.2: The argument raising sources

source is either empty, in which case no arguments are raised. Or it is a verb or adjective required to be $\left[\textsc{lex}\ +\right]$ from which the complements are returned to be raised. Finally, nouns can also return their complements, but different from verbs and adjectives the nouns are not required to be $\left[\textsc{lex}\ +\right]$.

Turning to the ID Principle in figure 13.3, the Cluster-Formation Schema (CF) licenses head-complement structures marked $\left[\textsc{lex}\ +\right]$ which consist of a *word* and a single $\left[\textsc{lex}\ +\right]$ complement. The Head-Complement Schema (HC), on the other hand, allows head-complement structures in which a *word* combines with any number of complements to form a $\left[\textsc{lex}\ -\right]$ constituent (just like the constituents licensed by the other ID schemata not directly relevant here).

$$
\begin{bmatrix}\textit{phrase} \\ \textsc{dtrs} \ \ \textit{headed-struc}\end{bmatrix} \rightarrow
\begin{array}{ll}
\begin{bmatrix}\textsc{s}\,|\,\textsc{lex} & + \\ \textsc{dtrs} & \begin{bmatrix}\textsc{head-dtr} & \textit{word} \\ \textsc{comp-dtrs} & \left\langle\left[\textsc{s}\,|\,\textsc{lex}\ +\right]\right\rangle\end{bmatrix}\end{bmatrix} & \text{(CF)} \\[6pt]
\vee \begin{bmatrix}\textsc{s}\,|\,\textsc{lex}\ - \\ \textsc{dtrs}\,|\,\textsc{head-dtr}\ \textit{word}\end{bmatrix} & \text{(HC)} \\[6pt]
\vee \begin{bmatrix}\textsc{s}\,|\,\textsc{lex}\ - \\ \vdots\end{bmatrix} & \text{(other ID schemata)}
\end{array}
$$

Figure 13.3: The ID Principle

Two examples Now that the relevant machinery has been introduced, let us look at two examples involving partial topicalization. We start with the analysis of a sentence with a partial NP topicalization, the example shown in (17), which in addition to the simple case (1b) discussed above includes a verbal complex.

(17) [Ein Buch] hofft jeder *hierzu* ausleihen zu dürfen.
a book hopes everyone on-this borrow be-allowed-to

[8]Relations are written in the functional notation traditionally used in HPSG. Definition of *indep*:

$$
\begin{array}{l}
\textit{indep} := \langle\rangle. \\
\textit{indep} := \left\langle\begin{bmatrix}\textsc{l}|\textsc{c}|\textsc{v}|\textsc{comps} & \langle\rangle \\ \textsc{lex} & -\end{bmatrix} \middle|\ \textit{indep}\right\rangle.
\end{array}
$$

The analysis tree for this example is shown in figure 13.4. The interesting detail is how the fronted partial NP *ein Buch* and the verbal complex *ausleihen zu dürfen* are licensed. The lexical entry for the verb *ausleihen* (borrow/lend) is shown in

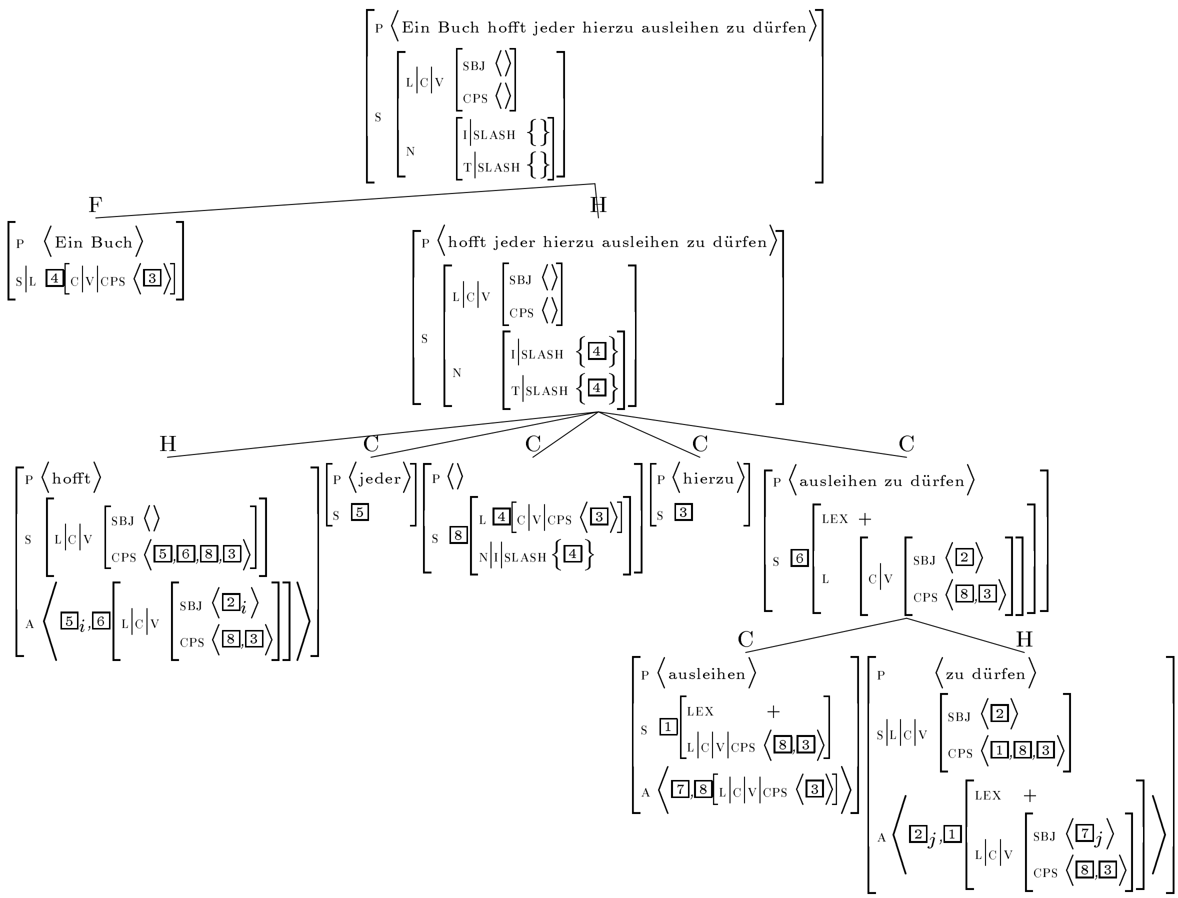

Figure 13.4: Topicalization of a partial NP in a sentence with a verbal complex

(18).

(18) $\begin{bmatrix} \textsc{phon} & \langle \text{ausleihen} \rangle \\ \textsc{s} \mid \textsc{l} \mid \textsc{c} \mid \textsc{head} & \textit{verb} \\ \textsc{arg-st} & \langle \textit{NP}, \textit{NP} \rangle \end{bmatrix}$

The argument raising principle applies to *ausleihen* so that the NPs on ARG-ST can be argument raising sources as defined in figure 13.2. The occurrence of *ausleihen* in the tree in figure 13.4 can therefore raise the PP argument *hierzu* ($\boxed{3}$) from its nominal complement.

The verb *dürfen* belongs to the obligatorily coherent verbs; so it has a lexical entry like *wollen* in (16 a) and requires its verbal complement to be [LEX +]. The argument raising principle therefore has to raise the (trace of the) NP *ein Buch* ($\boxed{8}$)

and the PP *hierzu* ($\boxed{3}$) from the verbal complement *ausleihen* ($\boxed{1}$) onto the COMPS requirements of *zu dürfen*.

The verb *hoffen* belongs to the optionally coherent verbs, for which a lexical entry was shown in (16 c). The argument raising principle ensures that the occurrence of *hofft* in the tree in figure 13.4 raises all independent complements from its verbal complement: the PP *hierzu* ($\boxed{3}$) and the (trace of the) NP *ein Buch* ($\boxed{8}$). But it cannot raise the verbal complement *ausleihen*, since *ausleihen* is unsaturated, i.e., not independent. Instead, *ausleihen* and *zu dürfen* form a verbal complex licensed by the VC schema. The verbal complex, the trace of the fronted NP *ein Buch*, the PP *hierzu*, and the subject NP *er* are then all realized in a flat head-complement structure.

The second analysis we want to show in detail is an example for a VP topicalization including a partial AP, namely the example (13b) we discussed in section 2.4. Such an example is interesting since here argument raising from an adjectival complement has to interact with argument raising from a topicalized verbal complement. The structure for this example as licensed by our theory is shown in figure 13.5. The important detail is how the topicalized constituent with its partial AP

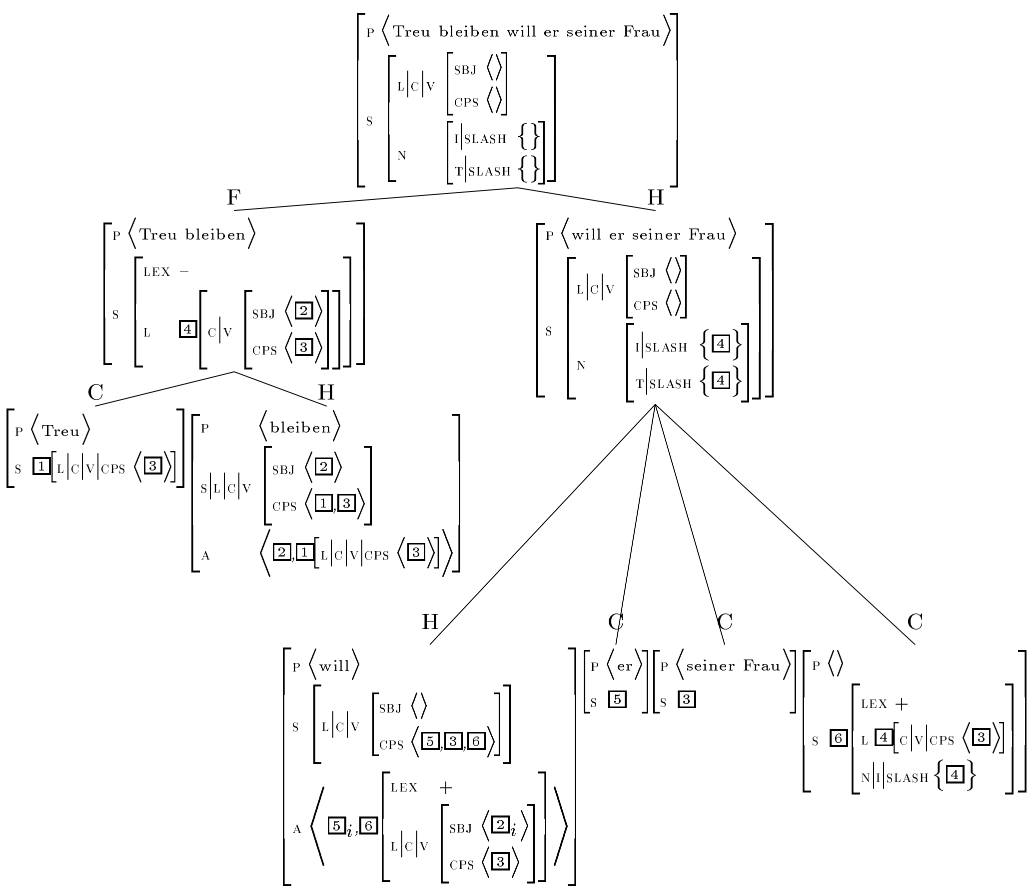

Figure 13.5: Fronting of a VP including a partial AP complement

treu bleiben is licensed. The lexical entry of *bleiben* (stay) is shown in (19).

(19) $$\begin{bmatrix} \textsc{phon} & \langle \text{bleiben} \rangle \\ \textsc{s} \mid \textsc{l} \mid \textsc{c} \mid \textsc{head} & \textit{verb} \\ \textsc{arg-st} & \left\langle \textit{NP}, \begin{bmatrix} \textsc{l} \mid \textsc{c} \mid \textsc{head} & \textit{adjective} \\ \textsc{lex} & + \end{bmatrix} \right\rangle \end{bmatrix}$$

As discussed in the section 2.2 on partial APs, the entry for such a verb is like that of an obligatorily coherent verbal complement taking verb in that it requires its complement to be $[\textsc{lex}\ +]$, only this time it is an adjectival complement and not a verbal one. As a result of the interaction of this specification with the mapping to the valence attributes enforced by the argument raising principle, the occurrence of *bleiben* in the tree in figure 13.5 raises the argument *seiner Frau* ($\boxed{3}$) from its adjectival complement *treu* ($\boxed{1}$). The remaining partial complement is then realized in a head-complement structure. The resulting VP *treu bleiben* is $[\textsc{lex}\ -]$ and has one element left on its COMPS list, the raised NP *seiner Frau* ($\boxed{3}$).

The verb *wollen* belongs to the obligatorily coherent verbs and requires its verbal complement to be $[\textsc{lex}\ +]$, as was shown in its lexical entry (16 a). Again, the argument raising principle ensures that the occurrence of *will* in the tree in figure 13.5 raises the NP *seiner Frau* ($\boxed{3}$) from (the trace of) its verbal complement *treu bleiben* ($\boxed{6}$). Note that for this to be possible, the trace must be $[\textsc{lex}\ +]$. This does not conflict with the $[\textsc{lex}\ -]$ specification on the topicalized VP since, as usual, only the local information ($\boxed{4}$) is shared between the filler and the trace of the unbounded dependency construction, in which the LEX specification is not included (cf. Meurers 1998, St. Müller 1997). Having raised the NP *seiner Frau* ($\boxed{3}$) to the COMPS requirements of *will*, one can license a flat head-complement structure with *will* as head daughter and the NP *er*, the trace of the fronted VP, and the raised NP as complement daughters. The NP *seiner Frau* has thus been raised twice and is realized independent from its original head *treu*, as a complement of the verb *will*.

4 Conclusion

We presented an account for general partial constituent fronting in German. The account extends the empirical coverage of previous HPSG proposals in a way which accounts for the similarities and the differences between three different kinds of partial constituents: partial APs, NPs, and VPs. The similarities derive from a generalization of the argument raising approach to PVPs: a lexical principle which introduces argument raising as a general possibility for verbal heads. The differences result from the different requirements with respect to the lexicality (LEX) of the complements as specified in the lexical entries and a relation (*raised*) parameterizing the lexical principle. As additional support for the analysis, we showed that the approach predicts the observable interaction between (partial) VP topicalization and partial NPs or APs.

Bibliography

Bech, G. (1955). *Studien über das deutsche Verbum infinitum*. reprinted 1983, Tübingen: Max Niemeyer Verlag.

Bouma, G. and G. van Noord (1998). Word Order Constraints on Verb Clusters in German and Dutch. In E. Hinrichs, T. Nakazawa, and A. Kathol (Eds.), *Complex Predicates in Nonderivational Syntax*. New York: Academic Press.

De Kuthy, K. (1998). Splitting PP arguments from NPs - An argument raising approach and its interaction with lexical semantics. In T. I. Kiss and W. D. Meurers (Eds.), *Proceedings of the ESSLLI workshop "Topics in Constraint-Based Germanic Syntax"*, Saarbrücken.

De Kuthy, K. and W. D. Meurers (1998). Incomplete Category Fronting in German without Remnant Movement. In *Proceedings of KONVENS 98*, Bonn.

Fanselow, G. (1987). *Konfigurationalität. Untersuchungen zur Universalgrammatik am Beispiel des Deutschen*. Tübingen: Gunter Narr Verlag.

Hinrichs, E. and T. Nakazawa (1989). Flipped Out: Aux in German. In *Papers from the 25th Regional Meeting of the CLS*, Chicago, pp. 193–202.

Hinrichs, E. and T. Nakazawa (1994). Partial-VP and Split-NP Topicalization in German - An HPSG Analysis. In: E. Hinrichs, D. Meurers, and T. Nakazawa: *Partial-VP and Split-NP Topicalization in German – An HPSG Analysis and its Implementation*. Arbeitspapiere des SFB 340 Nr. 58, Universität Tübingen.

Kathol, A. (1995). *Linearization-Based German Syntax*. Ph. D. thesis, Ohio State University.

Kiss, T. (1992). *Infinite Komplementation: Neue Studien zum deutschen Verbum infinitum*. Ph. D. thesis, Universität Wuppertal.

Meurers, W. D. (1997a). Statusrektion und Wortstellung in kohärenten Infinitkonstruktionen des Deutschen. In E. Hinrichs, W. D. Meurers, F. Richter, M. Sailer, and H. Winhart (Eds.), *Ein HPSG-Fragment des Deutschen. Teil 1: Theorie*, Volume 95 of *Arbeitspapiere des SFB 340*, pp. 189–248. Universität Tübingen.

Meurers, W. D. (1997b). Using lexical principles in HPSG to generalize over valence properties. In *Proceedings of the 3rd Conference on Formal Grammar*, Aix-en-Provence.

Meurers, W. D. (1998). German Partial-VP Fronting Revisited. In G. Webelhuth, J.-P. Koenig, and A. Kathol (Eds.), *Lexical and Constructional Aspects of Linguistic Explanation*. Stanford: CSLI.

Müller, G. (1991). Abstrakte Inkorporation. In S. Olsen and G. Fanselow (Eds.), *DET, COMP und INFL - Zur Syntax funktionaler Kategorien und grammatischer Funktionen*. Tübingen: Max Niemeyer Verlag.

Müller, G. (1993). *On Deriving Movement Type Asymmetries*. Ph. D. thesis, Universität Tübingen.

Müller, G. (1996). Incomplete Category Fronting. SfS-Report 01-96, Universität Tübingen.

Müller, S. (1997). Yet another Paper about Partial Verb Phrase Fronting in German. Research Report RR-97-07, DFKI, Saarbrücken. (a shorter version appeared in *Proceedings of COLING 96)*.

Nerbonne, J. (1994). Partial Verb Phrases and Spurious Ambiguities. In J. Nerbonne, K. Netter, and C. Pollard (Eds.), *German in Head-Driven Phrase Structure Grammar*, pp. 109–150. Stanford: CSLI Publications.

Pollard, C. (1996). On Head Non-Movement. In H. Bunt and A. van Horck (Eds.), *Discontinuous Constituency*. Berlin/New York: Mouton de Gruyter. (published version of a ms. dated January 1990).

Thiersch, C. (1985). VP and Scrambling in the German Mittelfeld. ms. dated 22. April 1985, U. Köln and U. Conn.

Webelhuth, G. and H. den Besten (1987). Remnant Topicalization and the Constituent Structure of VP in the Germanic SOV Languages (abstract for the 10th GLOW Colloquium). In H. Bennis and J. Koster (Eds.), *GLOW Newsletter Nr. 18*, pp. 15–16. Dodrecht: Foris.

Chapter 14

A Relational Approach to Relativization in Turkish

Zelal Güngördü and Elisabet Engdahl

Abstract. In this paper we propose an HPSG account of the complex phenomenon of relativization in Turkish. Relative clauses in this language are prenominal and headed by a participle whose form depends on the existence of a genitive subject in the clause in the case of bounded dependencies and on two further factors, namely the grammatical function of the gap host and the gap, in the case of long-distance dependencies. Previous accounts have all been transformational. We present an account for this phenomenon in HPSG, making use of lexically specified MOD values, valency lists and non-local feature handling. We outline a comprehensive analysis that exploits relational constraints on lexical entries.

1 Introduction

Relative clauses in Turkish are prenominal and have verbal heads that are morphologically marked with one of a number of participle suffixes. There are two different strategies of relativization in Turkish, distinguished by the morphological marking on the verbal head of the clause (and its subject, if any). Several accounts have been proposed in the literature which try to formulate the distribution of the two relativization strategies, all accounts so far being within the tradition of transformational grammar; for example, [Underhill, 1972], [Hankamer & Knecht, 1976], [Dede, 1978], [Csató, 1985], and [Barker et al., 1990] (see [Knecht, 1979] for an overview of the first three accounts). Here, we propose a purely lexical account of the phenomenon within HPSG, which we claim is empirically more adequate than the previous accounts, as well as being computationally more attractive. Our analysis exploits the identifying morphology on verbal heads of Turkish relative clauses, and is based on an assumption that such clauses have lexically specified MOD values (encoded in the lexical entry of the verbal head of the clause). In addition, the analysis adopts a mechanism proposed by [Bouma & Nerbonne, 1994] that combines inheritance-based methods and relational constraints in describing (inflectional) morphology.

2 Bounded Relativization

The two relativization strategies in Turkish have traditionally been called *subject participle (SPc)*, with the suffix '*-(y)En*', and *object participle (OPc)*, with the suffix

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Gosse Bouma, Geert-Jan Kruijff & Richard Oehrle (editors).

'-dIk', reflecting the correlation between the grammatical role of the relativized constituent and the choice of the relativization strategy; cf. [Knecht, 1979] and [Sezer, 1986]. This correlation is quite strong and seems to determine the choice of the strategy in cases like (14.1).

(14.1) (a)

[$\_{i}$	*kadın-ı*	*gör-en]*	*adam*$_i$
	woman-ACC	see-SPc	man

'the man who saw the woman'

(b)

[adam-ın	$\_{i}$	*gör-düğ-ü]*	*kadın*$_i$
man-GEN		see-OPc-3sPoss	woman

'the woman that the man saw'

(14.1a) is a case of subject relativization and the SPc strategy is used, with the corresponding suffix on the verbal head *'gör'*. (14.1b) exemplifies object relativization, with an OPc suffix on the verbal head, as well as a possessive suffix which agrees, in person and number, with the genitive marked subject of the clause. This pattern of object relativization in fact applies to relativization of any non-subject constituent, including adjuncts. There are nevertheless cases where non-subject constituents are relativized using the SPc, apparently violating this generalization concerning the correlation between the grammatical function of the relativized constituent and the strategy to be used. Consider, for example, (14.2), where the locative adjunct NP *'house'* can be relativized using either the OPc, as in (14.2a), or the SPc, as in (14.2b).

(14.2) (a)

[her	*gece*	$\_{i}$	*bir*	*çocuğ-un*	*ağla-dığ-ı]*	*ev*$_i$
every	night		a	child-GEN	cry-OPc-3sPoss	house

'the house where a (certain) child cries every night'

(b)

[her	*gece*	$\_{i}$	*bir*	*çocuk*	*ağla-yan]*	*ev*$_i$
every	night		a	child	cry-SPc	house

'the house where some child cries every night'

Note that the choice of OPc or SPc leads to different interpretations, with specific and nonspecific subject readings, respectively. This is due to the fact that genitive marking on subjects of non-finite Turkish clauses generally correlates with a specific reading of the subject. Thus, one may argue that it is in fact the existence of a genitive marked subject in the clause that determines the particular relativization suffix on its verbal head (rather than the grammatical role of the relativized constituent), and that a genitive subject always induces the use of OPc, whereas the lack of such a subject leads to the SPc.[1]

3 Long-distance Relativization

In Turkish relativization is also possible out of embedded phrases of certain kinds such as relative clauses, possessive phrases, postpositional phrases, nominalization clauses, and non-subject infinitive clauses, resulting in structures with long-distance dependencies. (14.3b) below is an example of relativization out of a relative clause, where the genitive subject, *'adamın'*, of the clause in (14.3a) has been relativized out of that clause, appearing as the head noun of a second relative clause surrounding the first one. The inner clause in (14.3b) consequently has two gaps while the outer one has none.

(14.3) (a)

Kadın	*[adam-ın*	$\_\_i$	*oku-duğ-u]*	*kitab-ı$_i$*	*gör-dü.*
woman	man-GEN		read-OPc-3sPoss	book-ACC	see-PAST

'The woman saw the book that the man read.'

(b)

[kadın-ın	*[$\_\_j$*	$\_\_i$	*oku-duğ-u]*	*kitab-ı$_i$*
woman-GEN			read-OPc-3sPoss	book-ACC

gör-düğ-ü]	*adam$_j$*
see-OPc-3sPoss	man

'the man that the woman saw the book he read'

In cases of long-distance relativization, the inner clause is always either a constituent or part of a constituent (modifier in (14.3b) above) in the outer clause. We refer to that constituent of the outer clause as the 'gap host'.[2] Until now, there have been two main (independent) proposals in the literature as to what determines in Turkish the relativization strategy in the outer clause in the case of long-distance relativization: i) the grammatical function of the gap (corresponding to the long-distance relativized constituent, i.e. the head noun of the outer clause), e.g. [Csató, 1985]; and ii) the grammatical function of the gap host, e.g. [Barker et al., 1990]. We claim that both these factors play a role, as well as a third one, namely the existence of a genitive-marked subject in the outer clause. More specifically, we argue that the choice of the relativization strategy in long-distance relativization can be characterized by the following pattern:

(14.4) a) if the gap host is a *non-subject* constituent then i) if there is a *genitive* subject in the clause, the OPc strategy is used, otherwise ii) the SPc strategy is used; or else
b) if the gap host is the *subject* then i) if the grammatical role of the gap is *subject*, the SPc strategy is used, otherwise ii) the OPc strategy is used.

It is perhaps surprising that this seemingly complex dependency pattern can be handled within a constraint-based theory like HPSG in a perfectly straightforward manner, as we present next.

4 An Analysis within HPSG

This section presents the HPSG analysis we propose for relativization in Turkish.[3,4] Following [Sag, 1997], we assume that *hd-adj-ph* has the two subtypes *simp-hd-adj-ph* and *hd-rel-ph* (for relative clauses), the latter being constrained in the following way:

(14.5)
$$hd\text{-}rel\text{-}ph \Rightarrow \begin{bmatrix} \text{HEAD} & noun \\ \text{CONT} & \begin{bmatrix} \text{INDEX} & \boxed{4} \\ \text{RESTR} & \{\boxed{3}\} \cup \boxed{5} \end{bmatrix} \\ \text{NON-HD-DTRS} & \left\langle \begin{bmatrix} \text{CONT} & \boxed{3}\ proposition \end{bmatrix} \right\rangle \\ \text{HD-DTR} & \begin{bmatrix} \text{CONT} & \begin{bmatrix} \text{INDEX} & \boxed{4} \\ \text{RESTR} & \boxed{5} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

(14.5) states that the CONT value of a *hd-rel-ph* object is constrained to have a restricted INDEX structure-shared with that of its head daughter (i.e. the NP being modified), and that the restriction set (the RESTR value) is determined by adding the (propositional) CONT value of the non-head daughter (i.e. the modifying clause) to the restrictions imposed by the head daughter.

Let us now consider some important characteristics of Turkish relative clauses that we exploit in our lexical approach. The first point is related to the fact that Turkish relative clauses have verbal heads with identifying morphology. This enables us to specify the MOD value of a relative clause in the lexical entry of its verbal head from where it is passed on to the clause via the Head Feature Principle.[5]

The second point is that Turkish relativization is in one way more restricted than other kinds of unbounded dependencies: No relativized constituent can cross the boundaries of a *finite* Turkish sentence, while an extracted (topicalized or backgrounded) constituent can. We therefore use two separate NONLOCAL features in the analysis of relativization and of other kinds of unbounded dependencies in Turkish, RELATIVIZED and SLASH, respectively. We can then readily formalize the above restriction on relativization as a constraint on only one of these NONLOCAL features (RELATIVIZED) of any *finite* sentence in Turkish grammar, requiring it to be empty.

Another important feature of the analysis comes up in the implementation of the long-distance relativization pattern (14.4). Note that (14.4b) requires a mechanism which, at the outer clause level, differentiates between the different grammatical roles of the gap in the inner clause, namely whether the gap is a subject or a non-subject. We therefore assume that subject and non-subject gaps introduced by relativized constituents are passed up in the structure using different RELATIVIZED features. Accordingly, the feature RELATIVIZED is assumed to take values of type *relativized*, a new type with two appropriate features, SUBJ-REL and NON-SUBJ-REL, both of which take values of type *set*(*local*). What is essential is then to make sure that a newly introduced subject relative dependency is always stored in the INHER|RELATIVIZED|SUBJ-REL value of the lexical entry introducing it, and similarly that a non-subject relative dependency is always stored in the INHER|RELATIVIZED|NON-SUBJ-REL value.

4.1 Lexical Entries for Participles

Note that in all examples of relative clauses where a *bounded* dependency is bound off, the head noun of the relative clause corresponds to (i.e. is coindexed with) a gap in the clause itself. On the other hand, in clauses where a *long-distance* dependency is bound off, the head noun doesn't correspond to a gap in the clause itself, but rather to one that is embedded somewhere within one of the constituents of the clause (i.e. the gap host). We make a distinction, in the analysis, between *part* verbs that head relative clauses of these two kinds. A generic lexical entry for a *part* verb licensing a clause with bounded dependency – ignoring the details for the time being – can be schematized as follows:

(14.6)

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{part} \\ \text{MOD} & \text{NP}_{\boxed{2}}\left[\text{TO-BIND}|\text{RELATIVIZED}|\text{Y} \;\; \left\{\boxed{1}_{\boxed{2}}\right\}\right] \end{bmatrix} \\ \text{ARG-S} & \langle \ldots, [\text{LOC} \;\; \boxed{1}], \ldots \rangle \\ \text{F} & \langle \ldots \rangle \\ \text{INHER}|\text{RELATIVIZED}|\text{Y} & \{\boxed{1}\} \end{bmatrix}$$

where $\text{F} \in \{ \text{SUBJ}, \text{COMPS} \}$ and
$\text{Y} \in \{ \text{SUBJ-REL}, \text{NON-SUBJ-REL} \}$

The intended interpretation of (14.6) is that the argument in the ARG-S list with the LOCAL value tagged as $\boxed{1}$ does not appear in the corresponding valence list (SUBJ or COMPS). Instead, the LOCAL value of the argument appears in either of the INHER|RELATIVIZED feature sets (SUBJ-REL or NON-SUBJ-REL) of the *part* verb, thereby indicating a relative dependency relating to that argument. Furthermore, the MOD value of the verb is constrained as an NP (cf. the paragraph above on lexically specified MOD values), whose corresponding TO-BIND|RELATIVIZED feature set contains a single element structure-shared with the only element in the INHER|RELATIVIZED feature set of the *part* verb itself, to ensure the discharge of this dependency in a head-adjunct phrase with a relative clause headed by this *part* verb. Finally, the coindexation of the modified NP and the element in its TO-BIND|RELATIVIZED set, hence the element in the INHER|RELATIVIZED set of the verb, guarantees that the NP will be assigned the appropriate semantic role (i.e. the one corresponding to the relativized argument) within the CONTENT value of the verb.

Let us now consider a generic lexical entry, as in (14.7), for a *part* verb licensing a clause with long-distance dependency. Notice that in this case one of the valence lists (SUBJ or COMPS) is constrained to have an element (the one to function as the gap host) with a non-empty INHER|RELATIVIZED feature value, which contains an element structure-shared with the only element in the corresponding TO-BIND|RELATIVIZED feature value of the modified NP (to guarantee the discharge of this long-distance dependency in a head-adjunct phrase with a relative clause headed by this *part* verb). It is important to note that there may well be other long-distance dependencies stored in the same INHER|RELATIVIZED feature value of the gap host, which would then be passed on to the mother NP of the relative clause headed by the *part* verb, via the Nonlocal Feature Principle in the usual way.

$$(14.7)\quad \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{part} \\ \text{MOD} & \text{NP}_{\boxed{2}}\left[\text{TO-BIND}|\text{RELATIVIZED}|\text{Y} \;\; \left\{\boxed{1}_{\boxed{2}}\right\}\right] \end{bmatrix} \\ & \\ \text{F} & \langle \ldots, \text{XP}\,[\text{INHER}|\text{RELATIVIZED}|\text{Y} \;\; \{\ldots, \boxed{1}, \ldots\}]\;, \ldots \rangle \end{bmatrix}$$

where $\text{F} \in \{ \text{SUBJ}, \text{COMPS} \}$,
$\text{XP} \in \{ \text{NP}, \text{PP}, \text{S}[\textit{nomin}], \text{VP}[\textit{inf}] \}$, and
$\text{Y} \in \{ \text{SUBJ-REL}, \text{NON-SUBJ-REL} \}$

In sum, a *part* verb for bounded relativization introduces in the structure a relative dependency that is bound off immediately by the NP being modified by the very same *part* verb. A *part* verb for long-distance relativization doesn't itself introduce a dependency, but only binds off one inherited from one of its arguments (the gap host).[6] Clearly, one also needs a way of introducing a relative dependency in an embedded clause that is then to be bound off as a long-distance dependency in a surrounding relative clause.

Note that many details have been left out in the above-mentioned schematizations of *part* verbs. In the case of (14.6), one must make sure that the correlation between the existence/non-existence of a *genitive* subject and the strategy to be used is always satisfied. And in the case of (14.7), it is essential to choose the right strategy to bind off a long-distance relative dependency (reflecting that choice on the PHON value of the lexical entry and the CASE value of its subject, if any), depending on whether the dependency is inherited from a subject or a non-subject gap host (and in the latter case whether the dependency is passed on by the INHER|RELATIVIZED|SUBJ-REL or INHER|RELATIVIZED|NON-SUBJ-REL value of the gap host).

4.2 A Relational Approach

One way to realize the lexical entries for *part* verbs (generically) introduced in Section 4.1 would be to make use of a number of lexical rules that derive *part* verbs from *base* verb entries in the lexicon, also performing certain other changes in their output entries, such as changing the PHON value to the appropriate inflected form (by affixing the appropriate participle suffix, SPc or OPc, to the PHON value of the input *base* verb), and relativizing one of the arguments of the input entry (by removing the argument from either of the valence lists SUBJ and COMPS of the input, and placing its LOCAL value in the corresponding INHER|RELATIVIZED feature value of the output) or constraining one of the arguments (the gap host in long-distance relativization) to have a non-empty INHER|RELATIVIZED feature value.

Recent work within HPSG have proposed several mechanisms as alternatives to lexical rules for expressing generalizations over lexical information (e.g. [Krieger & Nerbonne, 1993], [Kathol, 1994], [Oliva, 1994], and [Bouma & Nerbonne, 1994]). In particular, [Bouma & Nerbonne, 1994] propose a mechanism combining inheritance-based methods and relational constraints in describing (inflectional) morphology. A basic lexeme in the relational approach is an underspecified feature structure that is instantiated by unifying the lexeme with one of the entries in the paradigm of the class to which the lexeme belongs. For example, the various inflected forms of the verb *gör 'see'* can be defined as follows:

(14.8)

$$\text{GÖR} \quad \equiv \quad \boxed{1}\begin{bmatrix} \text{ROOT} & \langle \textit{gör} \rangle \\ \text{HEAD} & \textit{verb} \\ \text{ARG-S} & \left\langle \text{NP}_{\boxed{2}},\ \text{NP}_{\boxed{3}}[\textit{acc}] \right\rangle \\ & \\ \text{CONT} & \begin{bmatrix} \textit{see} & \\ \text{SEER} & \boxed{2} \\ \text{SEEN} & \boxed{3} \end{bmatrix} \end{bmatrix} \quad \longleftarrow \quad \textit{member}(\boxed{1},\ \text{VERB})$$

(14.8) states that the underspecified feature structure $\boxed{1}$ must unify with one of the entries in the paradigm VERB; each solution will result in a different inflected form. The paradigm VERB is itself a feature structure specified as a list of entries, each of which specifies the phonological form of a verb as well as the corresponding morphosyntactic features.

Bouma and Nerbonne note that one advantage of the relational approach is its *reversibility*, that is, that it can be used both to instantiate the morphological features of an inflected form and to determine what the form of a lexeme must be given a specification of its morphological features. Moreover, [Oliva, 1994] argues that the use of relational constraints in the organization of lexical information is more in line with the declarative nature of HPSG, rather than the use of lexical rules (because of the procedurality inherent in the description of the latter). One further advantage of the relational approach outlined above is that it is possible to relate any number of entries within the same paradigm (e.g. via structure-sharing), since a paradigm is itself specified as a feature structure. With lexical rules, however, one can only relate two lexical entries, since a lexical rule is basically regarded to map an input lexical entry to an output entry.

We therefore adopt the mechanism proposed by Bouma and Nerbonne in the analysis of relativization in Turkish. One must note however that recursion, which is so naturally handled by lexical rules, is not so easy (if at all possible) to model in the relational mechanism adopted here. It is the lack of recursion in the phenomenon of relativization in Turkish that enables us to propose such an analysis: There is always at most one subject to be relativized out of a single clause, and it is not possible to have more than one non-subject constituent relativized out of the same clause. Thus, one can have at most two constituents relativized out of a single clause.

The paradigm VERB is assumed to contain entries for (among other inflected verbal forms in Turkish) *part* verbs, specifying the phonological and syntactic features of such verbs that are to license different cases of relative clause constructions. More specifically, we assume four different paradigm entries for participles, two of them licensing *part* verbs for subject or non-subject relativization in the case of bounded relativization (two separate versions of (14.6), where i) F is SUBJ and Y is SUBJ-REL; or ii) F is COMPS and Y is NON-SUBJ-REL), and the remaining two licensing *part* verbs for long-distance relativization with a subject or a non-subject gap host (two separate versions of (14.7), where the argument constrained to have a non-empty INHER|RELATIVIZED feature value takes place in the SUBJ or COMPS list). For example, (14.9) below depicts the paradigm entry for bounded subject relativization. (Here $\bullet$ denotes list concatenation.)

(14.9)

$$\begin{bmatrix} \text{PHON} & \boxed{1} \bullet \langle yEn \rangle \\ \text{MOR} & [\text{ROOT}\ \ \boxed{1}] \\ \text{HEAD} & \begin{bmatrix} verb & \\ \text{VFORM} & part \\ \text{MOD} & \text{NP}_{\boxed{3}} \left[\text{TO-BIND}|\text{RELATIVIZED}|\text{SUBJ-REL}\ \ \left\{\boxed{2}_{\boxed{3}}\right\}\right] \end{bmatrix} \\ \text{ARG-S} & \langle [\text{LOC}\ \ \boxed{2}], \ldots \rangle \\ \text{SUBJ} & \langle\rangle \\ \text{INHER}|\text{RELATIVIZED}|\text{SUBJ-REL} & \{\boxed{2}\} \end{bmatrix}$$

The lexical entry for the *part* verb *gören* licensing relative clauses as in (14.1a) will then be as in (14.10) (once the underspecified lexeme in (14.8), tagged $\boxed{1}$, is unified with the VERB paradigm entry in (14.9)).

(14.10)

$$\begin{bmatrix} \text{PHON} & \langle g\ddot{o}ren \rangle \\ \text{MOR} & [\text{ROOT}\ \ \langle g\ddot{o}r \rangle] \\ \text{HEAD} & \begin{bmatrix} verb & \\ \text{VFORM} & part \\ \text{MOD} & \text{NP}_{\boxed{3}} [\text{TO-BIND}|\text{RELATIVIZED}|\text{SUBJ-REL}\ \ \{\boxed{2}\}] \end{bmatrix} \\ \text{ARG-S} & \left\langle \text{NP}_{\boxed{3}}\ [\text{LOC}\ \ \boxed{2}], \boxed{4}\ \text{NP}_{\boxed{5}}[acc] \right\rangle \\ \text{SUBJ} & \langle\rangle \\ \text{COMPS} & \langle \boxed{4} \rangle \\ \text{CONT} & \begin{bmatrix} see & \\ \text{SEER} & \boxed{3} \\ \text{SEEN} & \boxed{5} \end{bmatrix} \\ \text{INHER}|\text{RELATIVIZED}|\text{SUBJ-REL} & \{\boxed{2}\} \end{bmatrix}$$

(14.11) shows the paradigm entry for long-distance relativization with a non-subject gap host. The relational constraint *strategy-used* guarantees the correlation between the CASE value of the subject (*genitive* or *nominative*) and the strategy to be used (OPc or SPC).[7]

$$
(14.11)\quad \begin{bmatrix} \text{PHON} & \boxed{1} \bullet \boxed{8} \\ \text{MOR} & [\text{ROOT } \boxed{1}] \\ \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{part} \\ \text{MOD} & \text{NP}_{\boxed{13}}\left[\text{TO-BIND}|\text{RELATIVIZED}|\text{Y } \left\{\boxed{9}_{\boxed{13}}\right\}\right] \end{bmatrix} \\ \text{ARG-S} & \boxed{10} \bullet \boxed{11} \\ \text{SUBJ} & \boxed{10}\ \langle \boxed{12}\text{NP}\rangle \\ \text{COMPS} & \boxed{11}\ \langle \ldots, \text{XP}\,[\text{INHER}|\text{RELATIVIZED}|\text{Y } \{\ldots,\boxed{9},\ldots\}]\ , \ldots\rangle \end{bmatrix}
$$

where *strategy-used* ($\boxed{8}$, $\boxed{12}$)

$\text{Y} \in \{\text{SUBJ-REL}\ ,\ \text{NON-SUBJ-REL}\}$ and

$\text{XP} \in \{\ \text{NP}\ ,\ \text{PP}\ ,\ \text{S}[\textit{nomin}]\ ,\ \text{VP}[\textit{inf}]\ \}$

The lexical entry for the *part* verb *gördüğü* licensing relative clauses such as the outer clause in (14.3b) will be as in (14.12) (once the underspecified lexeme for *'gör'* is unified with the paradigm entry in (14.11).

$$
(14.12)\quad \begin{bmatrix} \text{PHON} & \langle \textit{gördüğü} \rangle \\ \text{MOR} & [\text{ROOT } \langle \textit{gör} \rangle] \\ \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{part} \\ \text{MOD} & \text{NP}_{\boxed{3}}\left[\text{TO-BIND}|\text{RELATIVIZED}|\text{SUBJ-REL } \left\{\boxed{2}_{\boxed{3}}\right\}\right] \end{bmatrix} \\ \text{ARG-S} & \langle \boxed{4}, \boxed{6} \rangle \\ \text{SUBJ} & \left\langle \boxed{4}\ \text{NP}_{\boxed{5}}[\textit{gen}] \right\rangle \\ \text{COMPS} & \left\langle \boxed{6}\ \text{NP}_{\boxed{7}}\ [\textit{acc}, \text{INHER}|\text{RELATIVIZED}|\text{SUBJ-REL } \boxed{2}] \right\rangle \\ \text{CONT} & \begin{bmatrix} \textit{see} & \\ \text{SEER} & \boxed{5} \\ \text{SEEN} & \boxed{7} \end{bmatrix} \end{bmatrix}
$$

In order to deal with relativization out of embedded clauses, we make use of two further verb paradigms VERB$'$ and VERB$''$, both of which are of the same length as the paradigm VERB. The elements in VERB$'$ are specified as $\perp$ except for the elements corresponding to the ones in VERB that may function as heads of embedded clauses out of which subject relativization is possible. Similarly, the elements in VERB$''$ are also specified as $\perp$ except for the elements corresponding to the ones in VERB that may function as heads of embedded clauses out of which non-subject relativization is possible.

Two further definitions for GÖR then follow, which state that the underspecified lexeme for *'gör'* must unify with one of the entries in the list that is the result of default unifying (see [Lascarides et al., 1996]) the paradigm VERB with VERB$'$, or is the result of default unifying VERB with VERB$''$. The effect of using default unification here is that certain constraints assumed to be default (defeasible) in the VERB paradigm entries will be overridden by conflicting non-default constraint specifications in the corresponding entries of VERB$'$ or VERB$''$. Accordingly, the VERB paradigm entries that may function as heads of embedded clauses out of which subject (complement) relativization is possible are assumed to have default values for their SUBJ (COMPS) feature, which are then overridden by conflicting non-default SUBJ (COMPS) values in the corresponding entries of VERB$'$ (VERB$''$), thereby relativizing the subject (a complement). Note that one could instead have additional paradigm entries in VERB for relativization out of embedded clauses (rather than introducing further verb paradigms). However, the approach outlined above helps us to capture certain generalizations over different verb forms out of which relativization is possible, thereby providing us with a more compact and clear solution to the problem.

5 Conclusions

Relative clauses in Turkish provide an interesting test case for linguistic theories of unbounded dependencies. The acceptable pattern of unbounded relativization reflects an interaction between the grammatical function of the gap, the grammatical function of the gap host and the case marking of the highest subject, which in turn reflects interpretational distinctions concerning specificity. In this paper we have outlined an analysis within a constraint-based framework, which captures this interaction through simultaneous constraints on feature values in the lexical signs for participles. Given the usual HPSG inventory of typed feature structures, head feature percolation and nonlocal feature handling, we were able to account for the whole pattern of bounded and unbounded relativization by systematically specifying the constraints that have to be met in order for particular forms of participles to be used in relative clauses. For instance, given a nonlocal feature for type of relativization, we can specify that a given participle is appropriate if one of its complements contains a relativization dependency of e.g. the subject type. In order to capture the systematic paradigm of available verb forms, we applied Bouma and Nerbonne's relational constraints, thereby avoiding redundancy in the lexicon. One question we have not tried to answer in this paper is whether it is just a language particular fact about Turkish that relativization is sensitive to, among other things, the grammatical function of the gap host. Given that the grammatical function of the gap host also appears to be relevant for unbounded relativization in Japanese, another head final language with prenominal relative clauses, it seems plausible that there is a correlation with the branching structure of the language, i.e. whether it is left or right branching, but more research is clearly needed on this topic.

Notes

[1]Further evidence supporting this argument comes from Turkish 'impersonal passives', that is, 'subjectless' constructions formed by passivized intransitive predicates. [Hankamer & Knecht, 1976] observe that relativization out of such constructions is only possible using the SPc (although it is – naturally – always a non-subject constituent that is relativized).

[2]We borrow the term 'gap host' from [Barker et al., 1990]. They define a gap host as the highest *nominal* in the relative clause dominating the gap. However, we use it in a broader sense here, which also includes possessive phrases, postpositional phrases, nominalization and infinitive clauses.

[3]The analysis presented here deals with argument relativization only, leaving relativization of adjuncts for further consideration.

[4]Due to space limitations, we only outline the main features of the analysis here. The reader is referred to [Güngördü & Engdahl, 1998] for futher details of the analysis, as well as a more elaborate discussion of the empirical facts.

[5]Such exploitation of the identifying morphology on verbal heads of relative clauses in languages like Korean is suggested by [Pollard & Sag, 1994][page 57].

[6]It would be possible to deal with bounded and long-distance relativization in a more uniform manner if one assumed two empty categories in the lexicon, one of them having its INHER|RELATIVIZED|SUBJ-REL and LOCAL values structure-shared, and the other having its INHER|RELATIVIZED|NON-SUBJ-REL and LOCAL values structure-shared (cf. the lexical entry for trace proposed by [Pollard & Sag, 1994] [page 164]). In that case, the generic participle entry (14.7) would suffice to handle both bounded and long-distance relativization. However, we prefer the account outlined in the text here to avoid exploiting empty categories in the analysis.

[7]The same relational constraint is also employed by the paradigm entry for bounded non-subject relativization. There is one further relational constraint in the analysis referred to by the paradigm entry for long-distance relativization with a subject gap host, which ensures the correlation between the strategy to be used (SPc or OPc) and the grammatical role of the gap (subject or non-subject).

Bibliography

[Barker et al., 1990] Chris Barker, Jorge Hankamer, and John Moore, "Wa and ga in Turkish," in D. Katarzyna, P. Farrell, and E. M. Bikandi, eds., *Grammatical Relations*, CSLI Lecture Notes, pp. 21–43. CSLI, Stanford, Ca., 1990.

[Bouma & Nerbonne, 1994] Gosse Bouma and John Nerbonne, "Lexicons for feature-based systems," in *Proceedings of KONVENS'94*. Berlin:Springer, 1994.

[Csató, 1985] Éva A. Csató, "A syntactic analysis of paticiple constructions in modern Turkish," in *Beşinci Milletlerarası Türkoloji Kongresi*, pp. 39–56, İstanbul, 1985.

[Dede, 1978] Müşerref Dede, "Why should Turkish relativization distinguish between subject and non-subject head nouns?," in *Pro-*

ceedings of the Fourth Annual Meeting of the Berkeley Linguistics Society, volume 4, Berkeley, Ca., 1978.

[Güngördü & Engdahl, 1998] Zelal Güngördü and Elisabet Engdahl, "An HPSG account of relativization in Turkish using relational constraints," Technical Report BU-CEIS-9806, Department of Computer Engineering and Information Science, Bilkent University, Ankara, 1998. (ftp://ftp.cs.bilkent.edu.tr/pub/tech-reports/1998/BU-CEIS-9806.ps.z)

[Hankamer & Knecht, 1976] Jorge Hankamer and Laura Knecht, "The role of subject/non-subject distinction in determining the choice of relative clause participle in Turkish," in Aissen and Hankamer, eds., *Harvard Studies in Syntax and Semantics*, volume 2, pp. 197–219, Cambridge, 1976.

[Kathol, 1994] Andreas Kathol, "Passive without lexical rules," in John Nerbonne, Klaus Netter, and Carl Pollard, eds., *German in HPSG*, CSLI Lecture Notes. CSLI, Stanford, Ca., 1994.

[Knecht, 1979] Laura Knecht, "The role of the genitive suffix in relative clauses in Turkish: A reply to Dede," in *Proceedings of the Fifth Annual Meeting of the Berkeley Linguistics Society*, volume 5, pp. 180–197, 1979.

[Krieger & Nerbonne, 1993] Hans-Ulrich Krieger and John Nerbonne, "Feature-based inheritance networks for computational lexicons," in Ted Briscoe, Valerie de Paiva, and Ann Copestake, eds., *Inheritance, Defaults, and the Lexicon*, pp. 90–136. Cambridge University Press, Cambridge, 1993.

[Lascarides et al., 1996] Alex Lascarides, John Briscoe, Nicholas Asher, and Ann Copestake, "Order independent and persistent typed default unification," *Linguistics and Philosophy*, vol. 19, pp. 1–89, 1996.

[Oliva, 1994] Karel Oliva, "HPSG lexicon without lexical rules," in *Proceedings of the 15th International Conference on Computational Linguistics*, volume 2, pp. 823–826, 1994.

[Pollard & Sag, 1994] Carl Pollard and Ivan Sag, *Head-Driven Phrase Structure Grammar*. CSLI and University of Chicago Press, Stanford, Ca. and Chicago, Ill., 1994.

[Sag, 1997] Ivan Sag, "English relative clause constructions," *Journal of Linguistics*, vol. 33(2), pp. 431–484, 1997.

[Sezer, 1986] Engin Sezer, "The unmarked sentential subject constraint in Turkish," in D. Slobin and K. Zimmer, eds., *Studies in Turkish Linguistics*, volume 8 of *Typological Studies in Language*, pp 123–135. John Benjamins Publishing Co., Amsterdam, 1986.

[Underhill, 1972] Robert Underhill, "Turkish participles," *Linguistic Inquiry*, vol. 3, pp. 87–99, 1972.

Chapter 15

Minor and Expletive Pronouns

Frank Van Eynde

Abstract.

The central claims of this paper are: (1) there are words which can never head a phrase; (2) such words are not necessarily members of nonsubstantive parts of speech; (3) their syntactic 'lightness' does not necessarily correspond to a lack of semantic content. While (1) is generally accepted in GPSG/HPSG (though not in GB/MP), (2) and (3) challenge the current HPSG practice. The empirical evidence for these claims is based on the Dutch personal pronouns, but its consequences will be spelt out in general terms.

1 Major and minor pronouns

In contrast to English, many languages have two paradigms of personal pronouns. French, for instance, has both full or tonic pronouns, such as *moi* and *toi*, and clitic pronouns, such as *me* and *tu*. Also in Dutch many of the personal pronouns come in two variants, i.e. full and reduced.

person	number	gender	full-nom	full-obl	reduc-nom	reduc-obl
1st	sing	m/f		mij		me
	plur	m/f	wij		we	
2nd	sing	m/f	jij	jou	je	je
3rd	sg/pl	fem	zij	haar	ze	ze
	plur	m/f/n	zij	hen, hun	ze	ze
	sing	neut			het	het

The singular neuter *het* (= it) does not have a full counterpart in the personal pronoun system, but –diachronically– it is the reduced variant of the demonstrative *dat* (= that).[1]

A salient syntactic difference between the full or tonic pronouns and their reduced or clitic counterparts is that the former can take various types of adjuncts, such as adjectives, prepositional modifiers, relative clauses and appositions, whereas the latter cannot.

(1) Moi/*Je seule connais mon appétit.
'I alone know my appetite'

[1]Notice that also the French clitic *il* derives from a demonstrative, cf. the Latin *ille*.

Proceedings of FHCG'98
Gosse Bouma, Geert-Jan Kruijff & Richard Oehrle (editors).

(2) Zij/*Ze die gaan sterven groeten u.
'Those who are about to die greet you'

Apparently, while the full pronouns can be heads of NPs, the reduced or clitic ones cannot. For the clitic pronouns of the Romance languages, this nonhead status is generally recognized. As a matter of fact, employing the criteria which have been proposed for distinguishing between words and affixes in Zwicky and Pullum (1983, Miller (1992 demonstrates that the French clitics are affixes, and Monachesi (1995 reaches the same conclusion for the Italian ones. The reduced pronouns of Dutch, however, require another type of treatment, because they do not show any of the typical properties of affixes. Their degree of selectivity, for instance, is very low, since they cannot only be dependents of verbs, but also of prepositions and of predicative adjectives.

(3) Ze heeft vannacht van je gedroomd.
'She has dreamt of you tonight'

(4) Hij is het beu.
'He is fed up with it'

Moreover, they can be separated from their heads by one or more constituents, and they can be combined with a coordinated head.

(5) ... dat ze me morgen eindelijk betalen.
'... that they will finally pay me tomorrow'

(6) Hij heeft het gelezen en goedgekeurd.
'He has read and approved it'

In sum, the Dutch reduced pronouns are words, rather than affixes, but at the same time they cannot be heads of NPs either.

⋆

In formal syntax, the distinction between words which can head a phrasal projection and those which cannot is often made in terms of the *major* vs. *minor* dichotomy, and is standardly applied to categories or parts of speech. GPSG, for instance, makes a distinction between the four major categories (V, N, A and P) with their respective phrasal projections, and the minor categories, which lack such projections. In the grammar fragment of Gazdar *et al.* (1985 there are four of them, i.e. Determiner, Degree, Complementizer and Conjunction.

HPSG draws the distinction in a slightly different way. Since it treats words like *much* and *many* as determiners, and since these words can take specifiers, such as *very* and *how*, the determiners are treated as heads of their own phrasal projection (DetP), cf. Pollard and Sag (1994. Similarly, since degree words like *more* and *too* can be specified by other degree words, such as *much* and *far*, they are treated as heads of DegPs. The only words then which HPSG treats as minor are the complementizers and the coordinating conjunctions, and these are claimed to belong to a separate part of speech, called *marker*.

Turning now to the reduced pronouns of Dutch, it is not clear how they fit in these classifications. For if they are nominal, just like their full or tonic counterparts, they are erroneously predicted to have a phrasal projection (NP), and if they are grouped with the words which cannot have a phrasal projection, they are claimed to belong to a category of elements with which they have nothing in common, such as the complementizers and the conjunctions.

In order to resolve the conflict, I will henceforth assume that the *major-minor* distinction does not apply to entire parts of speech, but rather to their individual members. In other words, I will treat the distinction as orthogonal to the part of speech classification. In terms of the HPSG sort hierarchy, the *major/minor* distinction will be applied to objects of type *category*. All objects of type *category* have a HEAD feature, but only the major ones have also got a SUBCAT feature.[2] The HEAD feature takes an object of type *head* as its value, and the subtypes of this value correspond to the traditional parts of speech, such as noun, verb, preposition and adjective. As usual, nouns have a CASE feature, verbs a VFORM feature, etc.

Making use of these features, the distinction between the full and reduced pronouns can be captured as follows.

$$_{\text{major}}\begin{bmatrix}\text{HEAD} & _{\text{noun}}[\text{CASE} \quad \textit{case}] \\ \text{SUBCAT} & \langle\ \rangle\end{bmatrix} \qquad _{\text{minor}}[\text{HEAD} \quad _{\text{noun}}[\text{CASE} \quad \textit{case}]]$$

Both types of pronouns are nominal and specified for case, but their CATEGORY values are different.

2 The syntax of minor signs

Generalizing from the Dutch reduced pronouns I will now propose a set of criteria for the identification of minor signs and then demonstrate how they can be applied to other pronouns.

2.1 Criteria for identifying minor signs

For a start, since minor signs cannot have a phrasal projection, it follows that phrasal signs must be major.

$$\textit{phrase} \quad \Leftrightarrow\!\!\rightarrow \quad [\text{SYNSEM|LOC|CAT} \quad \textit{major}\ ]$$

Another constraint which follows from the definition itself is that minor signs cannot be used as heads, and that head daughters must hence be major.[3]

$$\textit{headed-phrase} \quad \Leftrightarrow\!\!\rightarrow \quad [\text{HEAD-DTR|SYNSEM|LOC|CAT} \quad \textit{major}\ ]$$

A third constraint concerns topicalization: since topicalized constituents bear stress, and since the reduced pronouns cannot be stressed, it naturally follows that they cannot be topicalized.

(7) Mij/*Me hebben ze niets gevraagd.
'To me they did not ask anything'

[2]In more recent versions of HPSG, the SUBCAT feature is replaced by the lexical ARG-ST feature and the valence features SUBJ, COMPS and SPR. In terms of this finer-grained structure, the major categories would have all of these features, whereas the minor categories lack them.

[3]I follow the practice of Sag (to appear to apply the typology of combination types to the objects of type *phrase*, rather than to the objects of type *constituent-structure*.

In terms of the HPSG inventory of phrase types, this can be expressed as a constraint on filler daughters.

head-filler-phrase ⇔→ [FILLER-DTR|SYNSEM|LOC|CAT *major*]

This constraint is stronger than the claim that topicalized phrases have to be major, since it also covers the *wh*-words, but there is evidence that also this stronger claim is valid, since the *wh*-words can take dependents, also in Dutch, cf. *wie van jullie* (= who of you), *wat voor boeken* (= what kind of books) and *waar/wanneer precies* (= where/when exactly).

For the other types of daughters in headed phrases there are no such *general* constraints: subjects, complements, specifiers and adjuncts can all be minor. This does not mean, though, that there cannot be any more *specific* constraints. Nominative subjects, for instance, can be either major or minor in finite clauses, but in combination with a nonfinite VP or a predicative XP, they have to be major.[4]

(8) Wij/*We gediskwalificeerd? Dat kan toch niet !
'We disqualified ? That's impossible !'

(9) Zij/*Ze alleen naar Griekenland ? Daar is ze toch te jong voor.
'She alone to Greece ? But she's too young for that'

Also complements can –in principle– be minor, but individual lexical items may require a major one. Some of the Dutch prepositions, for instance, do not allow a minor pronoun as their complement, cf. *volgens mij/*me* (= according to me) and *in plaats van jou/*je* (= instead of you). In French, this constraint applies to all prepositions, e.g. *pour moi/*me* (= for me) and *avec lui/*le* (= with him).

Turning to the nonheaded phrases, we find some further general constraints. In coordinate phrases, for instance, the conjunct daughters must be major.

(10) Ik twijfel nog tussen Mark en jou/*je.
'I'm still hesitating between Mark and you'

Interestingly, this constraint need not be stipulated, since it follows from the interaction of the present treatment with the COORDINATION PRINCIPLE, as defined in Pollard and Sag (1994.

> *In a coordinate structure, the CATEGORY and NONLOCAL value of each conjunct daughter is subsumed by (is an extension of) that of the mother.*

Since coordinate structures are by definition phrasal, they have CATEGORY values of type *major*, and given the principle this implies that the conjunct daughters cannot be minor.

Generalizing over the constraints which have been mentioned so far, it turns out that a phrase has to contain at least one major daughter, i.e. the head daughter in headed phrases or the conjunct daughters in coordinate phrases. Further evidence for this generalization is provided by the fact that clauses have to contain at least one major constituent; an elliptical clause, for instance, cannot consist solely of a minor word.

[4]Since such subjects are necessarily stressed and clause-initial, they could perhaps be analyzed as topics, and hence as fillers; in that case, this constraint would simply follow from the one on filler daughters.

(11) Wie heeft het gedaan ? Zij/*Ze.
'Who did it ? She did'

(12) Hij heeft meer gereisd dan zij/*ze.
'He has traveled more than she has'

Summing up, it can be concluded that minor signs are words which cannot take any dependents, which cannot be topicalized nor conjoined, and which cannot be the only constituent of a clause.[5]

It may be worth stressing that a word has to show all of these properties in order to qualify as minor. The English pronoun *it*, for instance, is the translational equivalent of the Dutch minor *het*, but in contrast to the latter, it does not qualify as minor, for it can take adjuncts and it can be conjoined.

(13) It alone is lexically specified as having *not* as the value of RELN on its RESTRICTION list. (I. Sag & Th. Wasow, 1997, p. 250)

(14) Recently speculation has been growing that it and the Roman Catholic Church will reunite. (TIME, May 5th, 1997, p. 47)

This discrepancy between the Dutch minor *het* and the English major *it* clearly demonstrates that the distinction is syntactic rather than semantic, for in the latter case one would expect the criteria to give the same result in both languages.

2.2 Application to another type of pronouns

A contrast which resembles the one between the personal pronoun *het* and the demonstrative *dat*, is the one between *er* and *daar* (= there). They belong to a paradigm which also includes the adverbs *hier* (= here), *waar* (= where), *ergens* (= somewhere), *nergens* (= nowhere) and *overal* (= everywhere). Like their English counterparts, they are used as locative adjuncts or complements.

(15) Hij woont hier/daar/er al jaren.
'He has been living here/there for years'

Besides this typically adverbial use, the [+R] adverbs have acquired a second use, which is more clearly pronominal: when combined with a preposition, many pronouns must be replaced by a pronominal adverb.

P + pronoun	example	[+R] + P	example
P + Personal (3rd)	* op het/ze	*er* + P	erop
P + Demonstrative	* op dat/die	*daar* + P	daarop
P + Demonstrative	* op dit/deze	*hier* + P	hierop
P + Relative	* op dat/die	*waar* + P	waarop
P + Interrogative	* op wat	*waar* + P	waarop

The pronominal must precede the preposition, and in spite of what the orthography suggests, it does not lose its syntactic autonomy in this combination, for in a clause the two parts of the prepositional phrase are usually not adjacent.

[5]Since these criteria do not rely on any language specific or category specific properties, they can be applied to all parts of speech and to all languages. In Van Eynde (1997, for instance, they are applied to the English determiners.

(16) Ik had er/daar/hier liever niet op gewacht.
'I had rather not waited for it/this/that'

The interesting fact now, in the present context, is the contrast between *er* and the other pronominal adverbs: applying the standard tests of adjunction, topicalization, conjunction and ellipsis, it turns out that the latter all qualify as major whereas the former does not.

(17) We zijn precies daar/*er waar de moord gebeurd is.
'We are exactly there where the murder took place'

(18) Daar/*Er had ze niet aan gedacht.
'She had not thought of that/it'

(19) Wil je liever hier of daar/*er zitten ?
'Would you rather sit here or there?'

(20) Ik zit liever hier dan daar/*er.
'I'd rather sit here than there'

English does not have a contrast which is comparable to the one between *er* and *daar*: its closest translational equivalent in both cases is *there*.

3 Referential and expletive pronouns

A nominal is nonreferential or expletive if it is not assigned any semantic role. The English pronouns *it* and *there*, for instance, are referential in (21), but not in (22).

(21) I'll put it there.

(22) It bothers her that there are no napkins on the table.

A quick-and-easy test to distinguish a referential nominal from an expletive one is that the former can be replaced by another referential nominal without loss of grammaticality, whereas the latter cannot. Further tests are provided in Postal and Pullum (1988.

Now, if it is assumed that there is a correlation between syntactic and semantic 'lightness', as in Pollard and Sag (1994, then words which cannot have a phrasal projection are expected to carry little or no autonomous content. As applied to the pronouns, one would expect the minor pronouns to be expletive. However, it turns out that all of the Dutch minor pronouns can be used referentially, and given the fact that their major counterparts are somewhat emphatic, they are even more commonly used in argument positions than the full ones.

At the same time, it should be added that the *major/minor* and *referential/expletive* distinctions are not entirely unrelated either, for there is some evidence for the assumption that the major pronouns have to be referential. In terms of the HPSG sort hierarchy this can be expressed as follows.[6]

[6] In Pollard and Sag (1994 *pronoun* is the CONTENT value of the personal and anaphoric pronouns, and is distinct from *nonpronoun*, which stands for the CONTENT values of all other nominal objects, such as the ones which correspond to proper and common nouns.

$$\left[\begin{array}{ll}\text{CATEGORY} & \textit{major}\\ \text{CONTENT} & \textit{pronoun}\end{array}\right]_{\text{local}} \Leftrightarrow\!\!\!\!\to \left[\text{INDEX} \quad \textit{referential}\,\right]$$

As a corollary, the expletive pronouns must be either minor words or affixes.

As far as Dutch is concerned, this constraint appears to be valid. The anticipatory pronoun in a sentence with an extraposed clausal complement, for instance, must be either *het* or *er*.

(23) Het schijnt dat ze niet komt.
'It seems that she does not come'

(24) We rekenen er niet op dat ze komt.
'We do not count on it that she comes'

Similarly, the subject of a weather verb must be *het*, and the subject of an existential clause must be *er*.

Expletive uses of non-3rd person pronouns are rare, but do occur. A relevant example is the use of the first person singular *me* as an ethical dative. In that use it does not express a semantic role of the predicate, but rather some kind of emotional involvement of the speaker (Haeseryn *et al.* 1997). Its expletive nature is clear from the fact that it cannot be replaced with any referential NP, and the fact that it has to be minor is clear from the fact that it cannot be replaced by its major counterpart *mij*.

(25) Wat zeg je me/*mij/*hem daarvan?
'What do you say of that?'

On the whole then it turns out that the Dutch expletive pronouns must indeed be minor.

Whether the constraint also holds for English is less obvious. At first sight, it does not, for the pronoun *it*, which is one of the most commonly used expletives in English, has been argued to be major in the previous section. However, taking a second look at the examples there, it turns out that they all concern referential uses of the pronoun. Moreover, when they are replaced with expletive uses, the typical properties of major pronouns get lost. The addition of adjuncts, for instance, leads to ungrammaticality, and conjunction turns out to be impossible.

(26) * It alone bothers me that she snores.

(27) * It and there were/was respectively proved to be raining and claimed to be floods in the valley.

In Postal and Pullum (1988, from which the last example is taken, the non-conjoinability is even treated as one of the diagnostic properties of expletives. It appears then that the expletive *it* is minor, even if its referential counterpart is not. A similar distinction applies to the major referential *there* and its minor expletive counterpart. As for the ethical dative, English does not use its first singular *me* in that way: as a piece of evidence, notice that the Dutch ethical dative in (25) has no translational equivalent.

Returning now to the initial assumption about the correlation between syntactic and semantic 'lightness', we cannot only conclude that it is incorrect, but –in a sense– we can even claim the opposite. For while the minor pronouns are syntactically more limited than their major counterparts, it is the latter which are more limited semantically. Indeed, while the minor pronouns have got both referential and expletive uses, their major counterparts can only be used referentially.

4 Conclusion

The Dutch reduced pronouns are syntactic atoms but cannot head an NP. This is problematic for syntactic frameworks in which all words without phrasal projection are required to belong to a small set of minor categories, such as Comp, Conj and Degree, cf. GPSG and HPSG. As a solution, I propose to treat the *major/minor* distinction as orthogonal to the part of speech classification. In order to identify the minor members within the various parts of speech I have developed a number of criteria. In a nutshell, minor signs are words which cannot take any dependents, which cannot be topicalized nor conjoined, and which cannot be the only constituent of a clause. Semantically, the distinction between major and minor signs has some relevance as well, albeit not in the way which is commonly assumed, for the pronouns which are semantically more constrained are not the minor ones, which are also syntactically more restricted, but rather those which are syntactically less restricted, i.e. the major ones.

Bibliography

Gazdar, G., E. Klein, G. Pullum & I. Sag. 1985. *Generalized Phrase Structure Grammar*. Oxford: Basil Blackwell.

Haeseryn, W., K. Romijn, G. Geerts, J. De Rooij & M. Van den Toorn. 1997. *Algemene Nederlandse Spraakkunst*. Groningen/Deurne: Martinus Nijhof Uitgevers / Wolters Plantyn.

Miller, Ph. 1992. *Clitics and Constituents in Phrase Structure Grammar*. New York: Garland.

Monachesi, P., 1995. *A Grammar of Italian Clitics*. Tilburg University dissertation.

Pollard, C. & I. Sag. 1994. *Head-driven Phrase Structure Grammar*. Stanford/Chicago: CSLI and University of Chicago Press.

Postal, P. & G. Pullum. 1988. Expletive Noun Phrases in Subcategorized Positions. *Linguistic Inquiry* 19.635–670.

Sag, I. to appear. English Relative Clause Constructions. *Journal of Linguistics*.

Van Eynde, F. 1997. On the notion 'Minor category'. In *CLIN VII. Papers from the Seventh CLIN meeting*, ed. by J. Landsbergen, J. Odijk, K. van Deemter & G. Veldhuijzen van Zanten, 191–206. IPO, University of Eindhoven.

Zwicky, A. & G. Pullum. 1983. Cliticization vs. inflection: English *n't*. *Language* 59.502–513.

Chapter 16

Noun Phrases as NPs – the case of Hebrew

SHULY WINTNER

ABSTRACT. Data from Hebrew have been claimed to support the hypothesis that noun phrases should be considered DPs universally. This paper shows that the application of the DP hypothesis to Hebrew is based on partial data and theory-internal considerations. A straightforward analysis of noun phrases as NPs is proposed; it is shown to account for a variety of facts that were believed to necessitate the introduction of functional categories and compulsory head raising in Hebrew NPs. Furthermore, this analysis provides a unified account for phenomena that were overlooked in previous works, such as definiteness agreement in the noun phrase and the similarities between construct state nouns and adjectives.

1 Introduction

Following [Abney1987], analyses carried out in Chomskian frameworks view noun phrases as DPs, headed by the functional category D. The DP hypothesis (DPH) has been applied to a variety of languages and is incorporated into most existing accounts for Modern Hebrew (MH). Originally motivated by the English '-ing' gerunds, that simultaneously possess properties of both sentences and noun phrases, the importance of the DPH is that it assigns parallel structures to clauses and noun phrases; in particular, both are headed by functional categories. In HPSG, however, functional categories are discouraged: English noun phrases are viewed as NPs, headed by the noun, and determiners – as subcategorized specifiers of nouns ([Pollard and Sag, 1994, section 9.4]). HPSG analyses for other languages, notably German, consider article-noun combinations to be DPs ([Netter, 1994]). Preferring either of the two analyses, in the context of HPSG, boils down to deciding whether it is the determiner or the noun that heads a nominal phrase. [Netter, 1994] lists several considerations in favor of each of the alternatives. In German, all the morphosyntactic features that must be transferred to the maximal projection of a nominal phrase (for agreement or government purposes) are manifested equally well on both the article and the noun. Determinerless noun phrases require, in German, disjunctive subcategorization frames for nouns under an NP analysis, and empty categories in a DP analysis. Finally, it is the declension phenomenon that causes [Netter, 1994] to favor a DP analysis. When applied to MH, these considerations yield a different result: information that is relevant for agreement, such as number and gender, is expressed on the noun only; determinerless phrases are always grammatical; and there are no declensions. Nevertheless, most existing

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analyses of MH noun phrases apply the DPH, with the definite article as the D head. This paper shows that there is no theory-independent reason to apply it to Hebrew; on the contrary, such accounts miss generalizations and yield the wrong predictions. We show that an NP analysis is not only possible but also plausible, accounting for a body of data traditionally believed to require functional categories and compulsory head raising in noun phrases.

2 The Hebrew Noun Phrase

MH has one definite article, *ha-*, which attaches (as a prefix) to *words* (nouns, adjectives, numerals and demonstratives, henceforth *nominals*), not phrases. Many elements in the noun phrase are marked for, and must agree on, definiteness:

(16.1) *ha- sepr ha- gadol ha- ze/lii*
the book the big the this/third
'this big book / the third big book'

MH provides two major ways of forming genitive relations: *free genitives* (FG), in which the genitive phrase is introduced by the preposition *$ell* 'of':

(16.2) *(ha-) sparim $ell m$orer*
(the) books of poet
'(the) books of a poet'

(ha-) sparim $ell ha- m$orer
(the) books of the poet
'(the) books of the poet'

and *constructs* (CS), in which the head noun is morphologically marked (and is said to be in the *construct* state, *cs*) and the genitive phrase must immediately follow it, preceding any other of the head's modifiers:

(16.3) *siprei m$orer xda$im*
books-*cs* poet new
'new books of a poet'

siprei ha- m$orer ha- xda$im
books-*cs* the poet the new
'the new books of the poet'

In FG the definiteness of the possessor is independent of that of the head, allowing for *four* different combinations of definiteness (both the head and the possessor can each be either definite or indefinite); in CS, the definiteness of the phrase is inherited from the possessor, allowing only *two* combinations: either both are definite, or both are not ([Wintner, 1998]). The definite article never combines with *cs*-nouns. A poorly studied yet closely related phenomenon is *cs*-adjectives, which exhibit the same definiteness behavior:

(16.4) *yruqqat (ha-) &einaym*
green-*cs* (the) eyes
'a/(the) green eyed'

3 Existing Analyses

The DPH is first applied to Hebrew by [Ritter, 1988], but this analysis is modified and extended in [Ritter, 1991], which is very similar in the main points to the one suggested in [Siloni, 1991, Siloni, 1994]. [Ritter, 1991] uses CS noun phrases, headed by derived (deverbal) nouns, as an evidence for DPs. It is indicated that in such constructions, only N-S-O order of the arguments is possible:

(16.5) **a.** *'ahbat* *dan* *'et* *'immo*
love-*cs* Dan ACC his-mother
'Dan's love of his mother'

b. *'kilat* *dan* *'et* *ha-* *tappux*
eating-*cs* Dan ACC the apple
'Dan's eating of the apple'

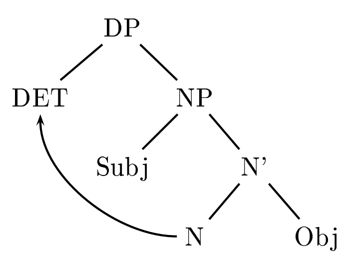
In addition, in such constructions the subject can bind an anaphoric object, but the object cannot bind an anaphoric subject:

(16.6) **a.** *'ahbat* *dan* *'et* *&acmo*
love-*cs* Dan ACC himself
'Dan's love of himself'

b. ∗*'ahbat* *&acmo* *'et* *dan*
love-*cs* himself ACC Dan

On the basis of the standard binding theory, [Ritter, 1991] concludes that the subject c-commands the object, but not vice versa. To arrive at such a derivation, the lexical head – the noun – must move. According to the *head-movement constraint*, heads can only move to the positions of heads that govern them, and hence the landing site for the raised noun would be the head of the entire construction, as depicted in (16.7):

(16.7)



To explain the fact that *ha-* never attaches to *cs*-nouns, [Ritter, 1991] further claims that CS noun phrases are DPs, headed by a phonologically null determiner called D_{gen}. As both D_{gen} and *ha-* are DETs, they appear in complementary distribution. The definiteness feature of CS DPs is inherited from the head D_{gen}, after the head of the construction has moved to its position, where it participates in a spec–head agreement with the genitive. In FG, DET is realized as *ha-*; the analysis is slightly more complicated, as compatability with the binding theory necessitates yet another functional category.

Several arguments against this analysis must be made. First and foremost, it is based on partial data. Derived nouns in Hebrew, even in the construct state, are not limited to the N-S-O order. Indeed, (16.6.b) is ungrammatical; but the *reason* it is ungrammatical has nothing to do with the order. It is because *&acmo* (himself) is the understood object of *'ahbat* (love), which leaves *dan* (Dan) the role of the subject. Of course, the subject cannot be introduced by the accusative marker; but it can be construed as a genitive:

(16.8)	*'ahbat*	*&acmo*	*$ell*	*dan*
	love-*cs*	himself	of	Dan

'Dan's self-love'

'kilat	*ha-*	*tappux*	*$ell*	*dan*
eating-*cs*	the	apple	of	Dan

'Dan's eating of the apple'

Moreover, the conclusion that the subject must asymmetrically c-command the object is a direct implication of the GB binding theory. This might not be the case in other linguistic theories, in which grammatical relations are not expressed solely by tree configurations. The head movement constraint is not only theory internal; it cannot even be formulated in a theory such as HPSG in which the concept of movement does not exist. It is also unclear where determiners other than *ha-* and D_{gen} fit into this analysis, as their natural position would have been heads of DPs, but this position is already occupied by the functional DET. Finally, this analysis completely ignores the strikingly similar phenomenon of *cs*-adjectives, and a unified account seems to be difficult to obtain.

4 An Alternative Analysis

The analyses delineated above are discussed by [Borer, 1994], listing some of their limitations and suggesting that definiteness is a feature of nouns, base generated on the N stem. An affixal view of the MH definite article is established in [Wintner, 1997], and is the starting point for the analysis we propose here. We first account for the fact that *cs*-nouns must have an immediate complement. We then explain why the article does not combine with *cs*-nominals. We justify a treatment of possessives as complements, and finally sketch an analysis for both FG and CS noun phrases as NPs.

4.1 Immediate Complementation of Constructs

Most subcategorized complements are optional in MH: objectless VPs are grammatical in many contexts, as are subjectless clauses. The requirement that *cs*-nouns have compulsory, immediate complements was used to motivate the application of the DPH to Hebrew. But this property is not unique to *cs*-nouns only; it holds for *cs*-adjectives and cardinals, as well as for prepositions and some quantifiers. In spite of the differences among these elements, there are some striking similarities: they can never occur without a noun phrase complement, which cannot be extracted, or 'moved'. But when the complement is a pronominal pronoun, it is always realized as a clitic on the element, never as a full form ([Borer, 1984, chapter 2]):

(16.9)	*siprei*	*ha-*	*m$or_rim*	/	*sipreihem*
	books-*cs*	the	poets	/	books+3rd-pl-m

'the poets' books / their books'

\$lo\$t	*ha-*	*m\$or_rim*	/	*\$lo\$tam*
three-*cs*	the	poets	/	three+3rd-pl-m

'the three poets / the three of them'

\$ell	*ha-*	*m\$or_rim*	/	*\$ellahem*
of	the	poets	/	of+3rd-pl-m

'of the poets / of them'

'et	*ha-*	*m\$or_rim*	/	*'otam*
ACC	the	poets	/	ACC+3rd-pl-m

'the poets (ACC) / them (ACC)'

&al yad	*ha-*	*m\$or_rim*	/	*&al yadam*
near	the	poets	/	near+3rd-pl-m

'near the poets / near them'

koll	*ha-*	*m\$or_rim*	/	*kullam*
all	the	poets	/	all+3rd-pl-m

'all the poets / all of them'

What is common to the elements that require an immediate, obligatory complement is that they are all phonologically weak. [Borer, 1988] claims that construct noun phrases in Hebrew are phonological words: their heads, construct nouns, are shown to be phonologically reduced, as a result of their lack of stress. This same phonological reduction process applies to construct adjectives and cardinals, too. We do not suggest a theory of prosody in HPSG; rather, taking advantage of the observation that the discussed constituents correlate well with phrases in MH, we account for them in the following way: we add a DEPendency feature to the lexical entries of *words*. The DEP feature is reminiscent of the ADJACENT feature of [Gunji, 1995], which is also used to encode immediate complementation. It is not clear from [Gunji, 1995] whether there is some phonological common property to words with non-empty ADJACENT list.

The relations between prosodically dependent words and their complements vary: the complement is an object in the case of prepositions, a subject or an object in the case of construct state nouns, a head in the case of construct state cardinals etc. But the obligatory complement is bound to be a member of the ARG_S of those words. The value of DEP can either be an empty list, or – for all the prosodically dependent words listed above – a list of one element, in which case this element must be reentrant with some element in some valence list of the word (in other words, DEP points to some element on the ARG_S value of the word). In addition, we introduce the *prosodic dependency* principle, by which words that are specified as prosodically dependent must first combine with the obligatory complement they depend on; only then can the obtained phrases combine with other modifiers and complements:

> In a headed phrase, in which one of the daughters is a word, either the DEP of this daughter is empty, or it is reentrant with (the SYNSEM value of) some other daughter.

4.2 The Combinatorial Properties of '*ha-*'

The fact that the definite article does not combine with *cs*-nouns is not an argument for the DPH. Not only nouns have construct states: adjectives (16.4) and cardinal numbers do, too. While *ha-* combines with the default form of these words, it does not combine with their construct forms. The rules that govern the combination of *ha-* with nominals are simple, when the article is viewed as an affix ([Wintner, 1997]): (i) *ha-* attaches to words, not to phrases; (ii) it attaches only to nominals, and to all kinds of nominals; (iii) it only combines with indefinite words. An additional (boolean) feature, DEFiniteness, is required for encoding the value of definiteness in nominals. As definiteness agreement in Hebrew is not a semantic process, we add this feature to the CATegory of nominals (rather than to their CONTent). Since definiteness is a feature of phrases, inherited from the lexical head, DEF is a head feature, appropriate for all *nominal*s. Viewing definiteness as a lexical process, justified by the affixal nature of the definite article, we introduce the *Definite Lexical Rule*[1] (DLR).

(16.10)
$$\mathrm{word}\begin{bmatrix}\text{phon:} & \boxed{1}\\ \text{s:l:c:head:} & {}_{\text{nominal}}\begin{bmatrix}\text{def:} & \Leftrightarrow\end{bmatrix}\end{bmatrix} \mapsto \begin{bmatrix}\text{phon:} & \textit{definite}(\boxed{1})\\ \text{s:l:c:head:def:} & +\end{bmatrix}$$

The DLR operates on all nominal words whose DEFiniteness feature is '⇔'. In all categories its effect on the phonology is determined by the same phonological rules, abstracted over by the function *definite*. The rule changes the value of the path SYNSEM|LOC|CAT|HEAD|DEF from '⇔' to '+'. *Adjuncts* specify the heads they select as the value of the MOD feature in their lexical entries. Like any other nominal, they have a DEFiniteness feature, whose value is shared with the value of the path MOD|LOC|CAT|HEAD|DEF. When the DLR operates on adjuncts, it results in a specification of a '+' value for both paths. Thus it is guaranteed that definite adjectives, for example, are not only specified as definite but also select definite heads. As for *cs*-nominals, these are not indefinite; we show below that they are unspecified for definiteness, and hence the DLR cannot apply to them.

4.3 Possessives as Complements

In standard HPSG ([Pollard and Sag, 1994, section 9.4.5]) possessives are *specifiers*: they combine with an N' to form a complete NP through the specifier-head schema, and they express the expectation for an N' as the value of the SPECified feature in their HEADs, just like other determiners do. As [Pollard and Sag, 1994, p. 375] note, this analysis is valid for German and English, but other languages might require different accounts. We advocate a position by which possessives of all kinds are not specifiers in MH. First, possessives differ from other determiners in their distribution. While most determiners precede the noun, possessives follow it:

(16.11) *koll* *sepr*
every book
'every book'

[1]Two assumptions are implicit in this rule: (1) that it is triggered by subsumption, not unification (see [Hinrichs and Nakazawa, 1996] for a discussion and other examples of this concept); (2) that when a value at the end of a path is modified, all paths that are reentrant with it are modified as well.

koll ha- sparim
all the books
'all books'

lot ha- sparim
three the books
'the three books'

ha- sparim $selli / $ell dan
the books my / of Dan
'my/Dan's book'

Second, possessives can regularly co-occur with other determiners:

(16.12) *koll sepr $selli / $ell dan*
every book my / of Dan
'each of my/Dan's books'

koll ha- sparim $selli / $ell dan
all the books my / of Dan
'all my/Dan's books'

lot ha- sparim $selli / $ell dan
three the books my / of Dan
'my/Dan's three books'

If determiners occupy the specifier position in NPs, possessives cannot fill the same function.[2]

Thus, possessives can be either subjects or non-subject complements. As all possessives occur post-nominally in Hebrew, and as the order among possessives that correspond to agent and theme in argument-taking nouns is free, we prefer to view all of them as (non-subject) complements, with no possessive designated as subject. Other arguments for viewing possessives as complements, in two languages that show many similarities to Hebrew, namely Welsh and Arabic, are given in [Borsley, 1995]. The arguments of [Borsley, 1995] are based on the following observations: both languages have subject-initial and verb-initial clauses; they have constructions in which an argument-taking noun is followed by its subject, but not vice versa; pronominal objects in subject-initial clauses can be realized as clitics; and the same clitics appear instead of a pronominal subject of a noun. All these observations are valid in Hebrew, too. Possessors, therefore, are listed in the COMPS list of nouns. When the noun has additional arguments, they are listed in its COMPS list preceding[3] the possessor. Thus, in the lexical entry of *sepr* ('book'), the value of the COMPS list has two members, an agent and an optional[4] possessor.

[2] Of course, if determiners other than the definite article are viewed as heads, this argument is not valid. We do not explore this possibility here.

[3] This order reflects the prominence of the noun's complements. Its interaction with HPSG's binding theory has not been investigated yet.

[4] Recall that most subcategorized elements are optional in Hebrew.

4.4 A Unified Treatment of Construct Phrases

As *cs*-nominals are words, their lexical entries express an expectation for an immediate complement; that is, an indication (the SYNSEM value) of the compulsory complement of *cs*-nominals is present in the lexical entry of the nominal. It is thus possible to share, in the lexicon, the values of the definiteness feature in both the nominal and its complement. This results in only two possibilities of definiteness combinations for constructs, as opposed to the four possible combinations of free genitives. The construct form is generated from the default form by means of a morphological process, modelled by a lexical rule:

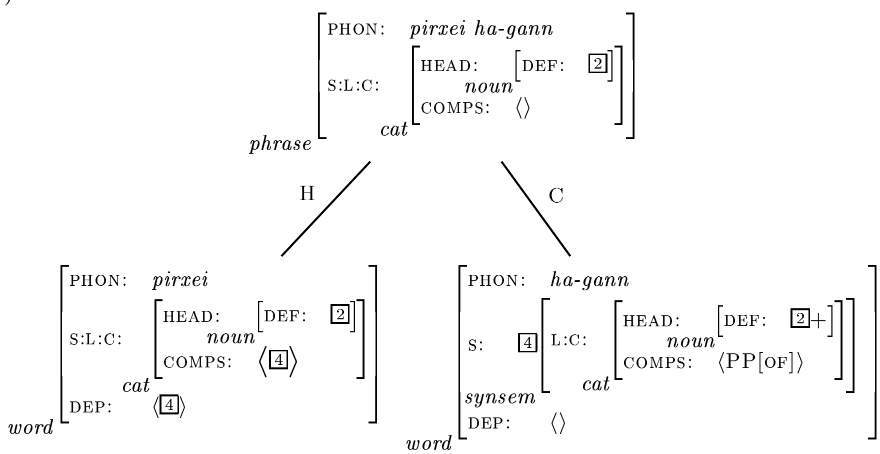
(16.13)
$$
{}_{\text{word}}\begin{bmatrix} \text{phon:} & \boxed{1} \\ \text{s:l:c:} & {}_{\text{cat}}\begin{bmatrix} \text{head:} & {}_{\text{noun}}\begin{bmatrix}\text{def:} & \Leftrightarrow\end{bmatrix} \\ \text{comps:} & \boxed{3} \oplus \langle \text{PP[of]} \rangle \oplus \boxed{5} \end{bmatrix} \\ \text{dep:} & \langle\rangle \end{bmatrix} \mapsto
$$
$$
{}_{\text{word}}\begin{bmatrix} \text{phon:} & \textit{phon\_reduce}(\boxed{1}) \\ \text{s:l:c:} & {}_{\text{cat}}\begin{bmatrix} \text{head:def:} & \boxed{2}\text{boolean} \\ \text{comps:} & \boxed{3} \oplus \left\langle \boxed{4}\begin{bmatrix}\text{l:c:head:} & {}_{\text{nominal}}\begin{bmatrix}\text{def:} & \boxed{2}\end{bmatrix}\end{bmatrix} \right\rangle \oplus \boxed{5} \end{bmatrix} \\ \text{dep:} & \langle\boxed{4}\rangle \end{bmatrix}
$$

Apart from modifying the phonology[5] of the nominal, this process has a double effect. First, the rule picks a genitive complement from the COMPS list, replaces it by a nominative noun phrase and unifies the values of the DEF feature of the nominal and the complement it depends on. In addition, the rule sets the value of 'DEP' to point to this complement, indicating that *cs*-nominals are prosodically dependent. When the nominal is combined with its complement, the resulting phrase inherits the definiteness from the latter. Notice that the results of this process, i.e., the lexical entries of *cs*-nouns, are not specified as 'DEF $\Leftrightarrow$' (in fact, they are not specified for definiteness at all), and hence the DLR cannot apply to them. The fact that *cs*-nominals cannot be rendered definite directly is naturally obtained.

Noun-noun constructs are thus constructed by the head-complement schema. An independent *cs*-noun, with no immediate complement, cannot be promoted to the status of a phrase, as the dependency principle prohibits its combination with other phrases until its DEP requirements are discharged. Since the DEF value of the construct head and its complement are shared, and since DEF is a head feature, it is also shared by the mother; thus, the DEF feature of the phrase is inherited from the complement, as required. This process is depicted in figure (16.14); notice in particular how the definiteness of the phrase is inherited from the complement using a reentrancy in the head.

[5]The function *phon_reduce* computes the phonology of the construct noun.

(16.14)



The striking similarities between noun-noun and adjective-noun constructs imply that they are actually only two instances of one process: any analysis that would suggest two different mechanisms to account for both phenomena is bound to be redundant. We simply extend the analysis of noun-noun constructs delineated above to the case of *cs*-adjectives. The lexical rule that derives *cs*-adjectives is slightly different from (16.13), since its inputs do not have a genitive PP on their COMPS list. But its outputs are such that *cs*-adjectives are lexically specified to subcategorize for nouns. They cannot occur independently, with no immediate complement, and hence are marked as dependent; and their phrase is constructed through the head-complement schema.

5 Conclusions

We have shown in this paper that there is no theory-independent reason to believe that noun phrases in Hebrew are anything other than NPs. While most existing analyses apply the DP hypothesis to Hebrew, we proposed a straightforward analysis of noun phrases as NPs, accounting for facts such as the combinatorial properties of the definite article, definiteness inheritance in constructs and the similarities between construct-state nouns and adjectives.

To reinforce the validity of the suggested analysis, many of its details still have to be worked out. In particular, a generalized lexical rule for generating all kinds of *cs*-nominals is missing. Determiners other than the definite articles must be accounted for, and the full range of data regarding word order in CS and FG must be explained. Finally, the analysis suggested here must be extended to cover the semantics of noun phrases. We intend to investigate these directions in the future.

Acknowledgments I want to thank Gerald Penn, Detmar Meurers, Tom Cornell and Tali Siloni for commenting on various versions of this work. I benefited greatly from the reviews of three FHCG referees. This work was supported by the Minerva Stipendien Komitee.

Bibliography

[Abney, 1987] Abney, Steven. 1987. *The English Noun Phrase in Its Sentential Aspect*. Ph.D. thesis, Massachusettes Institute of Technology, Cambridge.

[Borer, 1984] Borer, Hagit. 1984. *Parametric Syntax - Case Studies in Semitic and Romance Languages*, volume 13 of *Studies in Generative Grammar*. Foris Publications, Dordrecht – Holland.

[Borer, 1988] Borer, Hagit. 1988. On the morphological parallelism between compounds and constructs. In Geert Booij and Jaap van Marle, editors, *Yearbook of Morphology 1*. Foris publications, Dordrecht – Holland, pages 45–65.

[Borer, 1994] Borer, Hagit. 1994. The construct in review. In Jacqueline Lecarme and Ur Shlonsky, editors, *Proceedings of the Second Conference on Afroasiatic Linguistics*, Sophia Antipolis, France, June. (to appear in *Studies in Afroasiatic Grammar*).

[Borsley, 1995] Borsley, Robert D. 1995. On some similarities and differences between Welsh and Syrian Arabic. *Linguistics*, 33:99–122.

[Gunji, 1995] Gunji, Takao. 1995. An overview of JPSG: a constrain-based grammar for Japanese. In Reiko Mazuka and Noriko Nagai, editors, *Japanese sentence processing*. Lawrence Erlbaum, Hillsdale, NJ, chapter 5, pages 105–133.

[Hinrichs and Nakazawa, 1996] Hinrichs, Erhard W. and Tsuneko Nakazawa. 1996. Applying lexical rules under subsumption. In *Proceedings of COLING-96*, pages 543–549, Copenhagen.

[Netter, 1994] Netter, Klaus. 1994. Towards a theory of functional heads. In John Nerbonne, Klaus Netter, and Carl Pollard, editors, *German in Head-Driven Phrase Structure Grammar*, volume 46 of *CSLI Lecture Notes*. CSLI, Stanford, CA, chapter 9, pages 297–340.

[Pollard and Sag, 1994] Pollard, Carl and Ivan A. Sag. 1994. *Head-Driven Phrase Structure Grammar*. University of Chicago Press and CSLI Publications.

[Ritter, 1988] Ritter, Elizabeth. 1988. A head-movement approach to construct-state noun phrases. *Linguistics*, 26(6):909–929.

[Ritter, 1991] Ritter, Elizabeth. 1991. Two functional categories in noun phrases: evidence from Modern Hebrew. In Susan D. Rothstein, editor, *Perspectives on Phrase Structure: Heads and Licensing*, volume 25 of *Syntax and Semantics*. Academic Press, pages 37–62.

[Siloni, 1991] Siloni, Tali. 1991. Noun raising and the structure of noun phrases. In Jonathan David Bobaljik and Tony Bures, editors, *Papers from the third Student Conference in Linguistics*, volume 14 of *MIT Working Papers in Linguistics*. Department of Linguistics and Philosophy, MIT, Cambridge, MA 02139, pages 255–270.

[Siloni, 1994] Siloni, Tali. 1994. *Noun Phrases and Nominalizations*. Ph.D. thesis, Départment de linguistique générale, Université De Genève.

[Wintner, 1997] Wintner, Shuly. 1997. The affixal nature of the Hebrew definite article. Presented in *Computational Linguistics in the Netherlands (CLIN-97), University of Nijmegen*, December.

[Wintner, 1998] Wintner, Shuly. 1998. Definiteness agreement and inheritance in Hebrew. Paper presented at the *14th annual meeting of the Israeli Association for Theoretical Linguistics (IATL-14)*, Ben Gurion University, Beer Sheva, and at the *4th Conference on Afroasiatic Languages*, SOAS, London, June.

Chapter 17

Determiners as Nominal Heads

ANDREAS KATHOL

ABSTRACT. This paper presents a new approach to the issue of headedness within NPs in the spirit of a recent proposal by Hudson (Forthcoming).[1] The "classical" distinction between NP vs. DP is dissolved in favor of a polycategorial analysis which treats both categories as subtypes of *noun*. This offers an elegant solution to the longstanding problem of the interaction between modification and specification. It will also be shown that the current proposal is superior to Netter's (1994) approach which is based on the notion of "functional completeness".

1 Modification and specification of nominals

A problem that has plagued constraint-based approaches to English syntax is the interaction between modification and specification. In the tradition of $\overline{\text{X}}$-syntax, adjectives attach at a lower node than determiners, giving rise to the NP/$\overline{\text{N}}$ distinction. In the valence-based encoding of this distinction adopted by HPSG, $\overline{\text{N}}$ has commonly been described as $\left[\text{SPR } \langle\text{DETP}\rangle\right]$. Accordingly, attributive adjectives such as *hot* combine with nominal categories of this sort, as in (17.1a). However, in the absence of empty determiners, this account fails to naturally extend to the modification of bare $\overline{\text{N}}$ categories, such as the mass noun *water* in (17.1b). If we allow for adjectives to combine with nominals that have an empty SPR value, we are immediately faced with the problem of ruling out (17.1c).

(17.1) a. the hot stove

b. hot water

c. *hot the stove

In this paper I suggest that this and a number of related problems find an elegant solution if we abandon the strict categorial dichotomy between nouns and determiners assumed in standard HPSG analyses. Following a recent proposal by Hudson (Forthcoming), I will assume that (i) determiners belong to the same lexical class as other nominals and that (ii) determiners are syntactic heads of nominal phrases.

[1] I would like to thank Dick Hudson and three anonymous reviewers for comments and Paul Kay for extensive discussion. The usual disclaimers apply.

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2 Nounless NPs

As Hudson points out, determiners in English quite systematically can occur either in combination with a common noun or by themselves, as in the examples in (17.2) and (17.3b).[2]

(17.2) a. Kim bought some broccoli yesterday.

b. Kim bought some yesterday.

(17.3) a. She read that book this morning.

b. She read that this morning.

The absence of a common noun in the (b) examples above may of course be attributable to to an empty element occupying that position. However, apart from the general undesirability of positing inaudibilia of this sort, such an analysis faces a number of explanatory challenges. For one thing it is not clear how to rule out the combination of determiners such as *the* with the empty noun head, cf. (17.4b).

(17.4) a. She read the book.

b. *She read the $\emptyset$.

Moreover, additional stipulations have to be adduced to prevent the occurrence of the empty head in the presence of attributive modification even with those determiners that ordinarily would seem to allow that empty element:

(17.5) a. He saw those green shoes.

b. *He saw those green $\emptyset$.

These problems disappear if we instead assume that in the noun-less cases in (17.2b) and (17.3b), determiners such as *some* and *that* have full phrasal status by themselves. However, as Hudson argues convincingly, the fact that such constructions make a good case for determiners as the heads of such phrases does **not** entail that all occurrences of NPs should be reanalyzed as DPs, as has become standard in much of the transformational literature since Abney (1987). For instance, the universal DP analysis has little of insight to offer as to what would provide DP status to unadorned proper nouns such as *Sandy*.

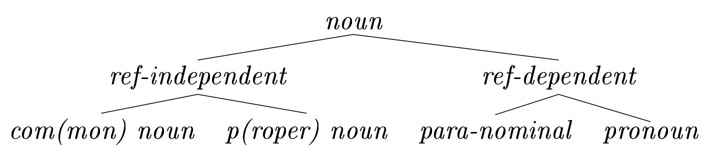
3 Nominal hierarchy

To reconcile the head status of determiners in (17.2) and (17.3) with the category of **noun** phrase, I propose the following hierarchy of *head* subtypes, which resembles Hudson's proposal for a "unified analysis" quite closely. The major division between the different kinds of *noun* is between those that canonically have referential properties of their own—common and proper nouns—and those which either are highly dependent in their referential properties on context or may not have

[2]Exceptions to this regularity are *the*, *a*, and *every*.

referential properties at all—pronouns and what I will call *para-nominal*s, that is, determiners that cooccur with a noun.[3]

(17.6)

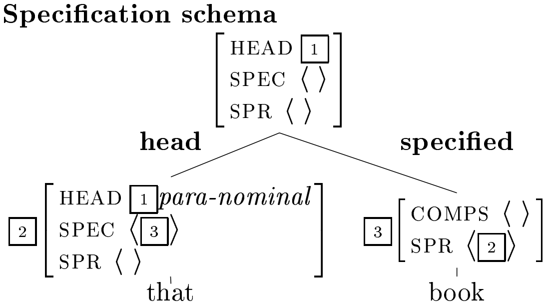


It automatically follows that any phrase consisting of a pronoun, a proper noun, or a (determiner-less, if licensed) common noun is an instance of a noun phrase, albeit of a different subtype in each case.

Crucially, I propose that determiner-initial phrases as in (17.1a) also qualify as phrasal nominal projections with the determiner as the syntactic head. I refer to the idea of construction-dependent headedness of NPs as the "polycategorial NP" approach. To this end two major changes of the HPSG theory of nominal specification are suggested: First, SPEC is treated as a list-valued valence feature with a concomitant combinatorial schema, outlined in (17.7).

Second, I require that the SPECIFIER-HEAD SCHEMA not extend to determiner-noun constructions. That is to say, while common nouns still record their specifiers via SPR, the noun's valence requirement is **not** discharged directly by the combinatorial schema, but instead results from the specification of the determiner head as $\left[\text{SPR } \langle\,\rangle\right]$.

(17.7) **Specification schema**



As in Pollard & Sag (1994), (singular) count and mass nouns (and bare plurals) are distinguished in terms of their obligatory vs. optional SPR marking:

(17.8) a. **Count noun** $\begin{bmatrix}\text{HEAD } \textit{com-noun}\\ \text{SPR } \langle[\ ]\rangle\end{bmatrix}$ b. **Mass noun** $\begin{bmatrix}\text{HEAD } \textit{com-noun}\\ \text{SPR } \langle([\ ])\rangle\end{bmatrix}$

We now have a straightforward solution to the puzzle posed in (17.1). What prevents the combination of an attributive adjective with a full NP is not the latter's SPR status. Instead, given the more fine-grained hierarchy in (17.6), the operative constraint is that adjectives may not modify NPs whose HEAD value is *para-nominal*, i.e., any nominal projection headed by a determiner. At the same time, the category of noun phrase now comprises all feature structure structures satisfying the following description:

[3]As Dick Hudson (p.c.) has pointed out to me, the distinction between *para-nominal* and *pronoun* assumed here may not actually be necessary in terms of defining irreducibly distinct word classes. That is, nouns of type *para-nominal* could simply seen as *pronoun*s with a nonempty SPEC value as suggested in Hudson Forthcoming.

(17.9)
$$\text{NP} = \begin{bmatrix} \text{HEAD } \textit{noun} \\ \text{SPR } \langle\, \rangle \\ \text{COMPS } \langle\, \rangle \end{bmatrix}$$

Furthermore, determiners that also double as pronouns such as the demonstrative *that* are lexically underspecified in terms of their nominal subtype. The two different instantiations are listed in (17.10b,c). In constrast, determiners that cannot make a phrase of their own in English (such as the definite article *the*) only have a lexical description corresponding to (17.10b).

(17.10) a. *that*
$$\begin{bmatrix} \text{HEAD } \textit{ref-dependent} \\ \text{SUBJ } \langle\, \rangle \\ \text{SPR } \langle\, \rangle \\ \text{COMPS } \langle\, \rangle \end{bmatrix}$$

b. **as a determiner**
$$\boxed{1}\begin{bmatrix} \text{HEAD } \textit{para-nominal} \\ \text{SPEC } \langle \text{N}[\text{ SPR } \langle \boxed{1} \rangle\,] \rangle \end{bmatrix}$$

c. **as a pronoun**
$$\begin{bmatrix} \text{HEAD } \textit{pron} \\ \text{SPEC } \langle\, \rangle \end{bmatrix}$$

In contrast with Hudson (Forthcoming), I do not assume that the two environments of occurrence are a result of the determiner's nominal "complement" being merely optional. This conclusion is motivated on the one hand by their different semantic type of pronouns vs. para-nominal determiners in HPSG (restricted index and quantifier, respectively) and on the other hand by subtle but important lexical semantic differences, as Hudson himself acknowledges, cf. (17.11),[4] as well as morphological distinctions exhibited by certain determiners, cf. (17.12).

(17.11) a. I'm married to that woman.

b. #I'm married to that.

(17.12) a. **Para-nominal:** my, her, our, your, their, no

b. **Pronoun:** mine, hers, ours, yours, theirs, none

Furthermore, the present analysis retains the mutual dependency between determiners and nouns proposed by Pollard & Sag (1994). This makes it possible to treat all obligatory cooccurrences entirely as valence properties: *the* requires an accompanying common noun because of its SPEC specification, whereas *stove* does not qualify as a complete NP because of its nonempty SPR value. This treatment is in contrast to Hudson's account[5] which makes reference to dependency relations unavailable in standard HPSG. The closest analogue within HPSG would be in terms of configurational relations. From a lexicalist perspective this is arguably undesirable.

[4] I leave a more extensive discussion of the associated semantic distinctions for a longer version of this paper.

[5] "[A] singular countable common noun must have a pronoun as its parent" (p. 18).

3.1 Semantics

One aspect of (17.7) that requires more discussion the construction of semantic representations within the NP, in particular the issue of semantic headedness. Since syntactic headedness by default also correlates with the status as semantic head, it would be natural to adopt that position for our proposal as well. Since the content of determiner-less NPs is commonly assumed to be of type *nom-obj* while that of determiners is *quantifier*, a direct implementation of that idea would result in an undesirable semantic type dichotomy among the different kinds of NPs.

Alternatively we could leave the CONTENT value of the determiner underspecified and instead structure-share it with the CONTENT specification of the nominal, cf. the schematic feature description in (17.13):

(17.13) $\begin{bmatrix} \text{HEAD } \textit{para-nominal} \\ \text{SPEC } \langle \text{N:}\boxed{2} \rangle \\ \text{CONT } \boxed{2} \\ \text{Q-STORE } \left\{ \begin{bmatrix} \text{DET } \ldots \\ \text{REST-IND } \boxed{2} \end{bmatrix} \right\} \end{bmatrix}$

The advantage of this solution is that it allows us to have a single type for both the paranominal and the pronominal occurrences of determiners, viz. *nom-obj*.

At the same time, however, this proposal posits a severe problem for the current treatment of NP-internal binding phenomena. Structure sharing with the nominal in CONTENT entails that the determiner's index value is identical to that of the nominal. That being so, we are immediately faced with violations of principle A in examples such as (17.14), where *that* is less oblique than *himself* within the valence of *picture*. tion.

(17.14) that picture of himself

According to the binding theory of Pollard & Sag (1994), *that* does not count as an o-commander since its CONTENT specification is not that of a referential NP, hence *himself* is an exempt anaphor in this context, allowing for well-formed examples such as *John doesn't like that picture of himself*. However, if the content of *that* is token-identical with the referential nominal it specifies (*picture of himself*), it takes on the status of an o-commander and hence *himself* is no longer an exempt anaphor, contrary to fact.

It therefore follows that the determiner, being the syntactic head of the schema in (17.7) must count as the semantic nonhead. Thus, as in the case of adjunction, we have an example of a mismatch between syntactic and semantic headedness, except that the specification case presents the dual of the relations holding adjunction in constructions.

4 Comparison with Netter 1994

Netter (1994) develops a theory of German NPs which is superficially rather similar to Hudson's polycategorial NP proposal and its adaptation advocated here. In particular, Netter shares the view that no single category (either noun or determiner) should be taken to be the sole possible head of any phrasal nominal category. Rather, only if a determiner is present is it the head of the phrase. Otherwise, it is the noun. The commonality in the external distribution is achieved by positing a feature FCOMPL which indicates whether a given category is "functionally complete". A negative value indicates that a determiner is still missing to achieve functional completeness whereas a positive value correlates with fully phrasal status. This is illustrated in the following feature description for fully saturated nominal categories:[6]

(17.15)
$$\left[\begin{array}{ll} \ldots|\text{HEAD} & \left[\begin{array}{ll} \text{MAJOR} & \left[\begin{array}{l} \text{N} + \\ \text{V} \Leftrightarrow \end{array}\right] \\ \text{MINOR} & \left[\text{FCOMPL} +\right] \end{array}\right] \\ \ldots|\text{SUBCAT} & \langle\rangle \end{array}\right]$$

Underlying Netter's proposal for the FCOMPL feature is the idea that (where present) functional categories are responsible for turning "functionally incomplete" categories into "functionally complete" ones. But of course, notwithstanding the fact that there is no independent criterion for functional completeness, this is precisely the position that Hudson argues against, i.e., the necessity of assuming a separate class of functional categories. Thus, it is necessary to investigate to what extent Netter's position is justified. As the following discussion reveals, Netter's assumption of functional categories in his implementation of the polycategorial approach is neither necessary nor sufficient.

First note that Netter intends to link his analysis of the nominal domain to his proposals for verb placement in terms of an HPSG-based variant of verb movement. In root clauses, the verb in V1/V2 position takes on the role of a functional category similar to the complementizer *daß* in the same position (Netter 1992). However, the conceptual and empirical motivation for such a move—in fact any attempts at implementing verb movement in HPSG—has been seriously called into question in Kathol 1995a and Kathol 1995b. Hence, the empirical base for the presumed functional categories is very weak.[7]

Second, Netter relies on the notion of functional completeness to account for the distribution of determiners. However, as Netter himself acknowledges, this concept is a primitive in the system without any relations to other properties in the grammar. In our system—as in Pollard & Sag's (1994) original formulation—on the other hand, no such primitive is needed because prenominal specifiers are selected by common nouns (cf. (17.8a)). This not only allows us to describe NP-internal binding relations in the same fashion as in the case of clauses. More significantly for the issues at hand, the nominal's valence properties are sufficient to distinguish between fully saturated, maximal projections and nonmaximal occurrences of nominals.

Finally, in his discussion of attributive adjectives, Netter (p. 322) notes that the adoption of FCOMPL is not sufficient to provide a satisfactory solution to the modification vs. specification problem pointed out above in the discussion of (17.1). Rather, in order to prevent the generation of ill-formed examples such as (17.1c), he has to stipulate another binary head feature (SPEC) that signals whether or not the

[6]This category is labelled *dp* by Netter who admits to it being a misnomer because categories of this kind need not be projected from determiners, as in the case of mass nouns or bare plurals.

[7]Similarly, note that Hudson (Forthcoming) covers in his critique of functional heads not only determiners, but also complementizers and shows that the differences among the various instances of that putative class do not warrant accepting any notion of *functional category* at all.

current nominal category contains a determiner. But as has been shown earlier, any feature of this kind is completely superfluous if we make more fine-grained distinctions among different nominal head types to which prenominal modification is rendered sensitive.

We conclude, therefore, that despite superficial similarities with Netter's proposal, the current adaptation of the polycategorial NP approach is clearly to be preferred.

5 Further consequences

5.1 Possessives

Common accounts of the possessive constructions, such as Pollard & Sag's (1994) analysis of *'s* as a "transitive" determiner, fail to account for the selectivity with respect to pronominal status exhibited by this possessive marker. Thus while all of the examples in (17.16a) are grammatical, none of the ones in (17.16b) are.

(17.16) a. Sandy's coat; some people's concerns; this dog's tail

b. *she's coat; *some's concerns; *this's tail

This is accounted for straightforwardly if we assume that the possessive marker attaches to NPs which must not be headed by a pronoun, i.e., $[\,\textsc{head}\ \neg\textit{pronoun}\,]$.

5.2 Restrictive and nonrestrictive modification

The distinction in *head* values proposed in (17.6) makes it possible to make further distinctions in the combinatorial potential of modifiers. Thus a subclass of attributive adjectives exhibits differences in meaning that coincide with their status as restrictive or nonrestrictive modifiers. For instance, *poor* with the meaning 'without means' can only act as a restrictive modifier and combine with common nouns. With the interpretation 'unfortunate', it acts as a nonrestrictive modifier and can also combine with proper nouns and a subclass of pronouns (cf. (17.17b,c)), giving rise to an ambiguity in the case of common nouns, cf. (17.17a).

(17.17) a. the poor man
'the pennyless man'
'the unfortunate man'

b. poor Sandy

c. poor him

Yet, no prenominal modification is ever possible when the phrase is headed by a determiner—even if the phrase as a whole has the status of a name, cf. (17.18). Hence prenominal modification is sensitive to whether or not the phrase is headed by a determiner.

(17.18) a. poor Elvis; beautiful Austria

b.*poor The King; *beautiful The Alps

On the other hand, as I will argue in greater detail in the full paper, postnominal restrictive modification by relative clauses (i) **always** involves full NP structures, rather than attachment to $\overline{\mathrm{N}}$nodes as is commonly assumed, and (ii) is sensitive to semantic distinctions. The first assumption offers a straightforward account of why restrictive relative clauses can attach to fully phrasal expressions such as *those*, *someone*, etc. Exemplified in (17.19a), such cases always have presented a challenge to the traditional view of relative clauses attaching to $\overline{\mathrm{N}}$ constituents, as well as more recent proposals such as Sag (1997), who restricts $\overline{\mathrm{N}}$ modification to non-*wh* relative clauses. On the other hand, restrictive modification is impossible with proper nouns (17.19b) and only marginally acceptable with personal pronouns in the case of certain kinds of *wh*-relatives, as seen in (17.19c).

(17.19) a. those/someone (that) I saw here

b. *Sandy (that) I saw here

c.??he who is free of sin

This pattern indicates that restrictive postnominal modification is only possible if the modified NP has **descriptive content**, which can be given either by an overt common noun or contextually in the case of pronominal uses of determiners such as *those*. The role of the relative clause is to further restrict the referent set by providing additional constraints on the domain under consideration. In HPSG terms, this corresponds to whether or not the index of the NP has a nonempty restriction. Proper nouns and personal pronouns are associated with an empty restriction, hence the additional information from the relative clause cannot contribute to restricting the domain in question—instead their referential properties are determined by means other than domain restriction.[8]

6 Summary and conclusion

The current proposal is an instance of a growing number of analyses that break down the strict categorial boundary between "lexical" or "substantive" and "functional" categories. Another instance of this line of investigation is Sag's (1997) idea of subsuming both verbs and complementizers under the single category *verbal*. Underlying this move is HPSG's type system which affords far more fine-grained distinctions than, for instance, the crude categorial space defined by Chomsky's $\pm$N/$\pm$V features that appear to still constitute the state of the art of the theory of categories in transformational grammar.

A logical next step would be to question the validity of having to identify a single constituent in a given construction as the head. Thus, rather than treating complex NP as **either** being headed by determiners or by nouns, another line of investigation would be to think of such constructions as headed by **both** components. This would then be the constructional equivalent of Malouf's (1996) recent proposal for gerunds as lexical categories that have both nominal and verbal properties. I will leave this idea to further investigation.

[8]Therefore restrictive modification of personal pronouns is only possible when the latter do not have an anaphoric reading, but instead are given the interpretation of indefinite pronouns.

Bibliography

ABNEY, STEPHEN. 1987. *The English Noun Phrase in its Sentential Aspect*. MIT dissertation.

HUDSON, RICHARD. Forthcoming. Syntax without functional categories. In *Syntactic Categories*, ed. by Robert Borsley, volume 31 of *Syntax and Semantics*. San Diego: Academic Press.

KATHOL, ANDREAS. 1995a. *Linearization-Based German Syntax*. Ohio State University dissertation.

——. 1995b. Verb-'Movement' in German and Topological Fields. In *Papers from the 31st Regional Meeting, Chicago Linguistic Society*, ed. by Audra Dainora, Rachel Hemphill, Barbara Luka, Barbara Need, & Sheri Pargman, volume 31, 231–245, Chicago, Illinois. CLS, CLS.

MALOUF, ROBERT. 1996. A constructional approach to English verbal gerunds. In *Proceedings of the Twenty-Second Annual Meeting of the Berkeley Linguistics Society*.

NETTER, KLAUS. 1992. On Non-Head Non-Movement. In *KONVENS '92*, ed. by Günter Görz, Reihe Informatik aktuell, 218–227. Berlin: Springer Verlag.

——. 1994. Towards a Theory of Functional Heads: German Nominal Phrases. In *German in Head-Driven Phrase Structure Grammar*, ed. by John Nerbonne, Klaus Netter, & Carl J. Pollard, 297–340. Stanford: CSLI Publications.

POLLARD, CARL J., & IVAN A. SAG. 1994. *Head-Driven Phrase Structure Grammar*. Chicago, IL: University of Chicago Press and Stanford: CSLI Publications.

SAG, IVAN A. 1997. English Relative Clause Constructions. *Journal of Linguistics* 33.431–484.

Chapter 18

Case, Obliqueness, and Linearization in Korean

Chan Chung

Abstract. This paper explores a case marking constraint on scrambling in Korean: how scrambling possibilities are affected by identical case on arguments and adjuncts.[1] Sells (1990) and Kuno (1980) account for this type of restriction based on the assumption of the existence of the VP constituent, and on a constraint on ambiguity processing, respectively. However, they do not account for all the given data appropriately. The main proposal of this paper is that Korean needs an LP constraint into which obliqueness and case are incorporated: when the arguments bear the same case marking, a less oblique argument must precede a more oblique argument. This paper shows how the LP constraint accounts for scrambling in the emotion verb, double object, control and causative, and adjunct constructions. Through the observation on adjunct scrambling, it is also suggested that adjuncts need to be listed on the valence list separately from the complement list, contrary to the "adjunct-as- complement" analysis in Bouma et al. (1997). Scrambling in the inalienable possession construction is accounted for by a separate constraint independently motivated for anaphor binding.

1 Introduction

It is a well-known fact that Korean allows scrambling out of a VP complement and a S-complement (long-distance scrambling), as well as clause-internal scrambling. However, there seem to be some constraints on scrambling, and the goal of this paper is to explore one of such constraints, namely the case marking constraint on scrambling. This constraint refers to how scrambling possibilities are restricted when the scrambled arguments and adjuncts have the same case marking.

2 Case Marking Constraints on Scrambling

2.1 Emotion Verb Construction

In the Korean emotion verb construction, the object of the emotion verb has nominative case and cannot precede the subject with the same case, as shown in (18.1):

[1]An earlier version of this paper was presented to the fall workshop of the Linguistic Association of Korea held at Wooseok University in Jeonjoo, Korea in 1997. We would like to thank the audience for their comments. We also thank three anonymous reviewers for their valuable comments and suggestions.

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(18.1) a. *Nay-ka sakwa-ka cohta.*
I-NOM apple-NOM like

'I like apples.'

b.*Sakwa-ka nay-ka cohta.

Sells (1990) proposes that this lack of scrambling is due to the existence of the VP node. That is, the ungrammaticality of (18.1b) is proposed to be evidence that *sakwa-ka cohta* is a VP constituent since the ungrammaticality is due to the extraction of *sakwa-ka* out of the VP. However, this analysis is not tenable when we consider the sentence in (18.2) where the subject is marked with the contrastive marker *-nun* and preceded by the nominative complement.

(18.2) *Sakwa-ka na-nun cohta.*
apple-NOM I-CONT like

'I like an apple (but I do not care whether others like it).'

In Sells' terms, the complement with nominative case in (18.2) seems to be extracted out of the VP node, which entails that the VP constituent cannot be the real reason of the ungrammaticality of (18.1b).

2.2 Double Object Construction

In Korean, both objects in the double object construction can exhibit accusative case. In this case, unlike in English, the order between the objects is free:

(18.3) a. *Nay-ka Mary-lul sakwa-lul cwuessta.*
I-NOM M-ACC apple-ACC gave

'I gave Mary an apple.'

b. Nay-ka sakwa-lul Mary-lul cwuessta.

The scrambling possibilities in this construction differ from those in the emotion verb construction: in the former, even the arguments with the same case marker can be scrambled, while in the latter, that kind of scrambling is not possible.

2.3 Scrambling out of the VP Complement

The case constraint also arises from the control and causative constructions. In these constructions, the order among the subject, the controller, and the VP complement is free. Furthermore, an argument of a governed verb (e.g., *ilkulako* 'read') can be scrambled with arguments of the control verb, as shown in (18.4):[2]

(18.4) a. *Mary-ka John-hanthey ku chayk-ul ilkulako seltukhayssta.*
M-NOM J-DAT the book-ACC read persuaded

'Mary persuaded John to read the book.'

b. Ku chayk-ul Mary-ka John-hanthey ilkulako seltukhayssta.

c. Mary-ka ku chayk-ul John-hanthey ilkulako seltukhayssta.

[2]The same observation can be made from the causative construction. Due to space limitations no examples of the construction can be provided here.

d. Ku chayk-ul John-hanthey ilkulako Mary-ka seltukhayssta.

In many control/causative constructions, the dative NP controller/causee can be replaced with an accusative counterpart controller/causee as shown in (18.5a) In this case, the accusative argument of an embedded verb cannot scramble with the controller/causee which have the same accusative marker, as shown in (18.5b–d):

(18.5) a. *Mary-ka John-ul ku chayk-ul ilkulako seltukhayssta.*
M-NOM J-ACC the book-ACC read persuaded

'I persuaded Mary to read the book.'

b.*Ku chayk-ul Mary-ka John-ul ilkulako seltukhayssta.

c.*Mary-ka ku chayk-ul John-ul ilkulako seltukhayssta.

d.*Ku chayk-ul John-ul ilkulako Mary-ka seltukhayssta.

To account for the data above, Kuno (1980) proposes the following constraint on processing that avoids the possibility of ambiguous interpretations:

(18.6) In general, the greater the likelihood of ambiguous interpretation, the more difficult it is to switch the word order of two NPs marked with the same grammatical formative.

It may be hard to deny that this kind of general constraint may be needed in Korean or Japanese grammar, but we doubt that the ungrammaticality of (18.5b–d) results from a violation of this kind of processing factor. In the real world, books never read people, and this pragmatic factor is strong enough to disambiguate their meanings. We may understand the sentences (18.5b–d) and their intended meaning due to this pragmatic factor, but the sentences are still unacceptable and hardly uttered with the meaning in any context. Thus, it seems that we need some syntactic constraint on this kind of scrambling.

2.4 Adjunct Scrambling

In Korean, an adjunct can bear accusative case, and it can scramble with a complement with identical case, therefore showing the same scrambling pattern as that of the double object construction in (18.3):

(18.7) a. *Mary-ka han sikan-ul John-ul kitalyessta.*
M-NOM one hour-ACC J-ACC waited

'Mary waited for John for an hour.'

b. Mary-ka John-ul han sikan-ul kitalyessta.

However, in the VP complement construction, the embedded accusative adjunct can scramble with the accusative controller or causee, thus showing a different scrambling pattern from that of complement long-distance scrambling in (18.5):

(18.8) a. *Mary-ka John-ul han sikan-ul kitalikey mantulessta.*
M-NOM J-ACC one hour-ACC wait made

'Mary had John wait for an hour.'

b. *Mary-ka han sikan-ul John-ul kitalikey mantulessta.*
M-NOM one hour-ACC J-ACC wait made

2.5 Inalienable Possession Construction

Another typical example of case constraint on scrambling in Korean comes from the INALIENABLE POSSESSION CONSTRUCTION (IPC hereafter). The IPC owes its name to the inalienable body-part relationship between two accusative NPs: e.g., *John-ul* is a possessor NP (PS NP hereafter) and *son-ul* is a body-part NP (BP NP hereafter) in (18.9).

(18.9) *Mary-ka John-ul son-ul capassta.*
M-NOM J-ACC hand-ACC held

'Mary held John's hand.'

In the IPC, a PS NP always precedes a BP NP (Yoon 1989, O'Grady 1991):

(18.10)* *Mary-ka son-ul John-ul capassta.*
M-NOM hand-ACC J-ACC held

'Mary held John's hand.'

The BP NP alone cannot be passivized (Kang 1987, Yoon 1989, O'Grady 1991), as shown in (18.11), while it can be passivized when the PS NP is passivized as shown in (18.12a):

(18.11) a.* *Son-i John-ul caphiessta.*
hand-NOM J-ACC be-caught

'John's hand was caught.'

b.* *John-ul son-i caphiessta.*
J-ACC hand-NOM be-caught

(18.12) a. *John-i son-i cap-hi-essta.*
J-NOM hand-NOM be-caught

'John's hand was caught.'

b.* *Son-i John-i cap-hi-essta.*
hand-NOM J-NOM be-caught

Note that when both NPs are passivized, the PS NP must precede its BP NP.

However, the BP NP can precede the PS NP when only the PS NP is passivized:

(18.13) a. *John-i son-ul cap-hi-essta.*
J-NOM hand-ACC be-caught

'John's hand was caught.'

b. *Son-ul John-i cap-hi-essta.*
hand-ACC J-NOM be-caught

3 Theoretical Background

Before we account for the given data, we briefly state the case assignment principle, scrambling mechanism, and obliqueness hierarchy in Korean assumed in this paper.

Based on the observations of English topicalization and Finnish case realization on adverbials, Przepiokowski (To appear) proposes that case assignment should take place on the argument list rather than on the valence list: nominative is assigned to the first structural NP on ARG-ST, and accusative is assigned to any following structural NP. On this approach, the emotion verb *cohta* in (18.14a) has the structure in (18.14b), and structural nominative case is assigned to the first NP on ARG-ST via the case principle mentioned above, while lexical nominative case is assigned to the second NP:

(18.14) a. *Nay-ka sakwa-ka/*-lul cohta.*
I-Nom apple-NOM/ACC like
'I like apples.'

b. $$\begin{bmatrix} \text{VAL} \begin{bmatrix} \text{SUBJ} \ \langle \boxed{1} \rangle \\ \text{COMPS} \ \langle \boxed{2} \rangle \end{bmatrix} \\ \text{ARG-ST} \ \langle \boxed{1}\text{NP}[str], \boxed{2}\text{NP}[nom] \rangle \end{bmatrix}$$

As for clause-internal scrambling, we assume that Korean has a flat clause structure and that scrambling results from the relative freedom of LP constraints among the non-head constituents at the sentence level. Following Chung (In press), this paper also assumes that long-distance scrambling is accounted for by the flat clause structure and by the notion of argument composition in terms of Hinrichs and Nakazawa (1994). That is, the valence list of embedded verb in the VP constituent in the control and causative verb constructions is list appended to the valence list of the matrix control verb. On this approach, the appended arguments are coarguments of the arguments of the matrix verb, and those arguments are licensed as sisters of the matrix verb all together in a flat structure. That is, a control verb like *seltukhayssta* ('persuaded') in (18.4) can take as its complement not only the VP but also the embedded verb *ilkulako* ('read'). When the control verb takes a verb as its complement, the complement(s) of the complement verb is (are) appended to the COMPS list of the control verb. Chung (In press) extends this argument composition analysis of scrambling into the account of adjunct scrambling. To this end, a new valence feature ADJT (adjunct), where adjuncts are listed, is introduced into the valence structure. On this approach, the verb *kitalyessta* ('waited') in (18.11) has the following structure:

(18.15) $$\begin{bmatrix} \text{VAL} \begin{bmatrix} \text{SUBJ} \ \langle \boxed{1} \rangle \\ \text{COMPS} \ \langle \boxed{3} \rangle \\ \text{ADJT} \ \langle \boxed{5} \rangle \end{bmatrix} \\ \text{ARG-ST} \ \left\langle \boxed{1}\text{NP}[str]_{\boxed{2}}, \boxed{3}\text{NP}[str]_{\boxed{4}}, \boxed{5}\text{NP}[str]_{\boxed{6}} \right\rangle \\ \text{CONT} \ \boxed{6}\,\textbf{for-an-hour}' \ (\textbf{waited}' \ (\boxed{2},\boxed{4})) \end{bmatrix}$$

Here, structural nominative case is assigned to $\boxed{1}$NP (subject) since it is the first element on ARG-ST, and structural accusative case to both $\boxed{3}$NP (object) and $\boxed{5}$NP (adjunct) since they are non-first elements. Note that this approach slightly differs from the adjunct-as-complement approach in Bouma et al. (1997) and Przepiokowski (To appear) in that the adjunct is separately listed on the ADJT list rather than on the COMPS list. The motivation of the separate ADJT list will be discussed in the following section. This paper assumes that the argument composition mechanism mentioned above applies to all the valence lists: the adjunct list of a governed verb can also be appended to the adjunct list of its governing verb when complements are appended (see Chung In press).

Finally, it is assumed that the distinction between the Primary Object and the Secondary Object does not exist in the obliqueness hierarchy in Korean, and that they are treated as having the same (or almost the same) degree of obliqueness. (See Branco 1996, Branco and Marrafa 1996, and Chung 1996 for the same proposal for the account of anaphor binding.)

4 LP Constraint with the Notion of Obliqueness

To account for the given data, the LP constraint in (18.16a) is proposed into which the obliqueness is incorporated. (18.16b) is a more formal version of (18.16a):

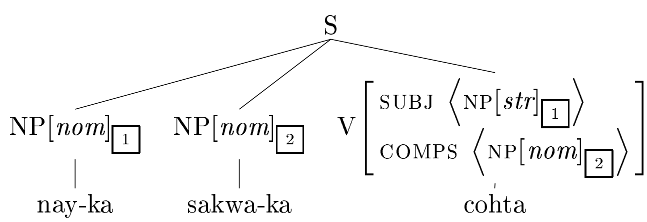
(18.16) a. Coarguments ("subject and complements" as opposed to "adjuncts") with the same case must be linearized in order of obliqueness, i.e., the less oblique one must precede the more oblique one.

b. $\text{NP}[\text{CASE } \alpha]_{\boxed{2}} \prec [\text{CASE } \alpha]_{\boxed{4}}$

$$\prec \begin{bmatrix} \text{VAL} \begin{bmatrix} \text{SUBJ} & \langle \boxed{1}_{\boxed{2}} \rangle \\ \text{COMPS} & \langle \dots, \boxed{3}_{\boxed{4}}, \dots \rangle \\ \text{ADJT} & \langle \dots, \boxed{5}, \dots \rangle \end{bmatrix} \\ \text{ARG-ST} \ \langle \boxed{1}\text{NP}_{\boxed{2}}, \dots, \boxed{3}\text{NP}_{\boxed{4}}, \dots, \boxed{5}, \dots \rangle \end{bmatrix}$$

As shown in (18.14b), the object of the emotion verb *cohta* ('like') bears lexically assigned nominative case. The subject has structural case, which is realized as nominative by the case principle. Thus, the sentence in (18.1) has the structure in (18.17):

(18.17)

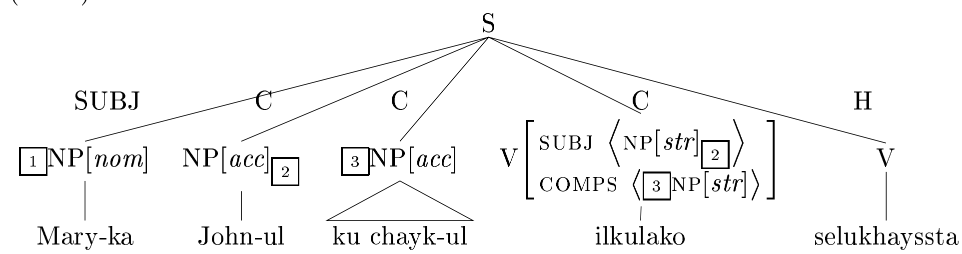


Then, by the LP constraint in (18.16), the less oblique nominative subject must precede the more oblique complement with the identical case marking. However, the LP constraint does not apply to the sentence in (18.2) since the NPs do not have the same case, and thus scrambling is possible.

The LP constraint does not apply to the sentences in (18.3) because according to the obliqueness hierarchy assumed for Korean, the Primary Object (PO) and the Secondary Object (SO) have the same degree of obliqueness. Thus, scrambling between the PO and SO is possible.

On our valence composition approach to long-distance scrambling, the sentence in (18.7a) can have the following structure:

(18.18)



In (18.18a), the case of the controller, John, is structurally assigned as accusative. The object of the governed verb *ilkulako* ('read'), *ku chayk* ('the book'), is also structurally assigned to be accusative. Then, the ungrammaticality of (18.5b–d) is accounted for by LP constraint (18.16). The object $\boxed{3}$NP cannot precede the controller NP$_{\boxed{2}}$ because they have the same case marking, and the former is more oblique than the latter with respect to the verb *ilkulako*: the former is the complement of the verb while the latter is its subject, as shown in the lexical entry of *ilkulako* in (18.18).

Now let us consider the examples of adjunct scrambling in (18.7–18.8). As shown in (18.15), accusative case is structurally assigned to the nominal adjunct since it is a non-first NP bearing structural case. In (18.7), scrambling between the adjunct and the complement with identical case is possible because LP constraint (18.16) applies only when a subject and a complement have identical case. As for the examples in (18.8), an adjunct of a governed verb can also be appended to its governing verb when the complements are appended. On this approach, sentences (18.8) can have the flat structure in (18.19).[3]

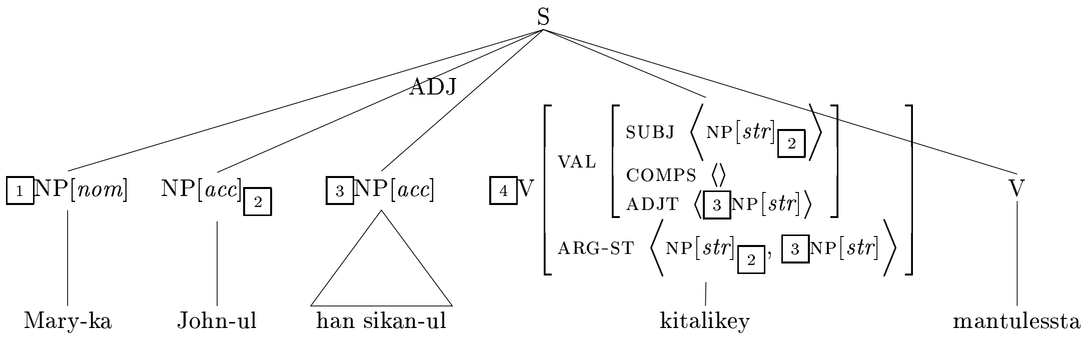
[3]In this case, if the semantic principle of Pollard and Sag (1994) is directly applied, the correct interpretation is not obtained.

(i) In a headed phrase, the CONTENT value is token-identical to that of the adjunct daughter if the DTRS value is of sort *head-adjunct-struc*, and to that of the head daughter otherwise.

According to (i), the semantic content of the whole sentence in (18.19) must be identical to the semantic content of the adjunct daughter, which can be roughly represented as follows: **for-an-hour'(waited'(John'))**. However, this is obviously not the correct interpretation of the whole sentence. This problem can be solved by a slight revision of (i) to (ii):

(ii) In a headed phrase, the CONTENT value is token-identical to that of an adjunct daughter if the head daughter is the value of MOD of the adjunct daughter, and to that of the head daughter otherwise.

(18.19)



In this case, differently from the case of complement scrambling shown in (18.18), LP constraint (18.16) does not apply, and scrambling between the controller and the embedded adjunct is allowed: the LP constraint is formulated to apply only when a subject and a complement have the same case.

The examples in (18.8) suggest that the adjunct-as-complement analysis proposed by Bouma et al. (1997) and supported by Przepiokowski (To appear) may be too strong. That is, if the adjuncts in (18.8) are considered as complements, it seems to hard to account for different grammaticality patterns between (18.5b–d) and (18.8b). Presently, it is not clear why they show this difference, but the assumption of the separate ADJT list on the valence feature at least makes it possible to simply describe their different syntactic behaviors with respect to the case constraint on scrambling.

So far, we have shown how LP constraint (18.16) accounts examples in Sections 2.1–2.4, but not the ones of the inalienable possession construction (IPC) in Section 2.5. The NPs with accusative case in (18.9) seem to have the same degree of obliqueness since they are both complements, and so are the NPs with nominative case in (18.12) since they are both subjects.[4] It means that LP constraint (18.16) appears to incorrectly predict that the NPs with the same case can be scrambled with each other as in the double object construction (e.g., (18.3)). In the rest of this section, we propose that scrambling in the IPC is constrained by an independently-motivated binding condition, not by LP constraint (18.16).

In the IPC, as argued by Guéron (1985), the referent of a body-part NP (BP NP) depends on its possessor NP (PS NP) within a local domain. Roughly speaking, in order to identify a BP NP, we need to identify its PS NP first. And this referential dependency of the BP NP makes it similar to anaphora.

The syntactic restriction in (18.20) is proposed to account for this type of dependency, based on the notion of local prominence-command (local p-command) which is utilized in the formulation of the syntactic anaphor binding condition in Korean in Chung (1996).

(18.20) A BP NP must be locally p-commanded by its PS NP.

Here the notion of p-command is defined as follows:

(18.21) Local P-Command: X locally p-commands Y iff either
(i) X locally obliqueness-commands (locally o-commands) Y, or
(ii) X and Y are equally oblique and X linearly precedes Y.

[4]See Chung (1993) for the flat structure analysis of the IPC and relevant discussions.

On this approach, (18.9) is acceptable because the PS NP *John-lul* locally p-commands the BP NP *son-ul* by (18.21ii): they are equally oblique, and the PS NP precedes the BP NP. In (18.10), the PS NP does not locally p-command the BP NP because the BP NP precedes the equally oblique PS NP. The sentences in (18.11) are all unacceptable regardless of the linear order because the BP NP is less oblique than the PS NP. (18.12a) is acceptable for the same reason as (18.9). (18.12b) is unacceptable for the same reason as (18.10). The sentences in (18.13) are all acceptable regardless of the linear order because the PS NP is less oblique than the BP NP, and thus the former locally p-commands the latter.

5 Conclusion

This paper proposes that scrambling possibilities among the arguments (as opposed to adjuncts) are restricted by the interaction of case and obliqueness of the arguments, i.e., when the arguments bear the same case marking, a less oblique argument must precede a more oblique argument. The linear order in the inalienable possession construction is not a counterexample to our proposal since it can be accounted for by a different constraint.

Korean (and probably Japanese) is not the unique language that needs this type of LP constraint into which the notion of obliqueness is incorporated. For example, Sag (1987), and Pollard and Sag (1987) propose that English needs it to account for the linear order among complements in the constructions such as the double object construction.

Bibliography

Bouma, Gosse, Rob Malouf, & Ivan Sag. 1997. Satisfying Constraints on Extraction and Adjunction. Unpubl. ms., Groningen University and Stanford University.

Branco, António. 1996. Branching split obliqueness at the syntax-semantics interface. In *Proceedings of COLING 16*, 149–156, Copenhagen. Center for Sprogteknologi.

——, & Palmira Marrafa. 1996. Subject-oriented and non subject-oriented long-distance anaphora: An integrated approach. In *Selected Papers from the 11th Pacific Asia Conference on Language, Information and Computation*, ed. by B.S. Park & J.B. Kim, 21–30.

Chung, Chan. 1993. A Lexical approach to inalienable possession constructions in Korean. In *Papers in Syntax*, ed. by Andreas Kathol & Carl J. Pollard, volume 42, 46–87. Ohio State University: OSU Working Papers in Linguistics.

——. 1996. Argument Composition and Long-Distance Scramling in Korean: An Extension of the Complex Predicate Analysis. In *Complex Predicates in Nonderivational Syntax*, ed. by Erhard Hinrichs, Andreas Kathol, & Tsuneko Nakazawa, 159–220. New York: Academic Press.

Guéron, Jacqueline. 1984. Inalienable possession, pro-inclusion and lexical chains. In *Grammatical Representation*, ed. by Jacqueline Guéron, Hans-Georg Obenauer, & Jean-Yves Pollock, volume 22 of *Studies in generative grammar*, 43–86. Dordrecht: Foris.

Hinrichs, Erhard, & Tsuneko Nakazawa. 1994. Linearizing Finite AUX in German Verbal Complexes. In *German in Head-Driven Phrase Structure Grammar*, ed. by John Nerbonne, Klaus Netter, & Carl J. Pollard, 11–38. Stanford: CSLI Publications.

Kang, Y S. 1985. Case marking in korean. volume 1 of *Harvard Studies in Korean Linguistics*, 88–100. Seoul: Hanshin.

Kuno, Susumo. 1980. A further note on tonoike's intra-subjectivization hypothesis. volume 2 of *MIT Working Papers in Linguistics*. Cambridge: MITWPL.

O'Grady. 1991. *Categories and Case: the Sentence Structure of Korean*. Amsterdam: John Benjamin.

Pollard, Carl J., & Ivan A. Sag. 1994. *Head-Driven Phrase Structure Grammar*. Chicago, IL: University of Chicago Press and Stanford: CSLI Publications.

Przepiókowski, Adam. 1998. On case assignment and "adjuncts as complements". In *Lexical and Constructional Aspects of Linguistic Explanation*, ed. by Gert Webelhuth, Jean-Pierre Koenig, & Andreas Kathol, volume 1 of *Studies in Constraint-Based Lexicalism*, 231–245. Stanford, CA: CSLI Publications.

Sells, Peter. 1990. VP in Japanese: Evidence from *-te* complements. In *Japanese/Korean Linguistics*, ed. by Hajime Hoji, 319–334. Stanford, CA: CSLI Publications.

Yoon, J. H-S. 1989. The grammar of inalienable possession constructions in korean, madarin and french. volume 3 of *Harvard Studies in Korean Linguistics*, 357–368. Seoul: Hanshin.

Chapter 19

An Informal Sketch of a Formal Architecture for Construction Grammar

PAUL KAY

ABSTRACT. A formal architecture for Construction Grammar (CG) is sketched. Modeling domain objects (constructs) are constituent structures with feature structures at the nodes, aka Feature Structure Trees (FTs). Constructions are partial descriptions of FTs, expressed as sets of constituent structure equations and path equations. Unification of constructions is defined. A construct c is licensed by a grammar G iff G contains a set of constructions whose unification fully describes c.

1 Introductory

The major empirical motivation for Construction Grammar (CG) is the need to develop a system of grammatical description in which the marked constructions (more or less 'idiomlike' forms of expression) are represented in the same formal system as the regular, 'core' patterns or rules (Kay & Fillmore Forthcoming).[1] The original representation system for Construction Grammar (CG) was a system that represents constructions (items of grammar) and constructs (items of language: sentences, phrases and words) in 'box diagrams', which depict constituent structure as concentric boxes, with the syntactic, semantic, lexical and phonological information associated with each constituent written in the box representing that constituent.

This paper takes a first step toward specifying what kind of formal objects these box diagrams are pictures of and what is really meant by 'matching up', 'combining' or 'unifying' two box diagrams, each of which gives a partial description of a construct (bit of language), into something that gives a fuller description of this construct, until finally we have licensed a sentential construct (i.e., a sentence). The paper concludes with a brief discussion of similarities and differences of CG with HPSG and LFG.

The empirical objects, sentences words and phrases, accounted for by a construction grammar are taken to have the form of constituent structure (CS) trees with feature structures (FSs) at the nodes. A construction is defined in terms of a set of simultaneous constraint equations, describing a class of such hybrid structures, rather like those of LFG. A hybrid structure which represents a fully parsed

[1]It is a pleasure to acknowledge the contributions to this paper of Ron Kaplan and Mary Dalrymple, without whose stimulation and advice it would not have been developed. Charles Fillmore, Andreas Kathol and J.-P. Koenig have also provided invaluable ideas. Errors are the author's personal contribution.

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Gosse Bouma, Geert-Jan Kruijff & Richard Oehrle (editors).

word, phrase or sentence of a language is called a construct of that language. Licensing a structure that satisfies more than one construction consists in putting together the relevant set of constructions (interpreted as a conjunction). The box notation of CG (Fillmore & Kay Forthcoming; Kay & Fillmore Forthcoming) is preserved by translating back and forth between that notation and an algebraic notation that looks much like LFG functional equations.

We first define FSs, then feature structure trees (FTs). The latter are the 'hybrid' structures: CS trees with FSs at the nodes. Modeling-domain objects (constructs) are FTs. CG modeling-domain objects are, thus, somewhat like those of LFG except that, like HPSG, phonological, semantic, categorial and 'bar' information are included in the FSs: no separate semantic and phonological modules and no labeling function, like LFG's λ, are posited. There is nothing corresponding to the up and down arrows of LFG. Also, LFG emhasizes the separateness of C-structures, F-structures and rules of correspondence between them, while CG emphasizes the unity of the construction, which, as in HPSG types (Pollard & Sag 1987; Pollard & Sag 1994, and especially Sag 1997), combines CS and non-CS aspects in a single unit.

Constructions are descriptions of classes of FTs, expressed as sets of constraint equations. Some of these equations express the constituent structure, as relations of dominance and precedence between nodes. Other equations are path equations which identify the CS node to which the beginning FS of each path is anchored. So we have equations that say things like "(The FS at node-1)'s syntax's head's cat is v." (Cf. Kaplan & Bresnan 1982:182ff, Kaplan 1995.)

2 Feature Structures

(19.1) Let the expression $(D \rightarrow R)$ denote the set of partial functions from domain D to range R.

The primitive notions of the current exposition are attributes, atomic values, phonological representations, and (constituent structure) nodes.

Feature structures are defined recursively as follows:

(19.2) A: a finite set of attributes,
V: a finite set of atomic values,
P: a denumerable set of phonological representations.

A function F is a feature structure (FS) iff $F \in (A \rightarrow V \cup P \cup F \cup \wp(F))$.[2]

In words, a feature structure is a partial function from a finite set of attributes to a range consisting of objects of any of the following four types: atomic values, phonological representations, feature structures, sets of feature structures.

3 Feature Structure Trees (FTs)

Feature structure trees are defined as follows.

(19.3) N: a finite set of CS nodes,
F: a finite set of FSs,
M(other): a function in $(N \rightarrow N)$;
$<$ ('precedes'): a strict partial order on N;
ϕ: a function in $(N \rightarrow N)$.

A five-tuple $t = < N, <, F, M, \phi >$ is a Feature Structure Tree (FT) iff

[2] '$\wp(F)$' denotes the power set of F.

(i) Exactly one node $r \in N$ has no mother in N,
(ii) Every node $n \in N$ other than r has exactly one mother,
(iii) For distinct nodes $n_i, n_j \in N$, if n_i and n_j are sisters, then $(n_i < n_j)$ or $(n_j < n_i)$,
(iv) For $n_i, n_j \in N$, if $M(n_i) < M(n_j)$, then $n_i < n_j$.

FTs are the formal objects which represent constructs. Note that no variables exist in the space of FTs and all precedence relations are specified by conditions (iii) and (iv).

4 Descriptions (Equations)

Let's start with a construct expressed in CG box notation and see what a description of it will look like in equation form.[3]

(19.5) *She sang.* (construct)

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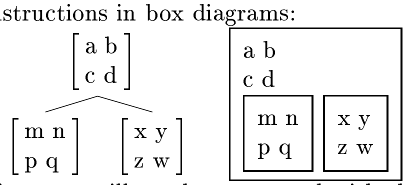
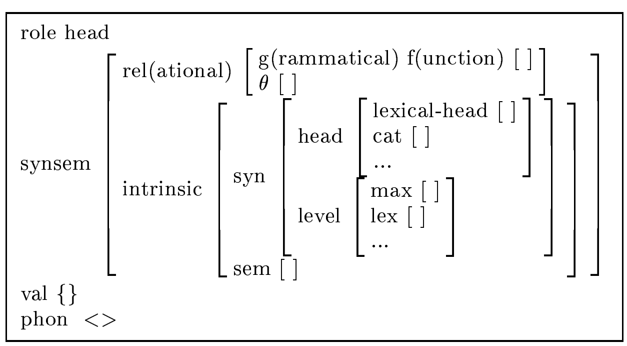
[3]CG often uses nested boxes rather than a structure of branching nodes to represent constituent structure. Thus, the two diagrams below are notational variants for a single FT. In the present paper, constructs are represented in branching node diagrams and constructions in box diagrams:



This paper will not be concerned with the feature geometry of any particular implementation of the CG approach. In order to simplify each example as much as possible, no attempt has been made to have all examples imply a single, consistent feature geometry. This paper is concerned only with the formal architecture in which CG grammars are expressed, not with the particulars of any one grammar or with a general theory of CG grammars. One version of a CG feature geometry which seems to work well for English is summed up in the following diagram.

(19.4)


In CG notation, empty brackets, braces, etc., specify, not the null FS, the null set, etc., but rather one of unspecified identity, an arbitrary instance of the appropriate type. For example, { } denotes an arbitrary set, [ ] an unspecified FS. Readers accustomed to HPSG usage should be wary.

$$\begin{bmatrix} \text{sem} & \begin{bmatrix} \text{tense past} \\ \text{scenes } \{...\} \end{bmatrix} \end{bmatrix}$$

$$\begin{bmatrix} \text{role comp} & \\ \text{syn} & \begin{bmatrix} \text{head} & \begin{bmatrix} \text{cat n} \\ \text{pro } + \end{bmatrix} \\ \text{level} & \begin{bmatrix} \text{max } + \\ \text{lex } + \end{bmatrix} \end{bmatrix} \\ \text{phon} & < \textit{she} > \end{bmatrix} \quad \begin{bmatrix} \text{role head} & \\ \text{syn} & \begin{bmatrix} \text{head} & \begin{bmatrix} \text{cat v} \\ \text{infl fin} \end{bmatrix} \\ \text{level} & \begin{bmatrix} \text{max } + \\ \text{lex } + \end{bmatrix} \end{bmatrix} \\ \text{sem} & \begin{bmatrix} \text{tense past} \\ \text{scenes } \{...\} \end{bmatrix} \\ \text{phon} & < \textit{sang} > \end{bmatrix}$$

(This representation of the construct is very partial, but we will pretend that it is complete.) We can write a description of (those aspects of) the construct shown in (19.4) in the following way. First we define the constituent structure as consisting of a mother and two daughters.

4.1 CS equations

(19.6) a. $M(n_2) = n_1$[4] b. $M(n_3) = n_1$ c. $n_2 < n_3$

4.2 FS equations

Using the LFG type of notation for path equations, based on the idea that paths represent successive functional application, we can write, for example:

(19.7) $\phi(n_1)$ sem tense = past

Equations (19.4) can be read '(the feature structure assigned by ϕ to n_1)'s sem's tense is past.' We can now proceed to a full decription of *She sang* (to the degree that its structure is specified in (19.4).

(19.8) a. $\phi(n_2)$ role = comp b. $\phi(n_2)$ syn head cat = n
c. $\phi(n_2)$ syn head pro = + d. $\phi(n_1)$ sem tense = $\phi(n_3)$ sem tense

Equation (19.8d) represents the kind of identity of information that is talked about in Fillmore & Kay Forthcoming as unification, and represented with unification variables that look like '#2'. When we come to the Subject-Predicate (S-P) construction, we will see that in the box diagram (19.18) this identity of information is represented by the occurrence of two instances of '#2[ ]'.

Although it is not shown in (19.4), we know that a fuller description of the construct *She sang* will also satisfy the following equation.

(19.9) $\phi(n_3)$ sem scenes $\subseteq \phi(n_1)$ sem scenes[5]

(Of course in this particular case, the more informative equation (19.10) also holds. But (19.9) is interesting because it will be true of every S-P construct.)

(19.10) $\phi(n_3)$ sem scenes = $\phi(n_1)$ sem scenes

A few more equations descriptive of *She sang*, just to give a little more of the flavor.

(19.11) a. $\phi(n_2)$ phon = < *she* > b. $\phi(n_3)$ role = head
c. $\phi(n_3)$ syn head cat = v d. $\phi(n_3)$ phon = < *sang* >

[4]More self-consciously: $\exists N, n_1, n_2[n_1 \in N \,\&\, n_2 \in N \,\&\, M(n_2) = n_1]$.

[5]The scenes value in CG is roughly analogous to the LISZT value in HPSG minimal recursion semantics (MRS). Broadly, CG semantic representation is similar in spirit and form, though not precisely equivalent, to MRS. Substantively, (19.9) means roughly that the semantics of a sentence will include everything in the semantics of its verb phrase.

We pretend equations (19.6–19.11) fully characterize the construct *She sang*. (There are two levels of pretense here (1) the pretense that diagram (19.4) fully characterizes the construct *She sang* and (2) the pretense that equations (19.6–19.11) fully characterize diagram (19.4).[6]) Any proper subset p of this set of equations will also describe (be satisfied by) *She sang* but will not describe *She sang* fully, in the sense that there will exist equations which are satisfied by *She sang* which are not in p (or implied by p). For example, if p is the set of equations (19.6–19.11c), p describes *She sang* only partially because (19.11d) is satisfied by *She sang* and is not in p (or implied by p).

5 Constructions and Licensing

Constructions are partial descriptions of FTs.

(19.12) A *description* is a set of constraint equations which makes use of numerical labels to identify individual nodes.

We want to be able to say that technically distinct descriptions (which differ only in the identifying numerals attached to their nodes) are mere 'renumberings' of each other.

(19.13) For two descriptions D, D', we will say that D' is a renumbering of D iff there is a one-to-one function g from node labels to node labels such that $g(D) = D'$ and $g^{-1}(D') = D$.

We want to restrict our attention to descriptions of objects of the kind we are concerned with, FTs.

(19.14) A description D is *satisfiable* iff there is at least one FT t such that for each equation $d \in D$, t satisfies d.

Any satisfiable description is a potential construction. The grammar of a language tells us which descriptions are the constructions of a given language. (The grammar also tells us the memberships of A, V, and (somehow) P.)

'Combining' constructions involves taking the union of the corresponding descriptions, subject to certain conditions to be described presently. Combining constructions produces sets of equations of increasing cardinality, providing increasingly detailed descriptions. We think of a sufficiently detailed description as 'licensing' a particular FT. A description's licensing (or not licensing) a FT is defined in part in terms of the FT's satisfying (or not satisfying) the description. However, the relation between a licensing description and the FT it licenses must include, but not be restricted to, satisfaction of the former by the latter. A description may, as we have noted, only partially describe a FT which satisfies it. We want a licensing description to be a full, not merely a partial, description of the licensed FT: the description and the model-object (FT) it licenses should specify the 'same information'. That is, the licenser should contain no information not embodied in the model-object and the model-object should embody no information not contained in the licenser.

[6] One respect in which equations (19.6–19.11) do not fully characterize the structure in diagram (19.4) is that these equations don't tell us that n_2 and n_3 are the only daughters of n_1. We could, for example, define predicates for the description language that would allow us to specify n_2 as the leftmost daughter of n_1 and n_3 as the rightmost daughter of n_1. More generally, we allow the description language to contain elements that are not part of the direct representation of modeling domain objects, e.g., negation, disjunction and material implication.

(19.15) A satisfiable description D fully describes a FT t, iff

(i) t satisfies each equation $d \in D$ and

(ii) for any description D', if t satisfies each equation $d' \in D'$, then $D \rightarrow D'$.

Property (i) ensures that D contains no information not embodied in t. Property (ii) ensures that t embodies no information not contained in D. The relation defined in (19.15) is sometimes described by calling the model object the 'minimal satisfier' of the description; the motivation for this terminology is that the model-object t is the least detailed object which the description D describes: if you added any more information to t, then D would no longer describe t (Kaplan & Bresnan 1982:201–203).

Our preferred terminology for the relation defined in (19.15) will be that D 'licenses' t.

(19.16) For a description D and a FT t, if D fully describes t we say equivalently that D licenses t or that t is a minimal satisfier of D.

We want the grammar (A, V, P and the constructions) to provide us with a description that licenses each construct in the language and with no description which licenses any FT that is not a construct of the language. This desideratum of a construction grammar corresponds to the familiar desideratum of generative grammar: a grammar of a language should account for all the sentences of the language, provide an analysis of the structure of each, and rule out all non-sentences. Put slightly differently, the object of the game is to select A, V, P and the constructions so that every FT which is a construct of the language is licensed by some combination of constructions and every combination of constructions that licenses a FT licenses a construct.

(19.17) A combination C of two satisfiable descriptions D, E is a satisfiable description $D' \cup E'$ such that

(i) D' is a renumbering of D,

(ii) E' is a renumbering of E, and

(iii) the satisfaction set of C is the intersection of the satisfaction set of D' and the satisfaction set of E'.

Certain things should be noted about definition (19.17). First, when the combination C fully describes a FT, D' and E' will necessarily have at least one node in common. Secondly, the definition of renumbering (19.13) allows us to 'match up' nodes in D and nodes in E in every possible way consistent with the dominance and precedence relations already specified in D and E.[7] Secondly, not every pair of satisfiable descriptions is combinable. The combined description must be such that there is at least one FT that satifies it. Moreover, there must be a way of assigning node match-ups such that condition (iii) of (19.17) is not violated. Thirdly, combination of descriptions is not an operation: there can be more than one combination of the same two descriptions.

5.1 Example: the Subject-Predicate (S-P) Construction

Some of the constraints (equations) in a construction will come from more general principles, which are simply more general constructions that are inherited by less specific constructions.

[7]To prevent the licensing of non-constructs (overgeneration) we have to be sure to set up the constructions in a way that will prevent non-constructs from being licensed. But this is just the problem that every grammarian has in making sure the hypothesized rules don't overgenerate.

In the diagram for a construction, we list at the top of the outer box in **boldface** the names of any constructions which are inherited by the one being diagrammed. For example, in the diagram of the Subject-Predicate construction in (19.18), it is indicated in this way that the Headed Phrase construction (19.24) is inherited. The notation in (19.18) **INHERIT Headed Phrase** does not denote an attribute-value pair. It indicates that the Headed Phrase construction contributes all its information, i.e., all its equations, to the Subject-Predicate construction. The notation **INHERIT Headed Phrase** expresses one link in an inheritance hierarchy of constructions which, in its entirety, represents the major grammatical generalizations of the language under study, for example, the generalization of English—and other languages—that lexical (and phrasal) heads share many syntactic and semantic properties with their phrasal mothers.

(19.18) Subject-Predicate (S-P) Construction (abbreviated)

INHERIT Headed Phrase
... head cat [ ]
... sem [tense #2 [ ]
scenes {}
val {}
#1 [role comp
... gf subj]
[role head
... head cat v
... max +
... sem [tense #2 [ ]
scenes {}
val {#1[ ]} ∪ { }]]]

Equations (19.19–19.23) express information presented diagrammatically in diagram (19.18). Equations (19.19) express constituent structure information about the construction. Equations (19.20) express path information which is peculiar to the S-P construction. Equations (19.21–19.23) express information contained in the S-P construction that is inherited from the Headed Phrase construction, see (19.24).

(19.19) **CS Equations**

a. $M(n_2) = n_1$ b. $n_2 < n_3$ c. $M(n_3) < n_1$

(19.20) **Equations proper to S-P**[8]

a. $\phi(n_2) \in \phi(n_3)$ val b. $\phi(n_2)$ role = comp

c. $\phi(n_2)$ ... gf = subj d. $\phi(n_3)$ role = head

e. $\phi(n_3)$ ... cat = v

f. $\phi(n_1)$ ... sem tense = $\phi(n_3)$ ... sem tense

FS Equations inherited from Headed Phrase. See 19.24

(19.21) $\phi(n_1)$ ... head cat = $\phi(n_3)$ ... head cat

(head feature percolation; '#2' in 19.24)

(19.22) $\phi(n_3)$ val = $\phi(n_1)$ val

(valence of head daughter is a subset of valence of mother; '#3' in 19.24)

(19.23) $\phi(n_3)$ ... sem scenes $\subseteq \phi(n_1)$ ... sem scenes

(scenes of head daughter are a subset of scenes of mother; '#1' in 19.24)

6 Constructional Inheritance

The Headed Phrase (HP) construction, which is inherited by the S-P construction, among others, follows in diagram form.

[8](19.20a) and (19.20f) correspond to '#1' and '#2' in (19.18), respectively.

(19.24) Headed Phrase (HP) (abstract) construction

synsem intrinsic $\begin{bmatrix} \text{sem scenes } \#1\{\ \} \cup \{\ \} \\ \text{syn head } \#2[\ ] \end{bmatrix}$
val $\#3\{\ \} \cup \{\ \}$

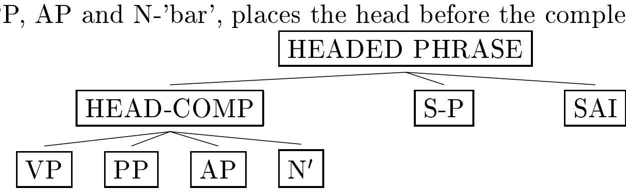
role head
synsem intrinsic $\begin{bmatrix} \text{sem scenes}\#1\{\} \\ \text{syn head } \#2[\ ] \end{bmatrix}$, $\boxed{\text{role comp}}^{+}$
val $\#3\{\}$

$(\phi(n_i)\text{role} = \text{comp}) \rightarrow (\phi(n_i) \in (\phi(M(n_1))\text{val}))$

The constraint expression at the bottom of diagram (19.24) says that the feature structure of each comp daughter unifies with (has the same structure as) a member of the valence value of the mother. There are cases, such as this, where it is more convenient to express a constraint directly in algebraic form than to create for it a special convention in the box diagram mode of representation.

All the properties of (19.24) are inherited by each of the more detailed constructions which license verb phrases, preposition phrases, adjective phrases, and 'n-bar' constituents, as well as the S-P construction, which licences subject-predicate clauses, and SAI, which licenses inverted clauses. The comma in (19.24) indicates that HP doesn't stipulate linear order between head and complement(s). The HEAD-COMPLEMENT construction, which inherits HP and is in turn inherited by VP, PP, AP and N-'bar', places the head before the complements.

(19.25)



(19.26) A construction C_1 *inherits* a distinct construction C_0 iff for some renumbering C_0' of C_0, $C_0' \rightarrow C_1$.

6.1 Recursive licensing

Unlike LFG phrase structure rules and lexical items and unlike HPSG types, distinct constructions can span the same (piece of) FT. For example, the English VP construction, which provides for a lexical verb followed by an arbitrary number of constitutents (subject to valence restrictions) can unify with a construction specifically licensing a VP displaying the 'heavy NP shift' property. In order to specify an explicit recursive licensing procedure for sentences, we need some way to deal with this overlap of constructions. We wish to reduce the set of constructions of a grammar to a set of construction-like objects (let's call them CLOs) with the property that in licensing a given sentence, exactly one CLO licenses each node. To obtain the set of CLOs from the set of constructions C: (1) form the power set of the set of constructions $\wp(C)$; (2) for each set of constructions in $\wp(C)$, attempt to unify all the members, matching the root nodes; (3) throw away all the sets that don't unify; (4) the remainder is the set of CLOs.

7 CG, LFG and HPSG

The relation of constructional inheritance has an empirical interpretation analogous to that of subtype in HPSG. Often a CG analysis can be directly translated into an HPSG analysis (and vice versa) by positing an HPSG type for each CG construction and assuming isomorphism between the relevant part of the type hierarchy in HPSG and a combination of the relevant part of the constructional inheritance hierarchy together with certain on-line combinations in CG.

The formal conception of CG architecture sketched in these notes is, however, more similar to that of LFG. A separation is maintained between constituency and other syntactic properties in the modeling space. The constraint equations which populate the description space in CG are quite similar to those of LFG. One difference between LFG and CG is the way the full set of constraint equations characterizing a model object is factored by the grammar. In LFG the factoring is into two subsets, one a set of (annotated) PS equations (= rules), the other a set of lexical items (containing semantic forms). Various principles ('up and down arrow' computations) provide for combining these into the full set of equations licensing the construct. CG, on the other hand, designates as linguistic units small subsets of constraint equations (the constructions); these contain both C-structure and non-C-structure information. CG resembles HPSG in this regard, in endowing the constructions (for HPSG: types) with semantic, including 'pragmatic', and phonological information, in addition to the syntactic information.

A formal difference between CG and (I think) both LFG and HPSG is that CG admits only actual words, phrases and sentences (constructs) as elements of the modeling domain. In HPSG terms, this would roughly amount to saying that the only modeling domain objects are signs. Abstractions over actual linguistic objects are not considered to be part of the modeling domain in CG.

7.1 Architecture and Theory

What has been sketched here is a formal architecture in which a theory of construction grammar can be expressed, not a theory of construction grammar. Within this architecture any sort of construction can be expressed; for example, we could express a construction for a transitive sentence whose subject begins with a vowel and whose object contains a relative clause specifying the color of its denotatum. A properly constrained constructional theory of grammar will have something to say about the likelihood of such a construction being encountered in any language. But that is a matter of theory, not of underlying architecture. To be sure, an architecture imposes constraints on the theories that can be expressed within it, but we should not expect a theory of grammar to follow from the notation in which it is expressed any more than we expect a theory of planetary motions to follow from the notation of differential equations.

Bibliography

FILLMORE, J. CHARLES. 1998. Inversion and constructional inheritance. In *Lexical and Constructional Aspects of Linguistic Explanation*, ed. by Gert Webelhuth, Jean-Pierre Koenig, & Andreas Kathol, volume 1 of *Studies in Constraint-Based Lexicalism*, 113–128. Stanford, CA: CSLI Publications.

——, & PAUL KAY. Forthcoming. *Construction Grammar*. Stanford: CSLI Publications.

KAPLAN, RONALD. 1995. The Formal Architecture of Lexical Functional Grammar. In *Formal Issues in Lexical-Functional Grammar*, ed. by Mary Dalrymple, Ronald Kaplan, John Maxwell III, & Annie Zaenen, 7–27. Stanford, CA: CSLI Publications.

——, & JOAN BRESNAN. 1982. Lexical Functional Grammar: A formal system for grammatical representation. In *The Mental Representation of Grammatical Relations*, 173–281. Cambridge, MA: MIT Press. Also appeared in Dalrymple et al., 1995, *Formal Issues in Lexical-Functional Grammar*, CSLI Publications, Stanford, 29–130.

KAY, PAUL, & CHARLES J. FILLMORE. Forthcoming. Grammatical Constructions and Linguistic Generalizations: the *What's X doing Y?* Construction. *Language* .

POLLARD, CARL J., & IVAN A. SAG. 1987. *Information-based Syntax and Semantics*. Volume 1, CSLI Lecture Notes Series No. 13. Stanford, CA: CSLI Publications.

——, & ——. 1994. *Head-Driven Phrase Structure Grammar*. Chicago, IL: University of Chicago Press and Stanford: CSLI Publications.

SAG, IVAN A. 1997. English Relative Clause Constructions. *Journal of Linguistics* 33.431–484.

Chapter 20

'A Unified Theory of Scope' Revisited

Quantifier Retrieval Without Spurious Ambiguities

Adam Przepiórkowski

Abstract. This paper presents an HPSG theory of quantification which builds and in various ways improves upon Pollard & Yoo (1997). By allowing only lexical retrieval, *à la* Manning *et al.* (1997), it is free from the spurious ambiguities problem. By shifting weight from VALENCE to ARG-ST, it is compatible with both traced and traceless analyses of extraction. The theory is formalized in Relational Speciate Re-entrant Logic (Richter 1997).

The aim of this paper[1,2] is to provide an HPSG theory of quantification which builds on Pollard & Yoo (1997) (henceforth, PY) and improves upon their analysis in some important ways. In particular, our account naturally avoids the problem of spurious ambiguities, it properly states certain generalizations missing in PY, it is (arguably) simpler than their analysis, and, unlike their account, it is compatible with both traced and traceless theories of extraction. We also show that our theory extends easily to *wh*-retrieval.

1 Pollard & Yoo (1997)'s Account

PY offer a substantial improvement over the theory of quantification of Pollard & Sag (1994) (henceforth, PS): they provide a solution to the problem of wrong behaviour of PS's analysis of quantification in raising and extraction environments, such as (23.25) below.

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

b. Five books, I believe John read. (ambiguous)

Since in PS's analysis a quantifier starts its life only at the surface position of the phrase to which it corresponds, only the wide-scope (*de re*) reading is predicted. The solution PY propose boils down to making the quantifier corresponding to

[1]My greatest thanks go to Carl Pollard, who has been very generous with his time and wisdom. His comments on earlier drafts led to several improvements in the theory presented here. I am also grateful to Tilman Höhle and Frank Richter, as well as the participants of the HPSG seminars at Tübingen and Ohio for useful comments on earlier versions of the paper. All the remaining flaws are *mea culpa.* The work reported in this paper was supported in part by the KBN grant 8 T11C 011 10.

[2]This paper is an abridged version of Przepiórkowski (1997), which additionally introduces a formalization of the 'adjuncts-as-complements' approach to modification (inspired by Manning *et al.* (1997)) and shows that this formalization properly interacts with the theory of quantification presented here.

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Gosse Bouma, Geert-Jan Kruijff & Richard Oehrle (editors).

a raised constituent available at the "initial" position, e.g., in (23.25a), at the embedded verb *approaching*. The quantifier then percolates up and can be retrieved either inside or outside the scope of *appear*.

For lack of space, and because of the rather high complexity of PY's analysis, we cannot present it in this paper. We will, however, point out certain problems with their account.

The foremost is perhaps the problem of spurious ambiguities (of which PY are well aware): for example, in (23.25a), there are four possible retrievals corresponding to the narrow reading, and three corresponding to the wide reading. Secondly, the analysis of PY is rather complex. If a simpler analysis with the same coverage can be obtained, it should be preferred. Thirdly, it is not compatible with the traceless analyses of extraction (e.g., ch.9 of PS). For example, getting the *de dicto* reading of (23.25b) requires *five books* to be a selected argument of the lower verb, *read*. However, in the traceless account of extraction, there is no element on *read*'s VALENCE corresponding to *five books*, so the latter is not a selected argument of *read*. Fourthly, by assuming that each word belonging to the 'amalgamating class' does so by virtue of its lexical properties, this analysis misses certain generalizations: the lexical entry of each word in this class must encode the same complex constraint (cf. PY's (15)).[3] Finally, PY's analysis preserves what we view as a conceptual problem of PS, namely the distribution of a *sign*'s semantics between CONTENT and QSTORE.[4] The analysis below solves these problems.

2 An Alternative Account

Our theory of quantification is summarized below.

(20.2) a. $\begin{bmatrix} \textit{content} \\ \text{QSTORE set(quant)} \end{bmatrix}$ with subtypes *psoa*, *nom-obj*, *quant*

b. $\begin{bmatrix} \textit{word} \\ \ldots \\ \text{NEW-QS set(quant)} \end{bmatrix}$

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

(20.4) $$\text{Desc}_1 = \begin{bmatrix} \text{SS|LOC|CONT} & \begin{bmatrix} \textit{nom-obj} \vee \textit{quant} \\ \text{QSTORE } \boxed{1} \end{bmatrix} \vee \begin{bmatrix} \textit{psoa} \\ \text{QSTORE } \boxed{2} \\ \text{QUANTS } \boxed{3} \end{bmatrix} \\ \text{NEW-QS } \boxed{5} & \end{bmatrix}$$

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

[3]As pointed out to us by an anonymous reviewer, this generalization can be properly stated in the hierarchical lexicon. As far as we can see, PY do not invoke the 'hierarchical lexicon' approach, nor are we aware of any formalization of this approach in SRL (King89; King94), a logic for HPSG close to that assumed by at least one of the authors of *A unified theory of scope ...* (Pollard 1998), so we maintain our claim that missing generalizations are at least a potential problem for Pollard & Yoo (1997).

[4]For example, the phrases *every person* and *some person* have the same values of CONTENT; they differ only in QSTORE.

$$\text{(20.5)} \qquad \text{Desc}_2 = \begin{bmatrix} \text{SS}|\text{LOC}|\text{CONT } \boxed{1} \\ \text{ARG-ST } \langle \ \dots\ , [\text{CONTENT } \boxed{1}], \ \dots \ \rangle \end{bmatrix}$$

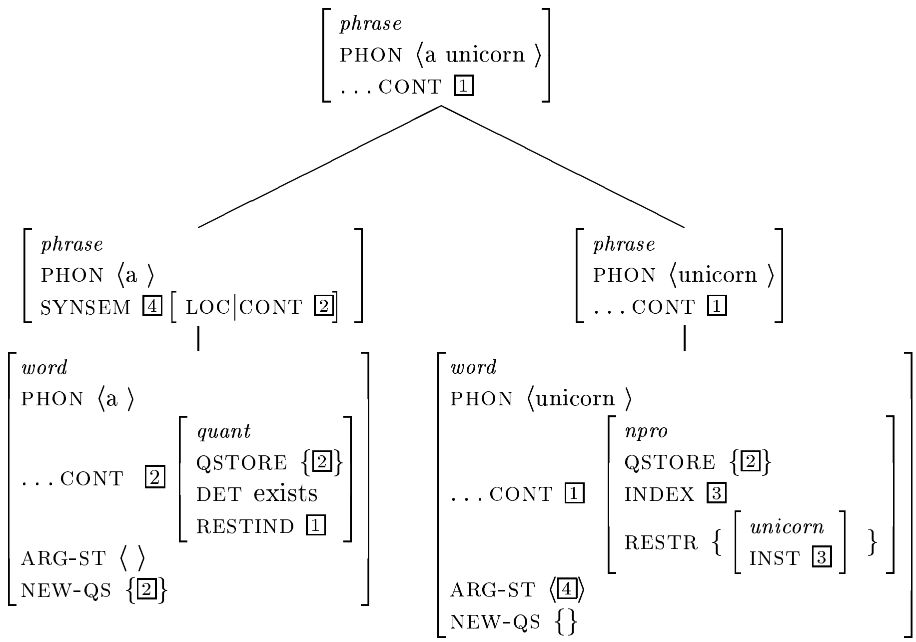
The way this analysis works is following. We build on Manning *et al.* (1997) and postulate lexical retrieval only. Thus, everything happens via the constraint on *word*s (20.3). Specifically, unless a word is semantically vacuous (its semantics is taken over from one of its arguments), cf. Desc_2 in (20.5), it must satisfy Desc_1 in (20.4). According to this description, if the word's CONTENT value is not of sort *psoa*, then this word simply amalgamates all quantifiers of its selected arguments, adding the quantifiers that it itself introduced (the quantifiers introduced by a word are present in this word's NEW-QUANTIFIERS value, cf. (??b)). On the other hand, if the word's CONTENT is *psoa*, then all these quantifiers are split between the word's QSTORE (they will be retrieved higher up) and its QUANTS (the quantifiers retrieved at this word). Since QSTORE is a part of *content* (cf. (20.2a)), it percolates to the maximal projection with the rest of the CONTENT value via the Semantics Principle.

In the above, we implicitly assumed PY's definition of selected arguments. This notion, as defined there, is heterogeneous: it takes into consideration VALENCE features (SUBJ, COMPS and SPR), the MOD feature, and *thematic* properties of some arguments. Since the only intended effect of these definitions is to prevent a quantifier from being retrieved more than once in cases of raised arguments, it seems reasonable to us to redefine the notion *selected arguments* in these terms: *selected arguments* are those members of ARG-ST, which are not raised from other arguments. For example, in (23.25a), the synsem element corresponding to *a unicorn* is a selected argument on the ARG-ST of *approaching*, but not on the ARG-STs of *be*, *to*, and *appears* because in each of these cases it is raised from the VP arguments of these verbs.[5] This shift of weight from VALENCE to ARG-ST will make our analysis compatible with traceless theories of extraction.

We will illustrate this analysis with example (23.25a). Let us start with the phrase *a unicorn*.

[5]This definition avoids a minor technical problem of PY's definition of thematic arguments: it is not clear how to formalize the notion of 'a role in the CONT|NUCLEUS' in their definition, short of enumerating all the attributes appropriate for various subsorts of *qfpsoa*.

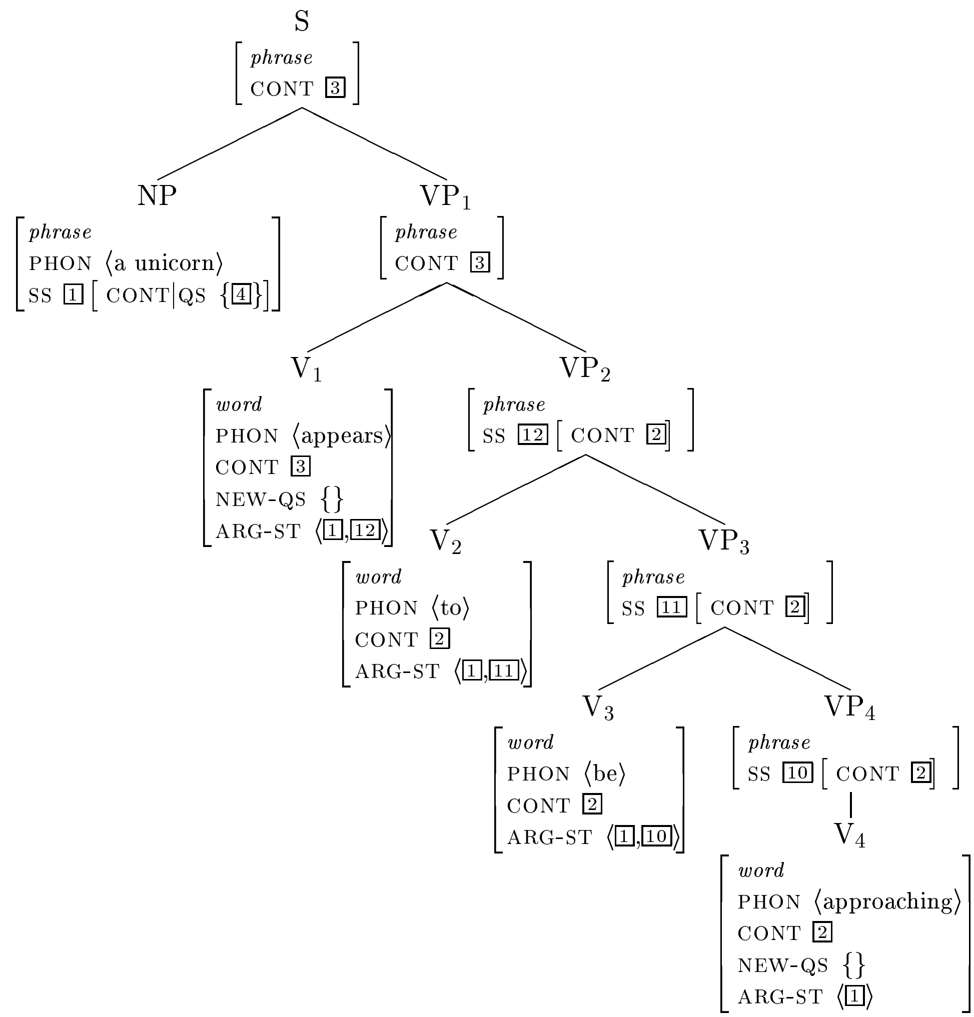
(20.6)



There are two *word* structures in this tree which must satisfy (20.3): *a* and *unicorn*. The former introduces a quantifier in NEW-QS and incorporates it into QSTORE via Desc_1 (20.4). This value percolates together with the whole CONTENT value to the maximal projection courtesy of the Semantic Principle. Since the synsem of this maximal projection is present in *unicorn*'s ARG-ST, this quantifier is amalgamated, again via Desc_1, to the noun's QSTORE. And, again courtesy of the Semantic Principle, it is present on the NP's QSTORE.

Let us now look at the tree structure corresponding to (23.25a).

(20.7)



There are six words in this structure (*a*, *unicorn*, *appears*, *to*, *be*, *approaching*), and they all have to satisfy the constraint (20.3). We have already considered the first two: since they are not semantically vacuous, they must satisfy Desc_1 (20.4). Another two of them, i.e., *to* and *be*, are semantically vacuous, so they trivially satisfy (20.3) by satisfying Desc_2 (20.5). The last two are, again, semantically non-vacuous and they can satisfy (20.3) only by satisfying Desc_1. Before we consider ways in which *appears* and *approaching* can satisfy Desc_1, a couple of notes are in order.

First, there are only two CONTENT values of sort *psoa* around. The approaching-*psoa* ($\boxed{2}$) is structure shared between the verb *approaching* (V_4) and its maximal projection (VP_4) by virtue of the Semantics Principle. This value is then taken over by the semantically vacuous verb *be* (V_3) and, again, structure shared with the maximal projection (VP_3). Analogously, also the CONTENT value of *to* (V_2) and its projection (VP_2) is $\boxed{2}$. The other *psoa* is the appears-*psoa* ($\boxed{3}$), which is shared by the verb *appears* (V_1) and its projections (VP_1 and S).

Second, since both QUANTS and QSTORE are parts of CONTENT, any quantifier retrieval can happen only at the two *psoa*-valued CONTENTs, namely at $\boxed{2}$ and $\boxed{3}$.

Third, there is only one quantifier to be retrieved, i.e., '$\exists x$ unicorn(x)' ($\boxed{4}$). This quantifier originates in the NP *a unicorn*, so the value of this phrase's CONT|QSTORE is $\{\boxed{4}\}$ (see the discussion below (20.6) on p.188). The whole SYNSEM value of this NP is structure shared with the (selected!) argument of *approaching*, hence, the QSTORE value of this selected argument is $\{\boxed{4}\}$, and thus, "the union of QSTOREs of selected arguments" (cf. (20.4)) of *approaching* is $\{\boxed{4}\}$. Since NEW-QS of this verb is empty, the pool of quantifiers to take care of at this node consists only of $\boxed{4}$.

Now there are two ways for *approaching* to satisfy Desc_1 (20.4): either $\boxed{4}$ becomes the (only) element of QSTORE (and QUANTS is empty), or it becomes the element of QUANTS (and QSTORE is empty). This results in two possible values of CONTENT $\boxed{2}$ illustrated below:

(20.8) a. narrow scope: $\boxed{2} = \begin{bmatrix} \textit{psoa} \\ \text{QSTORE } \{\} \\ \text{QUANTS } \langle \boxed{4} \rangle \\ \text{NUCL approach} \end{bmatrix}$ b. wide scope: $\boxed{2} = \begin{bmatrix} \textit{psoa} \\ \text{QSTORE } \{\boxed{4}\} \\ \text{QUANTS } \langle \rangle \\ \text{NUCL approach} \end{bmatrix}$

In case of the narrow scope (20.8a), the value of QSTORE of *approaching* is the empty set, and so is the value of QSTORE of $\boxed{12}$ (cf. V_1 in (20.7)), i.e., of the only selected argument of *appears* ($\boxed{1}$ is not a selected argument here!). Hence, the set of quantifiers collected at *appears* is the empty set:

(20.9) $\boxed{3} = \begin{bmatrix} \textit{psoa} \\ \text{QSTORE } \{\} \\ \text{QUANTS } \langle \rangle \\ \text{NUCL appear} \end{bmatrix}$

On the other hand, in case of the wide scope (20.8b), the QSTORE value of the selected argument of *appears* is the singleton set $\{\boxed{4}\}$, so, by the same reasoning, there are two possible values of $\boxed{3}$, cf. (20.10). Of course, once there is a constraint on root clauses to the effect that their QSTORE be empty, only (20.10a) is possible.

(20.10) a. $\boxed{3} = \begin{bmatrix} \textit{psoa} \\ \text{QSTORE } \{\} \\ \text{QUANTS } \langle \boxed{4} \rangle \\ \text{NUCL appear} \end{bmatrix}$ b. $\boxed{3} = \begin{bmatrix} \textit{psoa} \\ \text{QSTORE } \{\boxed{4}\} \\ \text{QUANTS } \langle \rangle \\ \text{NUCL appear} \end{bmatrix}$

This exhausts the possibilities of quantifier retrieval.

The following features of this account should be noted: 1) there are no spurious ambiguities: the quantifier can be retrieved either at the approaching-*psoa* or at the appear-*psoa* rendering narrow and wide scope, respectively; 2) since the selected arguments are defined in terms of ARG-ST rather than VALENCE, this analysis is compatible with both traced and traceless analyses of extraction; 3) the constraint responsible for amalgamation and retrieval of quantifiers, (i.e., Desc_1 in (20.3)) is stated only once in the grammar; 4) all semantics of a sign (including quantificational semantics) is present at one place in the sign, i.e., in *content*; 5) the analysis presented above is arguably much cleaner than that of PY.

3 *Wh*-Retrieval

PY make two observations concerning the scope of *wh*-elements in English. First, a fronted *wh*-phrase has exactly the scope indicated by the surface realization of the phrase. Second, the quantifier corresponding to an *in situ* *wh*-phrase (thus, also subject *wh*-phrase) can be retrieved only when there is a left periphery (subject or filler) *wh*-phrase. This can be illustrated with example (20.11) cited by PY after Baker (1970).

(20.11) Who remembers where we bought which book?

This example has two readings (given here by possible answers):

(20.12) a. John and Martha remember where we bought which book.

b. John remembers where we bought the physics book and Martha and Ted remember where we bought *The Wizard of Oz*.

These readings are captured by the observations above. First, the extracted phrase *where* has to scope immediately over *bought*. Secondly, *Who* cannot be retrieved any higher than its surface position, so it scopes immediately over *remembers*. However, the quantifier corresponding to *which book* can be retrieved either together with the filler *where*, or together with the subject *Who*, thus giving two possible readings. On the basis of these observations, PY propose the following principle governing the scope of *wh*-quantifiers:

(PY 37) Syntactic Licensing Constraint on *Wh*-Retrieval (for 'English-like' syntactic *wh*-movement languages)

a. At any node, retrieval, if any, of *wh*-operators must include the member of the left peripheral daughter's QUE value.

b. At any filler-head node, if the filler has nonempty QUE value, then its member must belong to the node's RETRIEVED value.

Since formalizing this principle requires retrieval at phrases, PY claim that "phrase-level retrieval is necessary in our analysis of interrogatives" (p.10).

Note, however, that there is nothing in the original observations that requires phrasal retrieval; they can be easily restated in our approach. First, (PY 37b) is trivially equivalent to (20.13):

(20.13) At any filler-head node, if the filler has nonempty QUE value, then its member must belong to the node's QUANTS value.

Second, (PY 37a) can be replaced by a principle to the effect that whenever a *wh*-operator is retrieved, there must be some retrieval from a left peripheral phrase. More carefully:

(20.14) If the QUANTS of a *psoa* contains a *wh*-quantifier, it must also contain the QUE member of a left peripheral daughter of some semantic projection of this *psoa*.

In other words, when a *wh*-quantifier is retrieved at a lexical item, there must be a semantic projection of this item, which is either a head-filler node or a head-subject node, such that the left periphery (filler or subject) contains QUE whose member is also retrieved at this lexical item.

Note that this formalization involves non-locality: although *wh*-quantifiers are retrieved lexically, this retrieval depends on the properties of projections of the lexical item. This is the main difference between our analysis and that of PY and it is the price we have to pay for allowing lexical retrieval only. Nevertheless, we do not consider it an excessive price and, in view of the advantages lexical retrieval brings, we are willing to pay it.

4 RSRL Formalization

This section presents a formalization of the above analysis in (a minor notational variant of) RSRL (Relational Speciate Re-entrant Logic) developed by Frank Richter and Manfred Sailer (Richter 1997; Richter *et al.* 1998) on the basis of Paul J. King's SRL (King89; King94).

The Signature We assume that the signature contains the following pieces of sort hierarchy and appropriateness specifications:

(20.2) a. b. $\begin{bmatrix} \textit{word} & \\ \ldots & \\ \textsc{new-qs} & \text{set(quant)} \end{bmatrix}$

Quantification The constraint (20.3)–(20.5) above can be formalized as in (20.15)–(20.19):[6]

(20.15)
$$
\begin{array}{ll}
\textit{word} \rightarrow & \\
\quad \exists u, u', s & (\text{Desc}_1) \\
\qquad \texttt{qs-union}(\text{:}\textsc{arg-st}, u) \ \wedge & \\
\qquad \texttt{set-union}(\langle u, \text{:}\textsc{new-qs}\rangle, u') \ \wedge & \\
\qquad\quad [[\neg\text{:}\textsc{ss}|\textsc{loc}|\textsc{content} \sim \textit{psoa} \wedge & \\
\qquad\quad \text{:}\textsc{ss}|\textsc{loc}|\textsc{content}|\textsc{qs} \approx u'] & \\
\qquad\quad \vee & \\
\qquad\quad [\text{:}\textsc{ss}|\textsc{loc}|\textsc{content} \sim \textit{psoa} \wedge & \\
\qquad\quad \texttt{list-to-set}(\text{:}\textsc{ss}|\textsc{loc}|\textsc{content}|\textsc{quants}, s) \wedge & \\
\qquad\quad \texttt{set-union}(\langle \text{:}\textsc{ss}|\textsc{loc}|\textsc{content}|\textsc{qs}, s\rangle, u')]] & \\
\quad \vee & \\
\quad \exists a & (\text{Desc}_2) \\
\qquad \texttt{member}(a, \text{:}\textsc{arg-st}) \ \wedge & \\
\qquad \text{:}\textsc{ss}|\textsc{loc}|\textsc{content} \approx a\text{:}\textsc{loc}|\textsc{content} &
\end{array}
$$

The auxiliary relation `qs-union/2` is defined as follows:

(20.16) $\forall a_0, u[\texttt{qs-union}(a_0, u) \leftrightarrow \texttt{selected-qs-union}(a_0, a_0, u)]$

(20.17)
$$
\begin{array}{l}
\forall a_0, a, u[\texttt{selected-qs-union}(a_0, a, u) \leftrightarrow \\
\quad [a \sim \textit{elist} \wedge u \sim \textit{eset}] \ \vee \\
\quad \exists u_1, u_2
\end{array}
$$

[6] As it is not clear what the representation of sets should be, we do not formalize relations on sets such as `list-to-set/2` and `set-union/2`. Intuitively, the former establishes the relationship between a list and the set of its elements, while the latter takes as its first argument a list of sets and specifies its second argument to be the (disjoint) union of the elements of this list.

$$\texttt{selected-qs-union}(a_0, a{:}\text{REST}, u_1) \wedge$$
$$\texttt{get-selected-qs}(a{:}\text{FIRST}, a_0, u_2) \wedge$$
$$\texttt{set-union}(\langle u_1, u_2\rangle, u)]]$$

(20.18) $\forall e, a_0, u[\texttt{get-selected-qs}(e, a_0, u) \leftrightarrow$
$[\neg\texttt{raised}(e, a_0) \wedge u \approx e{:}\text{LOC}|\text{CONTENT}|\text{QS}] \vee$
$[\texttt{raised}(e, a_0) \wedge u \approx \textit{eset}]]$

An element a in a list l is raised iff there in an element b in this list such that a is in a VALENCE attribute of b.

(20.19) $\forall a, l[\texttt{raised}(a, l) \leftrightarrow$
$\exists b\ \texttt{member}(b, l) \wedge$
$[\texttt{member}(a, b{:}\text{LOC}|\text{CAT}|\text{VAL}|\text{SUBJ}) \vee$
$\texttt{member}(a, b{:}\text{LOC}|\text{CAT}|\text{VAL}|\text{SPR}) \vee$
$\texttt{member}(a, b{:}\text{LOC}|\text{CAT}|\text{VAL}|\text{COMPS})]]$

***Wh*-retrieval** Finally, Pollard & Yoo's (1997) theory of *wh*-retrieval for English can be reformulated as below. (20.13) (corresponding to the second clause of (PY 37)) is trivial to formalize:

(20.20) $\forall q[\texttt{set-member}(q, {:}\text{DTRS}|\text{FILL-DTR}|\text{SS}|\text{QUE}) \rightarrow$
$\texttt{member}(q, {:}\text{SS}|\text{LOC}|\text{CONTENT}|\text{QUANTS})]$

(20.14) (cf. the first clause of (PY 37)) is less trivial: an appropriate constraint has to be more global than in Pollard & Yoo (1997).[7] What the constraint below says is that if the QUANTS list of a *psoa* contains a *wh*-quantifier, there must be a semantic projection involving a left-periphery *wh*-phrase, whose QUE member is also on this QUANTS list. This description is meant to hold of root clauses.[8,9]

(20.21) $\forall w, q[\ [\texttt{wh-quantifier}(q) \wedge w \sim \textit{word} \wedge$
$\texttt{member}(q, w{:}\text{SS}|\text{LOC}|\text{CONTENT}|\text{QUANTS})] \rightarrow$
$[\exists n, q_1$
$[\texttt{semantic-projection}(n, w) \wedge$
$\texttt{member}(q_1, n{:}\text{QUANTS}) \wedge$
$[\texttt{set-member}(q_1, n{:}\text{DTRS}|\text{SUBJ-DTR}|\text{SS}|\text{LOC}|\text{QUE}) \vee$
$\texttt{set-member}(q_1, n{:}\text{DTRS}|\text{FILL-DTR}|\text{SS}|\text{LOC}|\text{QUE})]]]]$

A node is a semantic projection of a word if it is the word or if a semantic projection of the word is the semantic daughter of the node:

[7] See Koenig (1998) for a different approach to stating such constraints.

[8] Thus, the complete constraint will have the form (i), where RootDesc depends on the particular analysis of root (unembedded) clauses, e.g., (ii) (cf. Uszkoreit's (1987) MAIN CLAUSE).

(i) RootDesc $\rightarrow$ (20.21)

(ii) RootDesc $= \begin{bmatrix} \textit{phrase} \\ \text{MC}\ + \end{bmatrix}$

[9] On the basis of Pollard & Yoo (1997), a wh-*quantifier* could be preliminarily defined as a quantifier whose DET is of sort *which*, i.e.:

(i) $\forall q[\texttt{wh-quantifier}(q) \leftrightarrow q{:}\text{DET} \sim \textit{which}]$

(20.22) $\forall n, w[\texttt{semantic-projection}(n, w) \leftrightarrow$
$[n \approx w \ \vee$
$\exists n_1[\texttt{semantic-projection}(n_1, w) \wedge$
$\texttt{semantic-daughter}(n_1, n)]]]$

The relation semantic-daughter is defined as in Pollard & Sag (1994):

(20.23) $\forall n, n_1[\texttt{semantic-daughter}(n_1, n) \leftrightarrow$
$[[n{:}\textsc{dtrs} \sim \textit{head-adj-str} \ \wedge \ n_1 \approx n{:}\textsc{adj-dtr}] \vee$
$[\neg n{:}\textsc{dtrs} \sim \textit{head-adj-str} \ \wedge \ n_1 \approx n{:}\textsc{head-dtr}]]]$

Bibliography

Baker, Carl L. 1970. Notes on the description of English questions: The role of an abstract Q-morpheme. *Foundations of Language* 6.197–219.

King, Paul John, 1989. *A logical formalism for head-driven phrase structure grammar*. Manchester, England: Manchester University dissertation.

——. 1994. An expanded logical formalism for Head-driven Phrase Structure Grammar. Sonderforschungsbereich 340 (Sprachtheoretische Grundlagen für die Computerlinguistik) Bericht Nr. 59, Seminar für Sprachwissenschaft, Universität Tübingen, Tübingen.

Koenig, Jean-Pierre. 1998. Inside-out constraints and description languages for HPSG. In (Webelhuth *et al.* 1998), chapter 17, 256–279. In print.

Manning, Christopher D., Ivan A. Sag, & Masayo Iida, 1997. The lexical integrity of Japanese causatives. To appear in G. Green and R. Levine (eds.), *Readings in HPSG*, Cambridge University Press. Version of March 5, 1997.

Pollard, Carl, & Ivan A. Sag. 1994. *Head-driven Phrase Structure Grammar*. Chicago University Press.

——, & Eun Jung Yoo, 1997. A unified theory of scope for quantifiers and *wh*-phrases. To appear in *Journal of Linguistics*. Final version of April 5, 1997.

Pollard, Carl J. 1998. Strong generative capacity in HPSG. In (Webelhuth *et al.* 1998), chapter 18, 281–297. In print.

Przepiórkowski, Adam, 1997. Quantifiers, adjuncts as complements, and scope ambiguities. Unpublished manuscript, Universität Tübingen. Version of December 2, 1997. URL: http://www.sfs.nphil.uni-tuebingen.de/~adamp/Papers/.

Richter, Frank. 1997. Die Satzstruktur des Deutschen und die Behandlung langer Abhängigkeiten in einer Linearisierungsgrammatik. Formale Grundlagen und Implementierung in einem HPSG-Fragment. In *Ein HPSG-Fragment des Deutschen, Teil 1: Theorie*, ed. by Erhard Hinrichs, Detmar Meurers, Frank Richter, Manfred Sailer, & Heike Winhart, number 95 in Arbeitspapiere des SFB 340, 13–188.

——, Manfred Sailer, & Gerald Penn. 1998. A formal interpretation of relations and quantification in HPSG. In *Proceedings of FHCG'98, 14–16 August 1998, Saarbrücken*, ed. by Geert-Jan Kruijff Gosse Bouma & Richard Oehrle. (This volume.)

USZKOREIT, HANS. 1987. *Word order and constituent structure in German*. Number 9 in CSLI Lecture Notes. Stanford: CSLI Publications.

WEBELHUTH, GERT, JEAN-PIERRE KOENIG, & ANDREAS KATHOL (eds.) 1998. *Lexical and Constructional Aspects of Linguistic Explanation*, Stanford, CA. CSLI Publications. In print.

Chapter 21

On certain properties of Romanian auxiliary (and modal) verbs

PAOLA MONACHESI

ABSTRACT. In this paper I propose that Romanian auxiliary verbs form a compound structure together with the verbal complement. This is not the case in French and in Italian where a flat structure is assumed. Given these two different configurations, it is possible to account for the fact that no element can separate the two verbs in Romanian, while subjects and adverbs can intervene between the auxiliary and the verbal complement both in Italian and French. The similarities exhibited by these Romance languages with respect to the distribution of the clitics in the presence of auxiliary and modal verbs are discussed. It is shown that they follow as consequence of the lexical mechanism of argument composition.

1 Introduction

Romanian auxiliary verbs have certain peculiar properties that set them aside from other Romance counterparts. It will be suggested that the differences between Romanian auxiliaries and French and Italian auxiliaries can be accounted for in terms of different syntactic structures. While in French and in Italian the auxiliary verb, the nonfinite one and the complements combine in a flat structure, in Romanian, the auxiliary and the lexical verb form a compound structure. If this structure is assumed, it is quite straightforward to account for the fact that Romanian auxiliaries can be placed after the verbal complement, in certain registers.

Furthermore, it will be shown that the Romanian data argue in favor of a monoclausal auxiliary structure and against the biclausal configuration proposed in [Dobrovie-Sorin, 1994]. She assumes that auxiliaries should be analyzed as adjoined to a CP/IP category and that the Infl node and the NP subject position of the main clause are lacking. However, the fact that no element can intervene between the auxiliary and the verbal complement and the distribution of clitics seem to support a monoclausal configuration.

Auxiliary verbs differ from modal verbs like *a putea* 'can' in certain respects. It will be shown that these differences can be accounted for if the modal verb will be associated with a flat structure. On the other hand, the similarities with respect to the distribution of clitics follow as consequence of *argument composition*. This is a lexical mechanism according to which the auxiliary inherits the complements of the embedded verb, including thus those ones which might be realized as clitics.

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2 Basic properties of Romanian auxiliaries

Romanian auxiliaries can be found in the present perfect, conditional and future paradigms. In the case of the present perfect, the auxiliary combines with a past participle, while in the other two cases it combines with a bare infinitive (e.g. an infinitive without the particle *a*). The following table summarizes the different forms of auxiliaries:

(1) Different forms of the auxiliaries

	1 Sg	2 Sg	3 Sg	1 Pl	2 Pl	3 Pl	
Aux Psp.	am	ai	a	am	aţi	au	past participle
Aux Cond.	aş	ai	ar	am	aţi	ar	bare infinitive
Aux Fut.	voi	vei	va	vom	veţi	vor	bare infinitive

A crucial property of these auxiliaries is that they are strictly adjacent to the lexical verb. Thus, unlike in French and in Italian, adverbs cannot separate them from the verbal complement:

(2) a. * Am adesea văzut filme bune.
have often seen good films

b. Am văzut adesea filme bune.
have seen often good films
'I have often seen good films.'

The only exception to this is constituted by a group of five monosyllabic intensifiers which have clitic status.[8]

Similarly, quantifiers cannot intervene between the auxiliary and the verb as shown in (3a):

(3) a. * Elevii tăi au toţi citit un poem de Verlaine.
students yours have all read a poem by Verlaine

b. Elevii tăi au citit toţi un poem de Verlaine.
students yours have read all a poem by Verlaine
'Your students have all read a poem by Verlaine.'

In Romanian, subjects can be found in different positions. They can occur before the verb (4a), between the verb and the direct object (4b) and after the direct object (4c):

(4) a. Mama a făcut o prăjitură.
mum has made a cake
'Mum has made a cake.'

b. A făcut mama o prăjitură.
has made mum a cake

c. A făcut o prăjitură mama.
has made a cake mum

However, unlike in Italian and in French, the subject cannot intervene between the auxiliary and the lexical verb:

(5) * A mama făcut o prăjitură.
has mum made a cake
'Mum has made a cake.'

Similarly, complements cannot occur between the two verbs:

(6) * Am filme bune văzut.
have good films seen
'I have seen good films.'

The data presented above suggest that the auxiliary and the lexical verb form a unit which cannot be separated by other elements and argue thus in favor of a monoclausal configuration and against the biclausal one proposed by [Dobrovie-Sorin, 1994].

3 The syntactic structure of auxiliary verbs

Two possible structures can be suggested in order to account for the properties of auxiliaries discussed in the previous section. One in which the nonfinite verb and its complements are sisters of the auxiliary verb in a flat structure (7) and one in which the auxiliary and the nonfinite verb constitute a complex verb (8):

(7) Flat structure (8) Compound structure

Given that the auxiliary and the lexical verb form a unit which cannot be separated by other elements, it seems that the compound structure in (8) is the most appropriate to capture this intuition. If the flat structure is adopted, it would be necessary to formulate special linearization constraints in order to account for the fact that it is not possible for subjects, adverbs, quantifiers and complements to intervene between the two verbs. On the other hand, the flat structure in (7) has been adopted for French [Abeille & Godard, 1994] and Italian [Monachesi, 1996] auxiliaries. Given this structure, it is possible to account for the fact that, differently from Romanian, subjects and adverbs can occur between the auxiliary and the nonfinite verb, both in French and in Italian.

A third possible representation in which the auxiliary takes a VP complement has not been taken into consideration:

(9) Hierarchical structures

This hierarchical structure does not seem plausible in view of the fact that Romanian auxiliaries can be optionally placed after the verbal complement:

(10) a. Văzut-am.
seen have
'I have seen.'

b. Mira-m-aş.
wondered cl.(acc) would
'I would wonder.'

c. Pleca-voi.
leave shall
'I shall leave.'

These data, which are discussed at length in [Dobrovie-Sorin, 1994] and in [Rivero, 1994], are limited to certain registers and are not triggered by illocutionary factors, as Rivero claims. In fact, this kind of inversion is only possible in some dialects, in poetry and in curse expressions. If the two verbs belong to the same domain, as in the compound configuration, one can account for the inversion data by means of simple linearization principles. This is not feasible if a hierarchical structure is assumed since the two verbs would belong to different domains.

In order to account for the inversion data, an approach similar to the one proposed by [Pollard & Sag, 1994] for English can be assumed. It relies on the use of the feature INV. Auxiliaries which cannot occur after the verb, such as the passive auxiliary, will be specified as INV ⇔, while auxiliaries which optionally invert will have INV *boolean* as their value. This applies to the future and the present perfect auxiliaries. The following LP constraints will account for the relevant orders:

(11) a. $[\Leftrightarrow INV] < V$
b. $V < [+INV]$

Given this analysis, it is quite straightforward to account for the fact that in the case of conditionals, inversion is possible only if clitics are present, as shown in (10b). The auxiliary cannot occur after the verb if there are no clitics:

(12) * Mînca aş.
eat would
'I would eat.'

This is accounted for by having conditional auxiliaries which have combined with clitics marked INV *boolean*. They can thus occur both before and after the lexical verb. Conditional auxiliaries which have not combined with clitics will be marked INV ⇔, so that they can only occur before the lexical verb.

It should be mentioned that the compound structure proposed for Romanian auxiliaries requires an appropriate schema to license it. The one suggested by [Hinrichs & Nakazawa, 1994] for the German verbal complex could also be adopted for this case:

(13) $\left[\mathrm{SS}\,|\,\mathrm{L}\,|\,\mathrm{C}\,|\,\mathrm{HEAD}\ \textit{verb}\right] \rightarrow \mathrm{H}\textit{word}\ ,\ \mathrm{C}\left[\mathrm{SS}\,|\,\mathrm{L}\,|\,\mathrm{C}\,|\,\mathrm{HEAD}\ \textit{verb}\right]$

The schema will allow for the auxiliary and the lexical verb to combine together before any non-verbal complements are added. This structure will thus account for the fact that no element can intervene between the two verbs, which is the desired result.

4 Auxiliary verbs and the distribution of clitics

Additional support in favor of a monoclausal auxiliary structure (and against the biclausal one proposed by [Dobrovie-Sorin, 1994]) comes from the distribution of clitics. If an auxiliary verb is present, the pronominal clitic, which is an argument of the embedded verb, must precede the auxiliary and cannot attach to the lower verb. The two verbs act thus as a unit:

(14) Le-am văzut.
cl.(acc) have seen
'I have seen them.'

I suggest that it is possible to account for the position of the clitic if an analysis in terms of *argument composition* [Hinrichs & Nakazawa, 1990] along the lines of that proposed for French [Abeille & Godard, 1994] and Italian [Monachesi, 1996] is adopted. This means that the auxiliary *am* in (14) has the following lexical entry associated with it:

(15)
$$\left[\begin{array}{ll}\text{PHON} & \langle \textit{am} \rangle \\ \text{SS}\,|\,\text{L}\,|\,\text{C} & \left[\begin{array}{ll} \text{HEAD} & \left[\begin{array}{l} \textit{verb} \\ \text{AUX} + \end{array}\right] \\ \text{VAL} & \left[\begin{array}{ll} \text{SUBJ} & \langle \boxed{1}\text{NP} \rangle \\ \text{COMPS} & \left\langle \left[\begin{array}{ll} \textit{w-ss} & \\ \text{HEAD} & \textit{verb} \\ \text{VAL} & \left[\begin{array}{ll} \text{SUBJ} & \langle \boxed{1}\text{NP}\rangle \\ \text{COMPS} & \boxed{2}\end{array}\right]\end{array}\right]\right\rangle \oplus \boxed{2}\end{array}\right]\end{array}\right]\end{array}\right]$$

The complements of the auxiliary verb are identified with those of the embedded verb through the operation of argument composition. This is reflected by the fact that the tag $\boxed{2}$ is present both in the COMPS list of the auxiliary verb and in that of the embedded verb. In the case of (14), the auxiliary inherits from the past participle the direct object, which will be realized as a clitic.

A lexical analysis of Romanian cliticization I assume a lexical approach to cliticization which treats Romanian pronominal clitics as affixes (cf. also [Miller & Sag, 1997] for French and [Monachesi, 1996] for Italian). There are several arguments which support this view. The order of pronominal clitics is fixed; Romanian has only accusative and dative object clitics and they occur in the order *dative-accusative*. There is thus a similarity between clitics and affixes which also exhibit rigid order. Furthermore, Romanian pronominal clitics do not have wide scope over coordination, but they must be repeated in front of each conjunct, a property they share with affixes. They also present arbitrary gaps in their combinations, as in certain inflectional paradigms. However, the most convincing evidence in favor of affixal status for Romanian pronominal clitics comes from the fact that, under certain conditions, they can cooccur with full complements behaving virtually as agreement markers:

(16)	Ion	m-a		văzut	pe	mine.
	Ion	cl.(acc)	has	seen	PE	me

‘Ion saw me.’

In addition, they present morphophonological idiosyncrasies, such as vowel deletion, which occurs in the case of the clitics *mă, vă* and *se* before verbs that start with *a* or *o*. This process doesn't seem to be explainable in terms of productive phonological rules: different allomorphs should be postulated. Therefore, three classes of pronominal clitics can be distinguished in Romanian: those that occur in front of any verbs, those that occur before verbs that begin with *a* or *o* and those that occur as enclitics.

Given the affixal status of clitics, they will not be considered lexical items, *signs* thus, but featural information which is provided in the lexicon and used in morphophonology for the realization of the cliticized verb form. I will assume that cliticization is a lexical operation which has both a syntactic/semantic and a morphophonological effect (cf. also [Monachesi, 1996], [Miller & Sag, 1997]). The former is reflected on the fact that clitics satisfy the subcategorization requirements of the verb they are an argument of. Within HPSG, a lexical rule can be proposed to achieve this effect; it relates two sets of words:[9]

(17) Complement Cliticization Lexical Rule (CCLR)

$$\begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{verb} \\ \text{VAL} \mid \text{COMPS} & \boxed{1} \bigcirc \boxed{2} \\ \text{CLTS} & \textit{elist} \end{bmatrix} \mapsto \begin{bmatrix} \text{VAL} \mid \text{COMPS} & \boxed{1} \\ \text{CLTS} & \boxed{2} \end{bmatrix}$$

The rule relates verbs which subcategorize for certain complements to other ones with the same properties except that their subcategorization list is reduced. In other words, the effect of the rule is that those complements which are in the COMPS list are removed and added as members of the CLTS list.[10] This list contains syntactic and semantic information about those complements which will be realized as clitics.[11] Verbs which have undergone cliticization are enriched with the relevant featural information, which is used for the morphophonological realization of the cliticized verb form. Appropriate constraints relate the featural information present on verbs to the actual phonological realization of the clitics. They are sensitive to the phonological structure (and the morphosyntactic form) of the verb. In the case of (14), the following constraint is relevant:

(18)

$$\begin{bmatrix} \textit{word} \\ \text{MORPH} \mid \text{STEM} \mid \text{SS} \mid \text{L} \mid \text{C} \mid \text{CLTS} \left\langle \text{NP}\begin{bmatrix}\textit{acc}\end{bmatrix}_{\textit{3MPl}} \right\rangle \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} \text{AFFIX} \begin{bmatrix} \textit{prefix} \\ \text{PHON} \left\langle \textit{le} \right\rangle \end{bmatrix} \end{bmatrix}$$

It states that if a verb contains an accusative, third singular masculine element in its CLTS list (which encodes the information about those elements that will be realized as clitics), the clitic *le* must also be present in the structure.[12]

Clitic climbing Romanian constitutes an exception to the generalization which holds across Romance languages that object clitics must precede the auxiliary verb. Unlike the other clitics, the third person feminine clitic *o* must attach to the embedded verb (19a) and cannot precede the auxiliary (19b):

(19) a. Am văzut-o.
have seen cl.(acc)
'I have seen her.'

b. * O-am văzut
cl.(acc) have seen

The reason for this fact seems to be of phonological nature: the clitic *o* cannot precede an auxiliary which begins with a vowel. Evidence for this hypothesis comes from the observation that in the future paradigm, the auxiliary begins with a consonant (e.g. *voi*) and in this case the clitic *o* can occur either after the infinitive (20a) or in front of the auxiliary (20b):

(20) a. Voi vedea-o.
will see cl.(acc)
'I will see her.'

b. O voi vedea.
cl.(acc) will see

In order to account for these peculiar facts, past participles and bare infinitives should be excluded as possible hosts for pronominal clitics. They can only be hosts for the clitic *o*. Therefore, additional conditions should be added to the constraints responsible for the realization of the clitics. For example, the one in (18) should be modified in the following way:

$$(21)\quad \begin{bmatrix} \textit{word} \\ \text{MOR}\,|\,\text{ST}\,|\,\text{SS}\,|\,\text{L}\,|\,\text{C} \begin{bmatrix} \text{HEAD} \begin{bmatrix} \text{VFORM} \begin{bmatrix} \neg\ (\textit{psp} \vee \textit{bare-inf}) \end{bmatrix} \end{bmatrix} \\ \text{CLTS} \left\langle \text{NP}\begin{bmatrix} \textit{acc} \end{bmatrix}_{\textit{3MSg}} \right\rangle \end{bmatrix} \end{bmatrix} \rightarrow \begin{bmatrix} \text{AFFIX} \begin{bmatrix} \textit{prefix} \\ \text{PHON} \left\langle\ \textit{l}\ \right\rangle \end{bmatrix} \end{bmatrix}$$

It states that the VFORM of the host must be different from past participle or from bare infinitive. It is thus possible to account for obligatory clitic climbing in the general case. On the other hand, this condition will not be present in the constraint that is responsible for the realization of the clitic *o*. It is therefore possible to deal with example (19a), where the clitic combines with a past participle. However, it is necessary to exclude those cases in which the clitic *o* attaches to the auxiliary, exemplified by (19b). This can be achieved by adding further conditions to the constraint that accounts for the realization of the clitic *o*:

$$(22)\quad \begin{bmatrix} \textit{word} \\ \text{MORPH}\,|\ \text{ST}\,|\,\text{SS}\,|\,\text{L}\,|\,\text{C}\,|\,\text{CLTS} \left\langle \text{NP}\begin{bmatrix} \textit{acc} \end{bmatrix}_{\textit{3FSg}} \right\rangle \end{bmatrix} \rightarrow \begin{bmatrix} \text{MORPH} \begin{bmatrix} \textit{complex-morph} \\ \text{STEM}\ \neg \begin{bmatrix} \textit{word} \\ \text{PHON} \begin{bmatrix} \text{VOW} \left\langle \boxed{1} \right\rangle \oplus \boxed{2} \\ \text{SKEL} \left\langle \boxed{1} \right\rangle \oplus \boxed{3} \end{bmatrix} \\ \text{SS}\,|\,\text{L}\,|\,\text{C} \begin{bmatrix} \text{HEAD} \begin{bmatrix} \textit{verb} \\ \text{AUX}\ + \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \text{AFFIX} \begin{bmatrix} \textit{prefix} \\ \text{PHON} \left\langle\ \textit{o}\ \right\rangle \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

The constraint states that if a STEM contains an accusative, third singular feminine element in its CLTS list, the clitic *o* must also be present in the structure and the verb is not an auxiliary which begins with a vowel.

5 Modal verbs

Romanian doesn't exhibit many environments in which clitic climbing is allowed; however the clitic distribution shown in (14) can also occur if the modal verb *a putea* 'can/may' is present:[13]

(23) O pot vedea.
cl.(acc) can see
'I can see her.'

An analysis in terms of argument composition can be assumed in this case as well. The following lexical entry will be associated with the modal *pot*:

(24)

$$\begin{bmatrix} \text{PHON} \left\langle \textit{pot} \right\rangle \\ \text{SS} \mid \text{L} \mid \text{C} \begin{bmatrix} \text{HEAD } \textit{verb} \\ \text{VAL} \begin{bmatrix} \text{SUBJ} \left\langle \boxed{1}\text{NP} \right\rangle \\ \text{COMPS} \left\langle \begin{bmatrix} \textit{w-ss} \\ \text{HEAD } \textit{verb} \\ \text{CLTS } \textit{elist} \\ \text{VAL} \begin{bmatrix} \text{SUBJ} \left\langle \boxed{1}\text{NP} \right\rangle \\ \text{COMPS } \boxed{2} \end{bmatrix} \end{bmatrix} \right\rangle \oplus \boxed{2} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

In addition, the fact that the clitic *o* does not attach to the embedded verb but to the modal constitutes further support for the phonological explanation of the impossibility of (19b). The modal begins with a consonant, so that *o* can attach to it, while this is not the case in (19b) where the auxiliary begins with a vowel. It should be noted that the condition CLTS *elist* excludes the possibility of the clitic *o* being attached to the bare infinitive.[14]

There are additional differences between the modal verb *a putea* and the auxiliaries. For example, a pronominal subject (25a) or an adverb (25b) can separate the modal from the infinitival:

(25) a. Putem noi închipui.
can we imagine
'We can imagine.'

b. Se putea uneori pierde.
cl.(refl.) can sometimes lose
'He could sometimes lose himself.'

These differences can be accounted for if the modal verb is associated with a flat structure like the one in (7) since this configuration allows elements to intervene between the two verbs.

The proposed analysis thus accounts for the differences between the Romanian auxiliaries and the modal *a putea* by assuming a slightly different constituent structure while the similarities, such as the distribution of the clitics, follow as a consequence of the lexical operation of argument composition. It should be noted that the modal has the same structure as the Italian and French auxiliaries, with which it shares several properties.

6 Conclusions

Romanian auxiliaries differ from French and Italian auxiliaries in several respects. These differences are captured by assuming that in Romanian the auxiliary and the verbal complement form a compound structure. Given this configuration it is possible to account for the fact that no elements can intervene between the two verbs. On the other hand, there are some crucial similarities across these Romance languages with respect to the distribution of the clitics in the presence of auxiliary (and modal) verbs, it is shown that they follow as consequence of the lexical mechanism of argument composition.

Notes

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[8]These intensifiers have a peculiar distribution since they are the only elements which can occur between pronominal clitics and the verb. I refer to [Monachesi, 1998a] for an analysis which is compatible with the treatment of auxiliaries proposed here.

[9]I will assume an interpretation of lexical rules as in [Meurers & Minnen, 1997] which view them as descriptions relating *word* objects. Note that in the lexical rule, the input and output descriptions are connected via "$\mapsto$", while in the case of the implicative constraints "$\rightarrow$" is used. In the lexical rule, $\bigcirc$ is the shuffle operator defined in [Reape, 1994].

[10]The rule doesn't account for cases of clitic doubling exemplified in (16) which are outside the scope of this paper. However, it is possible to extend the analysis by adding to the subcategorization list of the verb, via lexical rule, only those complements that satisfy the semantic and pragmatic conditions of doubling. An additional requirement is that the pronominal clitic and the doubled complement should share agreement and case information.

[11]The approach presented here differs in certain respects from that in [Miller & Sag, 1997]. They propose constraints on types in order to deal with French cliticization. However, this leads to a distinction of (morphosyntactic) words in plain and cliticized ones which is not a natural one. In the case of cliticization, the crucial opposition is between cliticized verbs and non cliticized ones and this property can be naturally captured by means of a lexical rule.

[12]I refer to [Monachesi, 1998b] for a detailed analysis of the morphophonological properties of Romanian clitics and a discussion of the signature adopted.

[13]It should be noted that the use of bare infinitives is disappearing in Romanian. Raising and control verbs are thus generally followed by a subjunctive.

[14]This feature is dispensed with in [Miller & Sag, 1997]; however, they introduce new types to achieve the same result: *basic verbs* to which noncliticized verb forms belong and *reduced verbs*, which include cliticized verbs. In their approach, the information that we have a cliticized verb form is encoded twice: in the subtyping of *word* and in that of *verb*. A certain amount of redundancy is thus introduced.

Bibliography

[Abeille & Godard, 1994] A. Abeillè, D. Godard, *The complementation of French Auxiliaries*. Proceedings of the Thirteenth West Coast Conference on Formal Linguistics. CSLI Publications, Stanford, pp. 157-173, 1994.

[Dobrovie-Sorin, 1994] C. Dobrovie-Sorin, *The syntax of Romanian. Comparative studies in Romance*. Mouton de Gruyter, Berlin. 1994.

[Hinrichs & Nakazawa, 1990] E. Hinrichs, T. Nakazawa, 'Subcategorization and VP structure in German'. *Proceedings of the Third Symposium on Germanic Linguistics*. Hughes, Shaun and Salmons (eds.). Benjamins, Amsterdam, 1990.

[Hinrichs & Nakazawa, 1994] E. Hinrichs, T. Nakazawa, 'Linearizing finite AUX in German verbal complexes'. J. Nerbonne, K. Netter and C. Pollard (eds.). *German in head-driven Phrase Structure Grammar*. CSLI Publications, Stanford, pp. 11-38, 1994.

[Meurers & Minnen, 1997] D. Meurers, G. Minnen, 'Computational Treatment of Lexical Rules in HPSG as Covariation in Lexical Entries'. *Computational Linguistics*, 23, 4, pp. 543-568, 1997.

[Miller & Sag, 1997] P. Miller, I.Sag, 'French clitic movement without clitics or movement'. *Natural Language and Linguistic theory*, 15, 3, pp. 573-639, 1997.

[Monachesi, 1996] P. Monachesi, *A grammar of Italian clitics*. Tilburg University. Ph.D. Thesis, 1996.

[Monachesi, 1998a] P. Monachesi, 'Linearization properties of the Romanian verbal complex'. *Recherches de linguistique française et romane d' Utrecht*. Vol. 17. To appear.

[Monachesi, 1998b] P. Monachesi, 'The morphosyntax of Romanian cliticization'. *Proceedings of Computational Linguistics in The Netherlands 1997*. To appear.

[Pollard & Sag, 1994] . C. Pollard, I Sag, *Head-driven Phrase Structure Grammar*. University of Chicago Press and CSLI, Stanford, 1994.

[Reape, 1994] M. Reape, 'Domain Union and Word order variation in German'. J. Nerbonne, K. Netter and C. Pollard (eds.). *German in head-driven Phrase Structure Grammar*. CSLI Publications, Stanford, pp. 151-198, 1994.

[Rivero, 1994] M. L. Rivero, 'Clause structure and V-movement in the languages of the Balkans' *Natural Language and Linguistic theory*. 12, pp. 63-120, 1994.

Chapter 22

Categories, Prototypes, and Default Inheritance

Robert Malouf

Abstract. Researchers in typological and functional approaches to language have argued that the cross-linguistic properties of nominalizations follow from the univeral semantic properties of syntactic categories. Specifically, nouns denote objects and verbs denote actions in the prototypical case. In this paper I argue that this prototypical association of semantic type with syntactic category can be represented in an HPSG lexical type hierarchy as a default constraint. Unmarked words will inherit from the categorial default, while words that do not inherit from the prototype will be structurally or behaviorally marked. Thus, default constraints provide a way to import insights about grammatical prototypes from more cognitively oriented work on language into a formal theory of grammatical structure.

It has long been noted [Comrie, 1976] that certain types of nominalizations are quite common in the world's languages, while other types are rare or nonexistent. For example, in English there are gerunds that combine with a subject like a noun does, but with an object like a verb does but no gerunds that combines with a subject like a verb does but an object like a noun does:

(22.1) a. Pat's often watching television [POSS-*ing*]
b. Pat often watching television [ACC-*ing*]
c.*Pat often watching of television [??]

[Croft, 1991, 83] summarizes the pattern of cross-linguistic variation with his Deverbalization Hierarchy (DH): "If a verbal form inflects for tense-aspect-modality like a predicated verb, then it will take subject and object dependents like a predicated verb. If a verbal form takes a subject dependent like a predicated verb, then it will take an object dependent like a predicated verb." This generalization is confirmed by [Koptevskaja-Tamm, 1993]'s much more extensive and systematic cross-linguistic survey of nominalization types.

Previous analyses of gerunds like *watching* in (22.1a–b) in Head-Driven Phrase Structure Grammar (e.g., [Malouf, to appear]) have treated them as a kind of mixed lexical category that show a combination of noun-like and verb-like lexical properties, derived by the Gerund Formation Lexical Rule (GFLR) in Figure 22.1. Like a typical verb, gerunds derived by the GFLR select for a subject and complements. But, like a typical noun, they select for a specifier, and since *gerund* is a subtype of *noun*, they project a phrase with the external distribution of an NP. While this analysis can account for the mixed properties of gerunds without recourse to highly

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

Figure 22.1: Gerund Formation Lexical Rule

abstract or unmotivated syntactic structures, nothing in this approach restricts what kinds of noun/verb hybrids can be formed. From this standpoint, the three construction types in (22.1) should be equally likely, as they all involve a deverbal noun with some combination of noun-like and verb-like lexical properties. If one were to make the (highly dubious) assumption that across languages all possible feature values are equally likely, then this analysis predicts that one should find many kinds of mixed categories that in fact do not occur.

One way to augment the analysis in Figure 22.1 to take the Deverbalization Hierarchy into account would be to impose the following constraints on possbile lexical entries:

(22.2) a. $\begin{bmatrix} \textit{word} & \\ \text{VFORM} & \textit{fin} \end{bmatrix} \supset \begin{bmatrix} \text{SUBJ} & \langle \textit{synsem} \rangle \end{bmatrix}$

b. $\begin{bmatrix} \textit{word} & \\ \text{SUBJ} & \langle \textit{synsem} \rangle \end{bmatrix} \supset \textit{predicator}$

If a word is finite (i.e. shows tense/aspect/modality marking), then it selects for a subject like a finite verb does. If a word takes a subject, then it is a predicator. That is to say, it inherits all the constraints on the linking of argument positions to grammatical functions that apply to verbs [Davis, 1996]. However, this is merely a representation of the Deverbalization Hierarchy and in no way explains why these particular constraints hold of gerund universally.

In contrast, [Croft, 1991] argues that the Deverbalization Hierarchy follows from the universal nature of syntactic categories. He proposes that syntactic categories are prototypical pairings of semantic type and pragmatic function, where the three basic universal semantic types are *action*, *object*, and *property*, and the three pragmatic functions are *predication*, *reference*, and *modification*. Croft's notion of semantic type corresponds well with the HPSG notion of semantic type. Pragmatic functions are more or less what [Searle, 1969] called **propositional acts**: referring indicates what one is talking about, and predicating indicates what is being said about it.

On the basis of a survey of twelve languages (along with informal observation of many more), Croft goes on to argue for the following three universal syntactic categories:

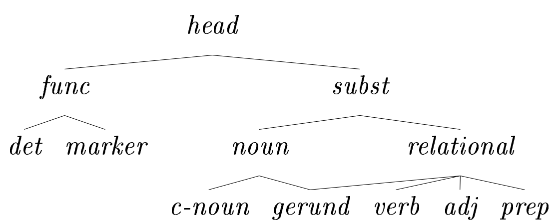
(22.3)	Verb	Action	$\longleftrightarrow$	Predication
	Noun	Object	$\longleftrightarrow$	Reference
	Adjective	Property	$\longleftrightarrow$	Modification

This is not to say that other associations cannot exist. The claim is only that these associations are prototypical. The prediction is that non-prototypical associations will be structurally or behaviorally marked, and that " ... nonprototypicality involves an 'unnatural' or at least 'imperfect' correlation of lexical semantic root with syntactic construction (referring expression, predication, attribution). In those cases, there will be a mixture of properties, some associated with the syntactic category expressed and some associated with the syntactic construction that the lexical semantic root is naturally correlated with" [Croft, 1991, 100].

In contrast to most generative treatments of syntactic categories, the approach taken by [Croft, 1991] is much like traditional grammars and modern school grammars in offering a semantic characterization of the parts of speech. In light of work on prototype categories, many of the shortcomings of the traditional approach to word classes can be seen as shortcomings of the classical Aristotelean approach to categories and classification in general. While it is not possible to state necessary and sufficient semantic conditions for nounhood, that does not mean the class of nouns has no semantic coherence.

In HPSG terms, pragmatic functions would have to be associated with types of constructions. Clausal constructions are used for predicating and certain head/specifier constructions are used for referring. However, the categories in (22.3) are *lexical* categories. The link between a word and the constructions it can be a part of is its HEAD value. A partial hierarchy of HEAD values is given in (22.4).

(22.4)



In this context, *c-noun* corresponds to Croft's *reference* and *verb* is Croft's *predication*. A straightforward way to express Croft's basic insight in the context of an HPSG lexical hierarchy is as pairings of a semantic type with a head type:

(22.5) a. $v \rightarrow$

$$\begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{CONT} & \textit{psoa} \end{bmatrix}$$

b. $n \rightarrow$

$$\begin{bmatrix} \text{HEAD} & \textit{c-noun} \\ \text{CONT} & \textit{nom-obj} \end{bmatrix}$$

The content type *psoa* stands for 'parameterized state of affairs' in the situation theoretic sense, and corresponds to Croft's *action*, and the content type *nom-obj* corresponds to Croft's *object*.

However, the constraints in (22.5) only capture half of Croft's claim: categories are not just associations of meaning and function, they are *prototypical* associations of meaning and function. Without a notion of prototype, this classification is either as easily falsified as the traditional semantic classification, or it is as empty of predictive power as the generative classification.

How then do we represent prototypicality in the HPSG lexical hierarchy? A standard HPSG type hierarchy is essentially a classification by **schema**, where a schema is "an abstract characterization that is fully compatible with all the members of the category it defines" [Langacker, 1987, 371]. A monotonic type hierarchy is a special case of what Langacker calls a **schematic network**, one that includes only elaboration links and in which the 'elaborates' relation is transitive. To generalize our type hierarchy to represent prototypicality then all we need to do is to introduce extension links, i.e., to allow **default inheritance** [Lascarides & Copestake, 1997]. In a default constraint, feature values marked with '/' can be overridden by conflicting constraints on more specific types.

(22.6) a. $v \rightarrow$

$$\begin{bmatrix} \text{HEAD} & \textit{relational} \ / \ \textit{verb} \\ \text{CONT} & \textit{psoa} \end{bmatrix}$$

b. $n \rightarrow$

$$\begin{bmatrix} \text{HEAD} & \textit{noun} \ / \ \textit{c-noun} \\ \text{CONT} & \textit{nom-obj} \end{bmatrix}$$

All things being equal, objects of type *v* will be constrained to have a HEAD value of type *verb*. Some subtype of *v* however could impose a conflicting constraint, say that the HEAD value be an object of type *gerund*. Rather than creating an inconsistency, this additional constraint **overrides** the default information in (22.6a).

Any more specific constraints that override the defaults in (22.6) must still satisfy the hard constraints in (22.6). By default the head value of a word of type *v* is of type *verb*, but no matter what its head value must be compatible with *relational*. This rules out a subtype of *v* with a head value of *det*, for example. As adverbs modify *relational* phrases, (22.6a) is consistent with the intuition that there is a connection between adverbial modification and event-denoting semantics.

Default inheritance as appealed to by, e.g., [Sag, 1997], is an abbreviatory device that helps simplify the construction of lexical type hierarchies. When used in this way, defaults add nothing essential to the analysis. They simply provide a mechanism for minimizing the number of types required. Any type hierarchy that uses defaults can be converted into an equivalent one that does not use defaults, but is perhaps undesirable for methodological reasons. Either way, the constraints that ultimately are inherited by phrasal and lexical constructions are the same, and the analysis will make the same predictions.

What I am proposing here is a rather different use of defaults. If default inheritance is used to model extension from a prototype, then two hierarchies that yield the same set of lexical constraints via a different arrangement of types would be substantively different. Different hierarchies implicitly make different claims about the prototypicality of certain constraints, and claims about prototypicality have empirical consequences. So rearranging a type hierarchy to eliminate defaults actually results in a theory that makes different predictions. This does not present a problem, since default unification operation as defined by [Lascarides & Copestake, 1997] avoids many of the shortcomings generally associated with multiple inheritance with default overriding (see [Lascarides et al., 1996]).

Following [Greenberg, 1966], [Croft, 1991] identifies several morphosyntactic criteria for identifying marked and unmarked forms. These properties follow more or less directly from a hierarchical representation of prototypes. For example, Croft points out that "an unmarked form will display at least as great a range of grammatical behavior as the marked form" (56). By definition, less marked types in the hierarchy are less specific than more marked types, and the constraints on a more marked type must be at least as specific as the constraints on a less marked type. Marked forms, which are of a more specific type and which are subject to potentially more specific constraints, will naturally occur in more specific environments.

Default inheritance provides a convenient way to model prototypicality in a lexical type hierarchy. In a narrow sense, every non-maximal type (that is, every type that has at least one subtype) is a prototype with respect to its subtypes. In a more general sense, we can say that the more subtypes a type has, the greater its prototypicality. What defaults do not explain is the connection between prototypicality and productivity. Nothing so far accounts for the fact that the prototype in effect provides a template for new members of a class.

As it is usually presented, the HPSG hierarchical lexicon is completely closed: all lexical types are explicitly listed and located within the type hierarchy. However, as [Koenig & Jurafsky, 1994] observe, such type hierarchies make it difficult to model productivity. In a closed hierarchy, every type is listed, whether or not its existence is predictable. Since no distinction is made between irregular types and regular types that follow a productive pattern, one must appeal to some external mechanism to explain why it is that new types, with a few interesting exceptions, always get assimilated to the regular pattern. Koenig & Jurafsky argue that the lexical hierarchy should only include types which are not predictable; all other types should be implicitly introduced by a process of **on-line type creation**. This same on-line type construction also applies to new forms, giving them the same behavior as existing but predictable forms.

Using a combination of default inheritance and on-line type construction, we can now give a picture of lexical organization that can account for the Deverbalization Hierarchy. Suppose every word is classified along four dimensions, according to linking, realization, inflection, and category properties.

The first two dimensions are familiar from much earlier work in virtually all syntactic theories. Within HPSG, linking has been explored in depth by [Wechsler, 1995] and [Davis, 1996]. The realization dimension has received less attention in the HPSG literature, but it is no less important. [Pollard & Sag, 1994] assume that realization is trivial, that is, that at least for verbs the first element on the argument structure is always the subject and any remaining arguments are complements. More recently, efforts have turned to exploring alternative realization possibilities: [Miller & Sag, 1997] and [Abeillé et al., to appear] propose that French allows certain arguments to be realized either as complements or as clitics, and [Bouma et al., 1998] analyze long-distance dependency constructions as a realization alternation.

So, semantic roles are associated with positions in an abstract syntactic argument structure, which are in turn realized as elements in the 'surface' syntax. Each of these associations allows a certain amount of variation but is constrained by general principles. So far, this model of the lexicon should be fairly uncontroversial. While the details are sometimes hotly contested, in its general outline this is the picture that has emerged as a standard view in HPSG and in many other

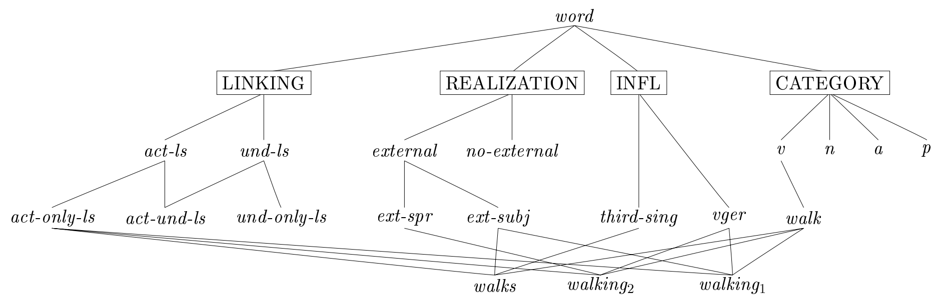


Figure 22.2: A completed type hierarchy

frameworks as well.

For concreteness, we can assume the linking constraints in [Davis, 1996], although the details will not be important. Realization types map argument structure to valence. In the realization dimension, the detailed formalization of these constraints is not vital to my argument, but to be specific I will assume constraints along the lines of those proposed by [Bouma et al., 1998]. Function words, like determiners and coordinating conjunctions, don't have any argument structure and so the realization is trivial. Substantive words make a distinction between internal and external arguments. Internal (i.e., non-initial) arguments are always mapped to the COMPS list, at least in languages with nominative/accusative case marking. The non-initial arguments of a substantive word are either realized as complements or are realized via a long-distance dependency construction. Substantives can be further divided according to how their external argument is realized. Relational words (e.g., verbs, prepositions, adjectives) realize their external argument as a subject, while nouns realize their external argument as a specifier.

Inflectional classes determine the phonological form of a word. For example, there would be an inflectional class that relates a present tense verb with a third person singular AGR value with the *-s* form. The GFLR can now be recast as an inflectional class:

(22.7) *vger* →

$$\begin{bmatrix} \text{MORPH} & \begin{bmatrix} \text{ROOT} & \boxed{1} \\ \text{I-FORM} & f_{ing}(\boxed{1}) \end{bmatrix} \\ \text{HEAD} & \textit{gerund} \end{bmatrix}$$

When the constraint in (22.7) combines with a subtype of *v*, the head value *gerund* will override the default head value *verb*.

The last dimension is category. The relevant constraints on category types were given in (22.6). Individual lexemes, defined as subtypes of a lexical category type, need only specify non-predictable information. At a minimum, this will include a phonological form and a semantic relation.

Given these constraints, we can now apply on-line type construction to yield a virtual type hierarchy. The result is given in Figure 22.2. Note that this is a classification of *signs*, and so is orthogonal to the classification of HEAD values in (22.4). Each word inherits from at least one of the maximal types in each of the four dimensions: any word which satisfies this requirement is predicted to be a valid word. Furthermore, the words in Figure 22.2 are the *only* words that will be generated. All other combinations of types will be ruled out by conflicting constraints. The only combinations of types that do not have conflicting constraints on them are *walks, walking*$_1$, and *walking*$_2$. These three types correspond to the third person singular form, the ACC-*ing* gerund, and the POSS-*ing* gerund, respectively.

The effect of the type *vger* is the same as that of the GFLR. Since *gerund* is a subtype of *noun* in the hierarchy in (22.4), a phrase projected by a gerund will be able to occur anywhere an NP is selected for. Thus, verbal gerund phrases will have the external distribution of NPs. Adverbs modify objects of category *relational,* which include verbs, adjectives, and verbal gerunds, among other things. Since adjectives only modify *c(ommon)-nouns,* verbal gerund phrases will contain adverbial rather than adjectival modifiers. Since *verb* is a distinct subclass of *relational* disjoint from *gerund,* verbal gerund phrases will not have the distribution of true VPs.

Because a gerund has a *psoa* content just like a verb does, its semantic roles will get linked to argument positions just like a verb's do. *Gerund* is a subtype of *subst*, so its non-initial arguments will get mapped to the COMPS list, and a gerund will take the same complements as the verb from which it is derived. But, *gerund* is a subtype of both *noun* and *relational*, so a gerund's external argument could get mapped either to the subject or to the specifier. Thus we get the effect of the old gerund lexical rule, without having to stipulate the exceptional argument mapping.

This kind of analysis is much more restrictive than the lexical rule analysis. One could write a lexical rule that produces a gerund which takes a subject like a verb does, but cannot take complements, even though cross-linguistically gerunds of that type do not seem to occur. Under the approach sketched here, the only way for a word to take a subject is for it to be a subtype of *ext-subj*. Since *ext-subj* is a subtype of *external*, anything that takes a subject will potentially take complements too. Similarly, VFORM values are only appropriate for objects of type *verb*. That means that any gerund that inflects like a finite verb (and thus is [VFORM fin]) will also by necessity inherit from *ext-subj*.

The implicational structure of the Deverbalization Hierarchy is directly reflected by the subsumption ordering in the lexical hierarchy in Figure 22.2. This means that given this lexical layout, there is no way to derive a gerund of the type seen in (22.1c). In a weak sense, this explains the behavior of the English verbal gerund. The properties of the English verbal gerund follow from the structure of the English lexical hierarchy, which in turn is motivated independently by other lexical constructions in English. There is no need to impose additional unmotivated constraints like those in (22.2).

The Deverbalization Hierarchy however is a universal claim about gerunds in all languages. It would be absurd to try to explain a universal pattern in terms of parochial facts about the structure of the English lexicon. If the lexical patterns in Figure 22.2 are to serve as an explanation for a universal property of language, they themselves must be universal. Obviously, the specific details of Figure 22.2 cannot be universal. At best only the general outlines of the organization of the lexicon could be universal, and even then there is considerable variation. [Manning, 1996] shows that nominative/accusative and ergative/absolutive languages have very different realization constraints, and [Manning & Sag, 1995] analyze a number of diathesis alternations as alternative realizations of a basic argument structure.

The best we can say is that there seem to be very general principles that govern the structure of the lexicon of all languages. Good candidates for such principles are that the mapping of semantic roles to syntactic positions is mediated by a level of syntacticized argument structure, and that inflectional morphology is part of the interface between the lexicon and the syntax. These entail that the lexical hierarchy of every language will be divided into at least the four dimensions discussed above. Within each dimension, the best we can say is that a language can avail itself of a limited number of choices out of a universal inventory of organizational schemes (say, nominative vs. ergative case marking).

One way of looking at this kind of model of language universals is to assume that parts of the lexical type hierarchy are mandatory, perhaps due to more general properties of human cognition or perhaps simply because they are innate. Other parts of the lexical hierarchy are then chosen from a set of universally available types. These in a sense come 'for free', since their existence is entailed by something about the way language works, and they provide the cross-linguistic motivation for the language specific types that inherit from them. Similarities between grammars of different languages arise from the similar diachronic and functional pressures that shape each language. Finally, the lower reaches of the lexical hierarchy are populated by strictly parochial types that have no cross-linguistic generality and reflect the uniqueness of each human language. This is the model that is developed in considerable detail by [Ackerman & Webelhuth, 1998], and is much like what [Croft, 1995, 504] calls **typological functionalism**. Typological functionalism makes an attractive way of integrating formal and functional approaches to language without substantially weakening either. It would allow a formal grammarian to draw on, for example, the competition models proposed by [Bates & MacWhinney, 1989] or [DuBois, 1985] without abandoning the idea that grammar is an arbitrary, self-contained, symbolic system.

Now the questions is, what is the status of the particular constraints in (22.6)? Are they hard-wired as part of Universal Grammar, or are they derived from something outside of grammar? There is some evidence from other work that suggests that the archetypes in (22.6) do indeed follow from something outside of grammar. In particular, the **semantic bootstrapping hypothesis** [Grimshaw, 1981, Pinker, 82, Pinker, 89] claims that children learning language use semantic types as a basis for syntactic classification. That is:

> ... certain cognitive categories have what I will call Canonical Structural Realization (CSR): CSR(object) = N, CSR(action) = V. [Language acquisition] employs a CSR principle: a word belongs to its CSR, unless there is evidence to the contrary [Grimshaw, 1981, 174].

If we suppose, following [Green, 97], that language acquisition is a process of incrementally building a type hierarchy, then Grimshaw's CSR principle will guarantee that types more or less like those in (22.6) will be introduced into the child's grammar early on, and will be high up in the adult hierarchy.

Thus, the constraints in (22.6) may be archetypes due to a heuristic employed by language learners and not due to anything fundamental about grammatical representation itself. Note that there is no contradiction in saying the constraints in (22.6) are archetypes and they can be derived from something outside the grammatical system. Archetypes as I use them here provide the link between language universals and grammatical particulars, but embody no specific claim as to the origin of those universals.

Bibliography

[Abeillé et al., to appear] Anne Abeillé, Danièle Godard, Philip Miller, and Ivan A. Sag. French bounded dependencies. In Luca Dini and Sergio Balari, editors, *Romance in HPSG*. CSLI Publications, Stanford, to appear. URL `ftp://ftp-csli.stanford.edu/linguistics/sag/fbd.3.ps.gz`.

[Ackerman & Webelhuth, 1998] Farrell Ackerman and Gert Webelhuth. *A Theory of Predicates*. CSLI Publications, Stanford, 1998.

[Bates & MacWhinney, 1989] Elizabeth Bates and Brian MacWhinney. Functionalism and the Competition Model. In Brian MacWhinney and Elizabeth Bates, editors, *The Crosslinguistic Study of Sentence Processing*, pages 3–73. Cambridge University Press, 1989.

[Bouma et al., 1998] Gosse Bouma, Robert Malouf, and Ivan A. Sag. Satisfying constraints on extraction and adjunction. University of Groningen and Stanford University, URL `ftp://csli-ftp.stanford.edu/linguistics/sag/ks-sem/bms-98-draft.ps`, 1997.

[Comrie, 1976] Bernard Comrie. The syntax of action nominals: a cross-language study. *Lingua*, 40:177–201, 1976.

[Croft, 1991] William Croft. *Syntactic Categories and Grammatical Relations*. University of Chicago Press, 1991.

[Croft, 1995] William Croft. Autonomy and functionalist linguistics. *Language*, 71:490–532, 1995.

[Davis, 1996] Anthony R. Davis. *Lexical Semantics and Linking in the Hierarchical Lexicon*. PhD thesis, Stanford University, 1996. URL `http://www-linguistics.stanford.edu/~tdavis/thesis-ps.html`.

[DuBois, 1985] John W. DuBois. Competing motivations. In John Haiman, editor, *Iconicity in Syntax*, pages 343–365. John Benjamins, Amsterdam, 1985.

[Greenberg, 1966] Joseph H. Greenberg. *Language Universals*. Number 59 in Janua Linguarum Series Minor. Mouton, The Hague, 1966.

[Green, 97] Georgia Green. Modelling grammar growth: Universal grammar without innate principles or parameters. Paper presented at GALA97 Conference on Language Acquisition, Edinburgh, 1997. URL `http://lees.cogsci.uiuc.edu/~green/edinout.ps`.

[Grimshaw, 1981] Jane Grimshaw. Form, function, and the language acquisition device. In C.L. Baker and J. McCarthy, editors, *The Logical Problem of Language Acquisition*, pages 165–182. MIT Press, Cambridge, 1981.

[Koenig & Jurafsky, 1994] Jean-Pierre Koenig and Dan Jurafsky. Type underspecification and on-line type construction. In *Proceedings of the West Coast Conference on Formal Linguistics*, volume 13, 1994. URL `http://stripe.colorado.edu/~jurafsky/papers/wccfl94.ps.Z`.

[Koptevskaja-Tamm, 1993] Maria Koptevskaja-Tamm. *Nominalizations*. Routledge, London, 1993.

[Langacker, 1987] Ronald W. Langacker. *Foundations of Cognitive Grammar*, volume I. Stanford University Press, Stanford, 1987.

[Lascarides et al., 1996] Alex Lascarides, Ted Briscoe, Nicholas Asher, and Ann Copestake. Order independent and persistent typed default unification. *Linguistics and Philosophy*, 19:1–89, 1996.

[Lascarides & Copestake, 1997] Alex Lascarides and Ann Copestake. Default representation in constraint-based frameworks. University of Edinburgh and Stanford University, URL `http://www-csli.stanford.edu/~aac/papers/yadu.ps.gz`, 1997.

[Malouf, to appear] Robert Malouf. Mixed categories in HPSG. In Robert D. Borsley, editor, *Syntactic Categories*. Academic Press, New York, to appear. URL `http://hpsg.stanford.edu/rob/papers/gerund.pdf`.

[Manning, 1996] Christopher D. Manning. *Ergativity: Argument Structure and Grammatical Relations*. CSLI Publications, Stanford, 1996.

[Manning & Sag, 1995] Christopher D. Manning and Ivan A. Sag. Dissociations between argument structure and grammatical relations, 1995. Paper presented at 1995 HPSG Workshop, Tübingen.

[Miller & Sag, 1997] Philip Miller and Ivan A. Sag. French clitic movement without clitics or movement. *Natural Language and Linguistic Theory*, 15:573–639, 1997.

[Pinker, 82] Steven Pinker. A theory of the acquisition of lexical interpretive grammars. In Joan Bresnan, editor, *The Mental Representation of Grammatical Relations*, pages 655–726. MIT Press, Cambridge, 1982.

[Pinker, 89] Steven Pinker. *Learnability and cognition*. MIT Press, Cambridge, Ma, 1989.

[Pollard & Sag, 1994] Carl Pollard and Ivan A. Sag. *Head-Driven Phrase Structure Grammar*. University of Chicago Press and CSLI Publications, Chicago and Stanford, 1994.

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

[Searle, 1969] John Searle. *Speech Acts*. Cambridge University Press, Cambridge, 1969.

[Wechsler, 1995] Stephen Wechsler. *The Semantic Basis of Argument Structure*. CSLI Publications, Stanford, 1995.

Chapter 23

Looks like a Trojan horse got into the argument structure

EMILY BENDER AND DAN FLICKINGER

ABSTRACT. This paper establishes the existence of three previously unrecognized complementizers in modern English and uses them to construct a historical argument supporting the need for a DEPENDENTS attribute within the Head-driven Phrase Structure Grammar (HPSG) framework.

1 Introduction

In this paper we argue that the closed class of complementizers in English has more members than previously thought,[1] and that the historical development of the additional members lends support to recent proposals within the Head-driven Phrase Structure Grammar framework ([Pollard & Sag, 1994]) for placing adjuncts on a DEPENDENTS list with complements. Our hypothesis is that these complementizer phrases (CPs) started historically as adjuncts with meaning similar to that of a neighboring complement, then in Trojan horse fashion, took advantage of their position on the DEPENDENTS list to supplant that complement in the argument structure.

The complementizers in question are *as if, as though,* and *like*, as illustrated in the following examples.

(23.1) a. It appears as if Kim will be late.
b. It sounds as though Kim will be late.
c. It looks like Kim will be late.

In section 2 we will present evidence that these phrases are, in fact, complementizers. Section 3 outlines their historical development and shows how an analysis of adjuncts as dependents leads to a natural modeling of that development.

[1]To our knowledge, no one has previously identified the three we discuss, not even [Quirk et al., 1985].

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Gosse Bouma, Geert-Jan Kruijff & Richard Oehrle (editors).

2 Evidence of complementizerhood

In this section, we will first establish that phrases marked by *as if* etc.,[2] are indeed selected complements of the verbs they follow. We take this to be a necessary condition for complementizer status. We then turn to some semantic evidence for such a categorization.

There are several fundamental differences between complements and adjuncts relevant to this discussion. The first is that complements can fill an argument role in the semantics of the selecting head, while adjuncts never do. Another is the direction of selection: heads select for their complements, while adjuncts select what they will modify. A third is that extraction from complements is less constrained than extraction from adjuncts. And a fourth difference is a semantic one, which comes to light in how certain ambiguous sentences react to syntactic, semantic, and pragmatic manipulation. On all of these criteria, certain uses of *as if* phrases qualify as complements rather than adjuncts.

A corpus search of North American newspapers[3] and 18th to early 19th century English prose fiction[4] was undertaken to discover which verbs might be taking *as if* phrases as complements. The following list of verbs was compiled on the basis of frequency of coocurrence with *as if* phrases and of the apparent intended meanings of attested examples involving the verbs and *as if*.[5,6]

(23.2)

Verb class	Members
Verbs of perception	look, seem, appear, sound, feel, strike
Verbs of deception	make, behave, act, go about, shew, feign, pass off, make believe
Verbs of insinuation	hint, intimate, insinuate
Verbs of construal	understand, consider, construe
Verbs of caring	think of, treat, love, feel for, bring up, look after
Verbs of expression	talk, write, speak

As the verbs of perception can appear with expletive subjects, they can be used to show that *as if* phrases are complements by the first criterion. In (23.1) and (23.3), the only phrase that could be filling an argument position of the verb is the *as if* phrase.

(23.3) She was all Joy, and new Transport to see him; 'twas *as if* she had never been in pain. (M. Manley, *The New Atlantis*, 1709)

[2]Henceforth, the term '*as if* phrases' will be used to refer to phrases headed by *as if*, *as though* and *like*.

[3]From the North American News Text Corpus, available from the Linguistic Data Consortium at www.ldc.upenn.edu.

[4]In Stanford University's Academic Text Service's collection.

[5]*As though* is somewhat less frequent than *as if* in the corpora, from the earliest uses of these constructions. It is attested for at least one verb in each class except for the verbs of insinuation and construal. Since *like* is both harder to search for and more recent, this list is based on *as if* and *as though*. The similar distribution of *like* may be established on the basis of native speaker intuitions.

[6]The verb *be* is also attested in such uses. We take this case to be less interesting, however, as *be* will take as complements many kinds of phrases that most verbs will not.

Given that most semantic predicates introduced by verbs have at least one argument position, the *as if* phrases must fill those argument positions. Since being a selected complement is a necessary condition for filling a semantic argument position, these phrases must be complements and not adjuncts.

The second criterion is selection. All through their history, these phrases have been able to function as modifiers. In their role as modifiers, they are relatively unselective, and appear with a wide variety of verbs, including all of the verbs listed in (23.2) above. This is illustrated in (23.4). Notice that in these sentences, the subcategorization requirements of the verbs are filled with other material:

(23.4)
a. Kim seems sad, as if something bad has happened.
b. Kim appears to be happy, as though today were a holiday.
c. Kim sounds angry, like we did something bad.
d. Kim hinted that there would be a test tomorrow, as if there could be a test on a holiday.
e. Kim strikes me strongly as likely to win, as if I had some premonition.
f. Kim treats Bob like a brother, like the world would end if anything happened to him.

On the other hand, it is only a small set of verbs that can take *as if* phrases as complements, and semantically similar verbs can show different behavior in this regard. Of the verbs listed in (23.2), the verbs of perception, except for *strike*, the verbs of deception, and the verbs of expression can be shown by either the first criterion or the third (see below) to take *as if* phrases as complements. The verbs of insinuation and *strike (one)* are attested in 18th-19th century prose fiction in suggestive examples, but are no longer grammatical with *as if* complements.[7,8] (23.5) gives examples of these verbs from the 18th-19th century corpus.

(23.5)
a. You seem to hint, as if you were to be in Town soon. (M. Davys, *Familiar Letters betwixt a Gentleman and a Lady*, 1761)
b. It strikes me as if it would do exactly. (J. Austen, *Mansfield Park*, 1814)
c. I must put in a Caution however, here, that you must not understand me as if I let my Friend the Quaker into any Part of the Secret History of my former Life; (D. Defoe, *Roxana*, 1724)

As shown in (23.4), *as if* phrases are relatively unselective as adjuncts. That only a small class of verbs allows what, on the strength of other tests, we are calling the complement use shows that the direction of selection in those cases is from the verb to the *as if* phrase. Thus, the second criterion adds its weight to the conclusion that they are complements.

The third distinction between adjuncts and complements involves the possibility of extraction from the phrase in question; extraction from complements is

[7] The judgment of ungrammaticality is supported by the fact that the sentences now sound archaic, and by the fact that the collocations are not attested in the modern newspaper corpora studied.

[8] As for the other verbs in (23.2), it is difficult to determine whether *as if* phrases following them are adjuncts or complements.

quite generally possible, while extraction from certain adjuncts is highly restricted. Consider the contrast in grammaticality for the following two examples:

(23.6) a. The president that he looked as if he was imitating was Ford.
b. *The president that he fell as if he was imitating was Ford.

In the second, ungrammatical example, the *as if* clause is clearly an adjunct modifying the intransitive *fell*, and here the extraction of the object of *imitating* is blocked. In the first example, the extraction of the object is fine, as predicted on our account where this *as if* phrase is a complement of the verb *looked*.

Our fourth argument is based on a class of ambiguous sentences involving *as if* phrases. In each case, one reading is licensed by a structure in which the *as if* phrase serves as a complement, and the other by a structure in which it serves as a modifier. The ambiguity of sentences such as (23.7a) alone is intriguing. More telling, however, is that these sentences retain or lose readings due to syntactic, semantic, and pragmatic effects in a way characteristic of the structures we have posited.

The syntactic effect is illustrated in (23.7) and (23.8).

(23.7) a. She behaved as though she expected to get a cookie.
b. As though she expected to get a cookie, she behaved.

(23.8) a. He started to talk as if he already felt the effects of the drug.
b. As if he already felt the effects of the drug, he started to talk.

The (a) examples have both the modifier reading and the complement reading, while the (b) examples have only the modifier reading. This suggests that while modifier *as if* phrases can appear with the expected free distribution of adjuncts, the one route to sentence initial position open to complements – viz., extraction – is not available to *as if* phrases. Here the *as if* phrases pattern with complementizer phrases headed by *whether* and *for*, leaving only *that*-phrases eligible for fronting in topicalized constructions:

(23.9) a. Kim wondered if Sandy would stay.
*If Sandy would stay, Kim wondered.
b. Kim wanted very much for Sandy to stay.
*For Sandy to stay, Kim wanted very much.
c. Kim insisted that Sandy stay.
That Sandy stay, Kim insisted.

If both readings of (23.7a) and (23.8a) were based on structures where the *as if* phrases were modifiers, this contrast based on position would be entirely unexpected.

The semantic effect involves negative polarity items (NPIs), and is illustrated in the two examples in (23.10), which only have the intransitive reading.[9]

(23.10) a. She behaved as if anyone would notice.
b. He continues to talk as if anyone was listening.

[9]In these cases, the comma intonation following the verb is required, but in fact it is also strongly preferred for the intransitive readings for (23.7a) and (23.8a).

While a thorough explanation of this interaction with polarity phenomena is beyond the scope of this paper, these data do seem to support our hypothesis. If *as if*, etc. undergo a semantic change in becoming complementizers (as discussed below), then it is plausible that their NPI-licensing properties would also change. In that case, the complement structures are ruled out for these sentences on semantic grounds, and only the modifier structures, licensing the intransitive readings, remain.

Finally, we turn to the pragmatic effect, which plays on the fact that the different valences for *behave* and *talk* have slightly different meanings. By making the *as if* phrases pragmatically incompatible with the semantics of the intransitive variants of these verbs, we can create sentences with only the complement readings. Further evidence that this test is distinguishing between adjunct and complement readings comes from combining it with the syntactic test discussed above. As expected, the topicalized examples are infelicitous.

(23.11) a. He behaved as though he'd never been taught any manners.
b.#As though he'd never been taught any manners, he behaved.

(23.12) a. She talks as if the ice age ended in the eighth century.
b.#As if the ice age ended in the eighth century, she talks.

The above evidence establishes that *as if* phrases can be selected complements, which is one necessary condition for a categorization of *as if*, etc., as complementizers. In the remainder of this section we present some further evidence for this categorization, as opposed to the two other options: clause-taking preposition (like *before* or *after*), or subordinating conjunction (like *since* or *because*).

This evidence comes from the semantic contributions of the lexical items in question. The prepositions and subordinating conjunctions both introduce a two-place predicate into the semantics, as shown in (23.13).

(23.13) a. Kim left before Sandy arrived.
b. Kim has been here since Sandy arrived.

In (23.13a), the two arguments to *before*'s predicate are Kim's leaving and Sandy's arrival. Similarly, *since* takes Kim's presence and Sandy's arrival.

In contrast, there is no second argument for *as if/ ...* in (23.14).[10]

(23.14) It looks as if/as though/like Sandy will win.

One might think that the second argument is the 'looking', but as there is no way select the predicate of *looks* without its complement (*as if ...*), this would lead to a circular structure.

We conclude that in at least this kind of example (for another kind, see the discussion near (23.23) below), *as if*, etc. bear only a one-place predicate. As such, they are similar to *if* and *whether*, which bear the one place predicate of question semantics, as in (23.15).[11]

(23.15) Kim wonders if/whether Sandy left.

This constitutes further evidence that, in this use, *as if*, *as though* and *like* are complementizers.

[10] The first argument is Sandy's winning.

[11] See [Ginzburg & Sag, 1998] for a semantic framework for these complementizers which employs the notion of a specific *message* introduced in each clause.

3 Historical development

Having established that *as if*, *as though*, and *like* are complementizers, we come to the second point of the paper: The historical development of these lexical items lends support to recent proposals ([Przepiorkowski, 1997a], [Przepiorkowski, 1997b], [Bouma et al., 1997]) that put post-verbal adjuncts together with complements on a single list in the feature structure for signs. In particular, [Bouma et al., 1997] propose using a DEPENDENTS attribute for this list, distinct from both the usual VALENCE features and the ARG-ST attribute, and we argue here that such a structure lends itself to an account of how certain CPs in English converted from adjuncts to complements.

Because *as though* is rare throughout the historical corpora available, and *like* developed much later, we will concentrate in this section on the development of *as if* into a complementizer.

The first uses of *as if* in the Helsinki Corpus[12] which resemble those which we argue show it to be a complementizer do not show up until the late 1600s, although the phrase *as if* shows up in other uses much earlier. All of the examples in the Helsinki Corpus involve the verb *look*, and of these, only one (given in (23.16)) is a clear-cut case:

(23.16) I believe ye Parliament is like to sitt longer than was expected for ye differences between ye houses are so widened, and yett itt is so necessary they should come to some composure before they part that itt looks *as if* their sitting would yett bee of a month's continuance at least. (J. Sommers, letter to the Earl of Essex, June 1, 1675)

The example in (23.16) is a clear-cut case because the subject of *look* is an expletive.

There are two other possible examples, given in (23.17).

(23.17) a. I had forgot to tell you, that those who are nobly born of that country, are so delicately cut and raised all over the fore-part of the trunk of their bodies that it looks *as if* it were japan'd, the works being raised like high point around the edges of flowers. (A. Behn, *Oroonoko*, 1688)

b. The Fellow looks *as if* he were broke out of Bedlam. (G. Farquhar, *The Beaux Stratagem*, 1707)

In both of these examples, but especially in (23.17a) it appears that the sense of *look* involved is the one synonymous with *appear* (as opposed to the one similar to *glance*), which, according to the *OED* ([Simpson, 1992]) is attested as early as 1400. Since *look* in that sense otherwise takes as complements phrases that usually function as modifiers, it is plausible that it is also taking these *as if* clauses as complements. The innovation, then, is the extension to clausal complements.

There are no examples of *seem* taking an *as if* clause as a complement in the Helsinki Corpus; the *OED* cites the following example from 1673.

(23.18) Stay, there's a Dance beginning, and she seems as if she wou'd make one. (Dryden, *Love in Nunnery*, iii. ii, 1673)

[12] Available from ICAME at www.hd.uib.no/corpora.html.

Taking this as evidence that *look* and *seem* were the first verbs to take *as if* clauses as complements, how might that innovation have occurred? A possible path is suggested by the examples in (23.19), both from the same period of the Helsinki Corpus as the above examples:

(23.19) a. This seemed to be done in distrust of the privy council, *as if* they might stifle his evidence; which to prevent, he put in safe hands. (G. Burnet, *History of Charles II*, c.1700)

b. But methinks, the Seat of our Family looks like Noah's Ark, *as if* the chief part on't were design'd for the Fowls of the Air, and the Beasts of the Field.
(J. Vanbrugh, *The Relapse: Or Virtue in Danger*, c.1696)

In these examples, *seem* and *look* have their complement requirements saturated by other phrases; in each case the *as if* phrase is an adjunct. However, in (23.19b) the adjunct provides an elaboration of the semantic content supplied by the PP complement of *look*, where the PP and the adjunct phrase have a similar semantic type. Given the semantic compatibility, only the syntactic subcategorization constraints of *look* prevent the *as if* phrase from serving directly as a complement of the verb.

Now recent work on the treatment of post-verbal adjuncts within the HPSG framework provides motivation from several languages for a DEPENDENTS attribute in the signs for words and phrases. This attribute has as its value a list including both complements and post-head adjuncts, and provides the basis for improved accounts of phenomena including word order variation, scope, and distribution of clitics. On this account both complements and post-verbal modifiers are sisters of the verb under a single VP, subject to ordering constraints.

Following this approach, both *like Noah's Ark* and *as if the chief part ... Field* will be on the DEPENDENTS list of *looks* in the (23.19b) example, although only the former is semantically selected by *looks*. Further, as noted above, both express similar semantic information, and both have similar semantic types, namely two-place relations with both an internal and an external argument, where the external argument is filled by the subject in a predicative construction and otherwise by the modified phrase. Given this structure for the DEPENDENTS attribute of the lexical entry *look*, it would be a simple step of lexical reanalysis for the *as if* phrase to usurp the position of the existing predicative complement, giving rise to a new lexical entry for *look* which omits the old complement and instead links the semantically equivalent *as if* phrase from the DEPENDENTS attribute to its COMPS attribute.

In this newly added lexical entry, the syntactic dependency between the verb and the *as if* phrase has been reversed: the *as if* is now selected by the verb as its complement, opposite from the original structure in which the *as if* phrase selects for the verb phrase that it modifies. We assume that the semantic contribution of the *as if* phrase remained unchanged initially, since it was on the strength of its semantic similarity to the original predicative phrase that the *as if* phrase began its career as a complement.[13]

These new complements could not, however, have remained unchanged as semantic two-place relations, since in modern English they also occur in sentences with expletive subjects, where there is no second argument to fill the relation.

[13] This lexical reanalysis is clearly preferable to one requiring a change in the phrase structure of the construction, given our lexicalist view of language competence.

(23.20) a. "It doesn't seem like anything could tarnish Chemical Waste's growth prospects," she says. (*Wall Street Journal*[14])

b. It was then that Northrop filed suit against the Koreans – in what the House investigators claim was an attempt to make it look as if Northrop had been swindled. (*Wall Street Journal*)

Hence at least in these entries for *appear* and *seem* the *as if* phrase must be only a one-place relation semantically, and the simple additional change needed would be for *as if* to be reanalyzed as a complementizer like *that* and *whether*. Evidence consistent with this reanalysis can be found in the spread of expletive subjects through these constructions. An example illustrating an intermediate step, where the subject is not expletive but instead refers to the situation in general, is given in (23.21).

(23.21) Does not all this look as if some unseen power, who guides our actions, had set a ... (F. C. Sheridan, *Memoirs of Miss Sidney Bidulph* 1761)

4 Future work

There are, as expected, numerous lexical idiosyncrasies in the distribution of *as if* complementizer phrases in modern English, with some verbs taking a wide range of CPs, and others being much more highly restrictive.

(23.22) a. It seems as if Kim could win.
It seems that Kim has won.
b. It sounds as if Kim could win.
*It sounds that Kim won.
c. *It strikes me (as likely) as if Kim could win.
It strikes me (as likely) that Kim could win.

Such idiosyncrasy is to be expected given our lexicalist treatment of these *as if* phrases as subcategorized-for complements, but the nature of the constraints on selection in (b) and (c) is not clear. In general the selection of CP complements appears to be semantic, which suggests that the *as if* CPs introduce a semantic type distinct from *that* CPs, yet with a common supertype distinct from, e.g., interrogative CPs. More work will be needed to fit this distinction into a framework like that of [Ginzburg & Sag, 1998].

These novel complementizers also appear in at least one construction unlike those for the more familiar complementizers *that, whether*, and *for*. When there is a non-expletive subject of the higher verb, it tends to be coindexed with the subject of the CP:

(23.23) a. Sara seems as if she could win.
*Sara seems as if I could win.
b. Sara sounds like she's tired.
*Sara sounds like I'm tired.

[14]Excerpts from the *Wall Street Journal* are from 1989. The texts examined in this case were included in the raw text portion of the Penn Treebank II, available from the LDC at www.ldc.upenn.edu.

This coindexing with the subject is not obligatory, showing that there is not a simple control relation holding between the higher verb and the *as if* complement:

(23.24) a. They look like someone just died.
b. You sound as if I never mentioned this to you.
c. He acts like the whole world is against him.

However, these complementizers do appear in at least one construction which requires a raising analysis, with an expletive *there* subject in both the higher and lower clauses:

(23.25) a. There sounds like there's going to be a riot.
b. *There sounds like it's going to rain.
c. *There sounds like we've lost.

These examples provide additional evidence supporting the need for an AGR feature at the top phrasal node in a clause, carrying the agreement properties of the clause's subject, as argued in [Bender & Flickinger, 1998], since those agreement properties must be visible to the higher verb in the (23.25a) example. However, more work is needed to characterize the nature of the constraints on the higher verb's subject in the (23.23) and (23.24) examples.

5 Conclusion

In this paper, we have shown that the set of English complementizers includes three previously unrecognized members, and that the historical development of these complementizers supports recent arguments for putting complements and adjuncts on a single DEPENDENTS list in the lexical entry of the selecting head. We provided a brief sketch of how the reanalysis of *as if* phrases from adjuncts to complements and then to CPs may have taken place given these assumptions, and supplied data from historical and contemporary corpora which are consistent with our proposal.

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Bibliography

[Bender & Flickinger, 1998] Emily Bender and Dan Flickinger. Peripheral constructions and core phenomena. In Gert Webelhuth, Jean-Pierre Koenig, and Andreas Kathol, editors, *Lexical and Constructional Aspects of Linguistic Explanation*, pages 199–214. CSLI, Stanford, 1998.

[Bouma et al., 1997] Gosse Bouma, Rob Malouf, and Ivan A. Sag. Satisfying constraints on extraction and adjunction. Groningen University and Stanford University, 1997.

[Ginzburg & Sag, 1998] Jonathan Ginzburg and Ivan A. Sag. English interrogative constructions. Hebrew University of Jerusalem and Stanford University, 1998.

[Przepiorkowski, 1997a] Adam Przepiorkowski. On case assignment and adjuncts as complements. Tuebingen University, 1997.

[Przepiorkowski, 1997b] Adam Przepiorkowski. Quantifiers, adjuncts as complements, and scope ambiguities. Tuebingen University, 1997.

[Pollard & Sag, 1994] Carl Pollard and Ivan A. Sag. *Head-driven Phrase Structure Grammar*. Chicago University Press, Chicago, 1994.

[Quirk et al., 1985] Randolph Quirk, Sidney Greenbaum, Geoffrey Leech, and Jan Svartvik. *A Comprehensive Grammar of the English Language*. Longman, London, 1985.

[Simpson, 1992] John Simpson, Chief Editor. *Oxford English Dictionary Online*. Oxford University Press, Oxford, 1992.

Chapter 24

A Point-Based Event-Ontology for the Phonetics/Phonology Interface

PETRA WAGNER AND PETER KÜHNLEIN

ABSTRACT. Recent rethinking of the Phonetics/Phonology-Interface has come to drop the old notion of a syntactic relationship between both research domains and replaced it by a semantic one. However, it remained relatively unclear how this relationship ought to look like. Progress in diagrammatic reasoning provides a fruitful approach towards a mutually constraining interface description. But to utilise this tool we first have to argue that it is reasonable to suppose a common ontology of a certain variant for both fields of research. This is so, because the heterogenous logics-approach attempted here relies on the sharing of models.

1 Introduction

On June 13th 1998 Anna uttered, as an assent to a preceding utterance "Uh-hm"; this is often taken to be a positive feedback signal in German, which is her mothertongue. The sounds/air turbulences that left her mouth can be represented[1], at a low level of abstraction, as shown in Figure 24.1.

[1]In this section we will talk a lot about representations. This is intended to be a kind of case study and we hope that much of what can be said about representations can also be said about theories. This hope is based upon the fact that representations are (licensed by) parts of theories and thus strongly connected to them. We will switch back to talk about theories in the subsequent sections.

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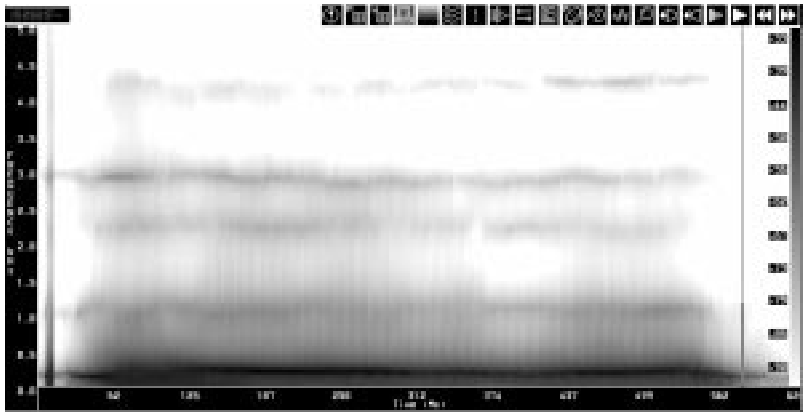

Figure 24.1: A spectral analysis of a sample utterance

Many alternative representations of the given utterance are possible, depending on the researchers' interest. An alternative phonetic representation is given in Figure 24.2.

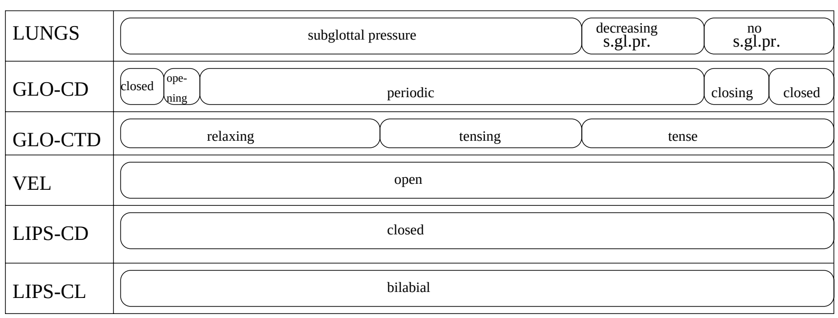

Figure 24.2: An articulatory representation of the same utterance as above

The representation in Figure 24.1 shows some properties of Anna's utterance in a different way than that in Figure 24.2, e.g., beginning and end of the utterance etc. Moreover, the representation in Figure 24.2 shows *other* properties than that in Figure 24.1, e.g. the articulators involved. However, what may not happen, and cannot happen if the representations are correct, is that they contradict one another in showing differing instantiations of the *same* property. The same holds if a representation from a different field of research is involved, say, phonology. (Figure 24.3 shows a simple phonological representation of Anna's utterance.) They can not contradict each other because they are about the same objects.

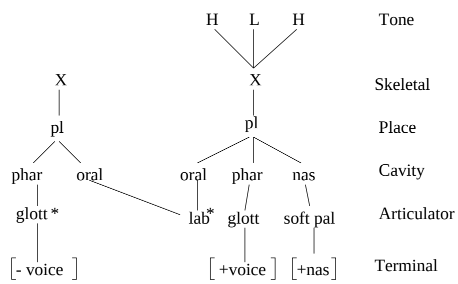

Figure 24.3: A phonological representation of Anna's utterance

This view is also expressed in Pierrehumbert's [11, 375] well-known paper:

> Both phonology and phonetics have the aim of describing and explaining the sound pattern of human language. Insofar as both are exact theories, both must provide exact representations of the sounds of language. But the work done by these representations is different.

We agree with Pierrehumbert on this aspect. What ought to be kept in mind is that the differences in description do not lie purely on the level of granularity but on the level of perspective. It may be an acoustic, auditory, articulatory or functional perspective, respectively. Now that we know what the differences are, something needs to be said about what all those different representations viz. the theories licensing them have in common. If we know this, we maintain, we have an answer for the interface-problem. But before we can discuss the questions related to this problem, in turn, we first have to make clear what the shared ontological commitments at stake are.

2 Ontology

So the question arises how the basic entities phonetics or phonology talk about should be construed. As it is up to now quite unclear which entities *the* scientific ontology has to comprise it is worthwhile to discuss the consequences of different commitments. A popular view (*inter alia* [4, 3, 2] postulates *events* as the basic ontological entities for both phonetics and phonology.) Events are elegant because they appear to capture important features of (interpretations of) both phonological and phonetic diagrams, like the beginning and ending of some represented unit. When interpreting a spectrogram, we talk about *simultaneity* of formant movements or of an occlusion phase *preceding* a release phase. When interpreting autosegmental diagrams, those constituents related via association lines are usually (unless they are subsegmental units) interpreted as being *temporally overlapping*, while units represented on the same tier, are conceived of as standing in a relationship of *precedence*[2]. In [6], the temporal interpretation of phonological representations is somewhat different. In this description, phonological heads (e.g. syllable nuclei) are temporally interpreted before non-heads (e.g. syllable onsets) and temporally

[2]For a detailed description of the temporal interpretation of the hierarchical and linear information inherent in autosegmental diagrams in terms of precedence and overlap, see [2]

overlap with those constituents they dominate. This interpretation also results in an event-based desription of phonological entities.
Two strategies concerning the status of events are possible. One is to say that events are entities in their own rights, the other to say they can be derived if other entities are assumed, most prominent among them instants. We vote for one version of the second option, a definition of events on the basis of beginnings and ends contra Bird [2] and in accordance with Coleman [6]. Bird's *formal* account is otherwise very much like our own, already rendered in Wagner [13].
The following discussion of viewing events as derivative of instants can be regarded as an answer to Bird's discussion of the issue.

2.1 Different notions of time

One reason for viewing events as ontological primitives is the need for phonological descriptions to remain temporally under-determined as opposed to phonetic events ([5, 2]). The necessity of defining different knowledge domains on the basis of different time domains has been defended by Carson-Berndsen [5]. She introduced the concept of *relative time* (typically) holding between phonological units as opposed to *absolute time* holding between phonetic units. We would not like to see a phonological description of an utterance to include information that a specific autosegment starts holding 200 milliseconds after the beginning of that utterance. In an approach where points of time stand in an ordinal relation to each other, this demand can be fullfilled. The argument for viewing an instant-based ontology not useful for phonological descriptions therefore seems to be based on a misconception of instants as necessarily referring to some point on an interval time scale. In many phonetic domains and applications (speech synthesis, labelling of speech signals), however, exact beginnings or endings of phonetic events need to be specified (even this may often be empirically difficult). In phonetic representations the (absolute) beginnings or endings cannot be ignored. Using a point-based ontology and leaving the temporal scale unspecified can thus serve for both descriptive levels.

2.2 Instants vs. atomic events

It seems to us that most of the arguments against point-based ontologies rely on the assumption, that points of time are temporally extended units, some kind of *atomic events* that cannot be further divided. However, if they are rather regarded as *cuts* or *instants* without having a temporal extension themselves—a view which was already put forward in Ducasse [7] against Russell [12]—at least part of these difficulties can be avoided[3].

2.3 Dynamic vs. stable events

Phonological event representations often abstract away from the dynamic movements of articulators, formants etc., which are a necessary ingredient in most phonetic descriptions. One could argue that those phonological events regard stable target configurations. An event-based description runs into problems when it tries

[3]For a more detailed discussion of this point, cf. [13].

to capture dynamic events that can be characterized by a constant change rather than a stable position.[4]

2.4 Cognitive Plausibility

Another argument mentioned by Bird is the apparent lack of cognitive plausibility of a point-based approach. According to him, it would take infinite processing time to recognise two events as preceding one another if they consisted of an infinite sequence of points. It is not clear, though, whether cognitive plausibility

- **is relevant**; after all we are engaged in determining the *nature* of (phonetic/phonological) events. It needs to be explained why their nature ought to be equivalent to the way they are cognitively processed.
- **is in favour of event-based ontologies** at all. One reason for our doubts is that it could very similarly be argued that it would take infinite processing time to recognise an event without ever determining the instant of its beginning or end or to produce one without ever starting to give motor commands.

3 Non-Reduction

Now that we have made clear what the basic entities in our ontology are, we have to explain how it happens that phonology and phonetics so often coincide in their predictions, or, to put it weaker, do not contradict each other.

A first proposal could be that phonology is reducible to phonetics and hence can not contradict the latter. Traditionally, a theory Θ_1 is called *reducible* to a (base-)theory Θ_0 iff the axioms of Θ_1 are (deducible from) theorems of Θ_0. We write $\vdash_{\Theta_0} \Theta_1$ for this. If one defends the view that phonology is reducible to phonetics, and has not an exotic view on reduction, this means that $\vdash_{\Phi_0} \Phi_1$, where Φ_0 is phonetics and Φ_1 is phonology, is supposed.

What makes this view attractive is that it complies with the classical view of all sciences being unified with Physics as the base-theory for all the other special sciences. It is generally accepted that correctness of the assumption that the physical work is closed is the legitimation for doing sciences the way we do. Clearly, phonetics is more often than phonology engaged in numeric measurements, hence it seems that phonetics is in a way closer to physics. This accounts for the hierarchy of theories with phonetics as a base-theory for phonology.

On the other hand, there are lots of problems in this view a solution of which is not so easy. One of these problems is that phonology, e.g., has in its vocabulary the expression "means", that is, at least one semantic expression, and it is not at all clear, how the bridge laws[5] mapping semantic expressions onto phonetic ones could look like if there are any.

So, though the view of a reductive relation between phonetics and phonology surely is attractive, it is by far not clear how (or if!) the reduction should be done.

[4] For a more detailed event definition based on instants and an explicit differentiation between dynamic and stable events see [15]

[5] We omit mentioning the bridge laws mapping the basic expressions of one theory onto that of the other from here on. It is clear that the reduction paradigm we have in mind is Nagel's from [10].

3.1 Semantic Cohesion

We defend another view on the relation; we hold[6] that

$$\nvdash_{\Phi_0} \Phi_1 \& \nvdash_{\Phi_1} \Phi_0 \tag{24.1}$$

But of course we take it that there is *some* relation between both sciences that prohibits that one contradicts the other. This is, under no circumstances may one of both state a fact that does not hold following the other.
Let us explain briefly: The idea is that there are models in which the laws of phonetics are true; if phonetics and phonology are correct and adequate (if their generalisations are right, or, as Pierrehumbert, p. 229 above, put it, if they are exact sciences) for the description of utterances, the set of models in which the phonetic laws are true is identical with the set of models in which the phonological laws are true. If this were otherwise, there were a contradiction between phonetics and phonology and one of them, or possibly both, had to be corrected. Note that this is in compliance with Pierrehumbert's [11, 380] characterisation of the relation between the two theories as a semantic one.
What we write for the fact that each model that satisfies Φ_0 satisfies Φ_1 as well is

$$\wedge_{\mathcal{M}}(\mathcal{M} \models \Phi_0 \Rightarrow \mathcal{M} \models \Phi_1) \tag{24.2}$$

So, to sum up, what we want from phonetics and phonology, and what we are sure they give us, is

$$\nvdash_{\Phi_0} \Phi_1 \& \nvdash_{\Phi_1} \Phi_0 \& \wedge_{\mathcal{M}} (\mathcal{M} \models \Phi_0 \Leftrightarrow \mathcal{M} \models \Phi_1) \tag{24.3}$$

where $\mathcal{M}$ is any standard Kripke model. This is what we talked about in the introductory remarks: Phonetics and phonology are about the same objects *and* they cannot contradict each other. If we conceive of events being modelled as relations between instants (the lesson from section 2), then it is clear how a language conforming to phonetics and phonology would look like.
It is interesting to see, what a reductionist account would say to our demand (24.2).

1. $\vdash_{\Phi_0} \Phi_1$ holds, i.e., Φ_1 can be deduced from Φ_0; hence it is necessarily the case that the set of models in which Φ_0 is true is not larger than the set of models in which Φ_1 is true: Theories are to be conceived of as conjunctions of axioms, hence each new axiom added will add new truth conditions to the previous ones.

2. Of course the other way round is not true on a reductionist's account, as $\nvdash_{\Phi_1} \Phi_0$ holds. To require $\vdash_{\Phi_1} \Phi_0$ would be grotesque in the context of (1); it would mean that the two theories collapsed and turned out to be one and the same theory. This could be the case with some theories, but surely is not the case with phonetics and phonology. And the relation between the two theories would rather be identity then reduction.

3. Hence it is no guarantuee that the two sciences are true in the same set of models. It is a matter of dispute whether one should require this, but it

[6]Indeed we do not hold a view quite as strong as what is defended here; we do not really want to say that we think that reduction is *impossible*, but only that it is *not necessary*. So what follows is too strong a claim and just put forward to take the strongest possible position here.

> seems to us that correctness and completeness together are hallmarks for good theories. Completeness alone will not do, as the theory will render too many theorems as true.

So it seems to us, that our demands concerning identity of the sets of models is justifiable and that a reductionist account would do only half of the work[7].

3.2 Interlingua

Barwise & Etchemendy [1] discuss the question, whether in such a case where two languages describe the same set of models it is necessary to have a third language translating the other ones in order to be able to co-ordinate the mutual constraints. Of course, Barwise & Etchemendy have some different problem in mind, namely co-ordinating diagrammatic inferences with inferences drawn in a propositionally represented format. But it is clear that, as the models used in the heterogenous logic paradigm are Kripke models for first-order logic and PL1 is complete for these models, all inferences drawn in the diagrammatic notation are expressible in PL1. Hence, if one chooses a proper weakening of PL1 with just the expressions necessary to formulate the diagrammatic inferences and another weakening of PL1 to capture what is written in the propositional format, there is a merge of both weakenings that is capable of expressing both of the theories and that is PL1-expressible.
We consider phonetics and phonology as weakenings of a first order language. So, in this sense our problem is analogous to Barwise & Etchemendy's. Now, the authors come to the conclusion that it is possible to find a translating language but that it is superfluous as it adds nothing—it is just the merge from the last paragraph.
Indeed, we as phoneticians or phonologists do not need an interlingua, either. We can do, say, phonology without looking over the fence. But as *theorists* and as people implementing linguistic knowledge we are bound to respect both fields of research. That is, we have a division between the *interface* that works without any interlingua and the *description of the interface* in our logical language.
As we understand Barwise & Etchemendy, one can look at formulae and depictions, together with their truth conditions, as being *restrictions over admissible models*. This, as they show, does all that is needed: Given inference rules for both notational systems, we can derive all valid formulae and, given the interpretations of the formulae, can find all the admissible models. No one working with constrained based grammars should be too surprised by this view[8]. So, let a language be a notational system plus interpretation. The set of models admissible for both notational systems plus their interpretations, i.e., for both languages, is just the intersection of both of the sets of models. In Tarski's terminology, it is just the set of sequences of objects that satisfy both languages. The same holds *mutatis mutandis* for the models that satisfy singular expressions in either format. This is the skeleton of what we do with phonetics and phonology.

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[7] An aside: What was said up to now is partially compatible with reductionism; if we wanted to help the reductionist, we could lend him the third conjunct, i.e. 24.2.

[8] Neither should anyone working with dynamic logics: Restrictions over admissible models accumulating during discourse is exactly the idea behind conjunction in DPL [8] and the construction algorithm in DRT [9]. E.g, the definition for the semantics of conjunction in DPL is $[\![\phi \wedge \psi]\!] =_{df} \{\langle g, h\rangle \,|\exists k(\langle g, k\rangle \in [\![\phi]\!] \& \langle k, h\rangle \in [\![\psi]\!])\}$, where k is a restricted assignment function relative to g.

4 Conclusion & Perspectives

We got

- from section 2 the result that we can have a common ontology for phonetics and phonology;
- from section 3 that if we have a common ontology, there are mutual constraints between both of them and the possibility to describe them in a unified format, the interlingua.

We did not yet exhaust the potential of the heterogenous logics; up to now we only concentrated on the basic feature of mutual restrictions between theories. The proposed view, however, can be augmented and fruitfully applied in phonology or phonetics alone: Heterogenous logics provide means to formalize the relation between the diagrams and text in both areas *themselves*. This, however can not be done here.
Another result of our treatment of the interface is that the relation between the representations in phonology and in phonetics can be described. One of the reviewers, to all of whom we are indebted for their inspiring comments, wrote that we could as an alternative to our methodology view phonetic representations as models for phonological representations. And, yes, this was what we had in mind when we chose the heterogenous logics approach. Unfortunately, due to restrictions by space, here, we cannot show what we achieved up to now in this area. In short, we include the representations in the set of models and get a fancy ontology for our descriptive apparatus.
In the end one might ask what is the practical outcome of such a relation on things for the working linguist? Basically, we say that phoneticians and phonologicians need not work on conflating their theories into one or try to deduce representations of the other kind via complicated rule systems. All they need to take care of is to make sure that their descriptions of objects do not contradict the ones given by other theories concerned with the sound structure of the language in question. So, we can expect with the ongoing research of both disciplines that scientific progress will not only affect ones own but also the neighboring discipline. One could thus think of phonetics and phonology as mututally constraining each other and this insight may prove productive in constraint-based grammar architectures which want to concern themselves with speech as well as language. The core idea of this approach has already been applied to a practical implementation in the small domain of German Discourse Particles (see [14]) and will be extended to larger domains in the future.

Bibliography

[1] Barwise, J. and J. Etchemendy (1995). Heterogenous Logic. In Chandrasekaran, B., Glasgow, J., & Narayanan, N.H., editors, *Diagrammatic Reasoning*, MIT Press, 1995.

[2] Bird, S. (1995). *Computational Phonology. A constraint based approach.* Studies in Natural Language Processing. Cambridge University Press.

[3] Bird, S. and Klein, E. (1990). Phonological Events. *Journal of Linguistics 26*, 33–56.

[4] Browman, C. and Goldstein, L. (1992). Articulatory Phonology: An Overview. *Phonetica 49*, 219–252.

[5] Carson-Berndsen, J. (1997). *Time Map Phonology—Finite-State Models and Event Logics in Speech Recognition*. Text, Speech and Language Technology Series, Volume 5. Dordrecht, Holland: Kluwer Academic Publishers.

[6] Coleman, J. (1992). The phonetic interpretation of headed phonological structures using overlapping constituents. *Phonology 9*, 1–44.

[7] Ducasse, C.J. (1926). On the nature and the observability of the causal relation. *Journal of Philosophy 23*, 57–68.

[8] Groenendijk, J. and Stokhof, M. (1991). Dynamic Predicate Logic. *Linguistics and Philosophy 14*, 39–100.

[9] Kamp, H. and Reyle, U. (1993). From Discourse to Logic *Introduction to Modeltheoretic Semantics of Natural Language, Formal Logic and Discourse Representation Theory.* Studies in Linguistics and Philosophy, Vol. 42, Kluwer AP.

[10] Nagel, E. (1961). The Structure of Science. Harcourt, Brace & World.

[11] Pierrehumbert, J. (1990). Phonological and phonetic representation. *Journal of Phonetics 17*, 231–278.

[12] Russell, B. (1913). On the notion of cause. *Proceedings of the Aristotelian Society 13*, 1–26.

[13] Wagner, P. (1997). *Phonologie und automatische Sprachsynthese.* M.A. Thesis, University of Bielefeld.

[14] Wagner, P. (1998a). *Parametric Synthesis of Multilinear Phonological Representations: Logical and Computational Aspects.* Abstract of Talk held at the Workshop on Computational Phonology at the 31st Poznan Linguistics Meeting. `http://coral.lili.uni-bielefeld.de/~berndsen/PLM/pw.html`

[15] Wagner, P. (1998b). *Mutual Constraints at the Phonetics-Phonology Interface.* To appear in: Proceedings of the 4th KONVENS Conference of Natural Language Processing.

Chapter 25

How to Match the Mismatch

Prosody–Syntax Interface for Japanese Spoken Sentences

KEI YOSHIMOTO

ABSTRACT. One of the most difficult problems in processing Japanese prosody from a compositional point of view is to deal properly with two kinds of information from mismatching sources. This paper addresses the issue by proposing an alternative, modular approach that integrates information from two syntactic sources on the basis of the typed unification formalism. It is argued that the proposed method is superior to the PSG–based ones in its simplicity.

1 Introduction

Sentential prosody in Japanese is a result of interplay between various factors such as phonology, morphology, lexicon, and different parts of syntax. Accordingly, it serves as a test of the effectiveness and conciseness of grammar specification. In particular, it instances a case of 'bracketing paradox' in that the constituent structure required by semantics is inconsistent with the grouping manifested by prosody. This paper addresses the issue by proposing a modular approach integrating information from two inconsistent syntactic sources on the basis of the typed unification formalism. A comparison is also drawn with the approaches proposed so far in terms of complexity.

2 Prosody in Japanese

2.1 Accentual Phrase

In the construction of Japanese prosody, an essential part is played by a tonal domain that has been traditionally referred to as BUNSETSU and which I will call ACCENTUAL PHRASE (AP). It contributes partly to the disambiguation of lexical meanings and partly to the delimitation of phonological phrases — pauses are inserted at the beginning and end of the AP, and the part near the end of the AP tends to be weakened and devocalized.

Each AP exhibits either a tone pattern with a sharp fall from high pitch or a pattern without a fall. The first is phonologically interpreted as ACCENTED (the accented mora is marked by '´' in the following examples) and the second as UNACCENTED. An AP is formed by recursively attaching a closed–class GRAMMATICAL WORD, i.e. a postposition, clitic complementizer, or conjugational ending, to an open–class FULL WORD, i.e. a noun, verbal or adjectival stem, or adverb.

Sentence (1a) is segmented into three AP's as shown in (1b).[1]

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(1) a.

[[[[kirei–	na]$_{ADJ}$	[ie]$_{N}$	[ga]$_{P}$]$_{NP}$	[deki–]$_{V}$]$_{S}$	[ta]$_{AUXV}$]$_{S}$
beautiful	COPL–ADNM	house	NOM	be built	PAST

'A beautiful house was built.'

b.

[kirei–	na]$_{AP}$	[ie	ga]$_{AP}$	[deki–	ta]$_{AP}$
FULLW	GRAMW	FULLW	GRAMW	FULLW	GRAMW

Note that there is an obvious discrepancy between this way of segmentation and the conventional parsing indicated in (1a); if Phrase Structure Grammar without feature constraints is to be used, the two parsings cannot be derived by a single set of PS–rules, but two independent sets of PS–rules are necessary. So far, speech processing researchers have adopted analyses based on the AP like (1b), referred to as A–STRUCTURE in this paper, while NLP researchers, syntacticians, and semanticists have employed the semantics–oriented syntactic structure as shown in (1a), which is inconsistent with A–Structure and called C–STRUCTURE in this paper. Strangely enough, these two groups have either neglected each other completely or argued for predominance over the other, little thinking that coexistence of the two structures may provide a more reasonable linguistic framework.

2.2 Metrical Boost

[Kubozono, 1987] has shown in his phonetic experiments that when two adnominal adjuncts modify a noun, a second adjunct directly modifying the noun has a higher f_0 peak than a second adjunct modified by the first adjunct. He calls this phenomenon METRICAL BOOST. In the following examples,

(2) a.

[aói	[**óokina**	méron]]
green	big	melon

'a green, big melon'

b.

[[aói	**rémon**]	no	niói]
green	lemon	GEN	smell

'the smell of a green lemon'

the peak of the AP *óokina* in (2a) is higher than that of *rémon* in (2b). Furthermore, in phrases with three adjuncts, the second adjunct receives the highest pitch value when it is the first constituent in the right branching and is located deepest in the tree.

[Choi, Satō & Min, 1995] also observe a similar difference in peaks of adverbial phrases modifying a verb. In a structurally ambiguous sentence in which an adverbial phrase modifies either an embedded verb or a matrix verb, the contour slope immediately after the adverbial phrase in the latter case is significantly steeper than that in the former. Evidently, Japanese native speakers make use of a pitch boost after an adjunct in disambiguating such ambiguous sentences. Moreover, Choi, Satō and Min give a typologically noteworthy report: Korean, Mongolian, and Turkish also employ prosodic means to disambiguate the meaning of sentences with structures parallel to their Japanese example. In these languages, however, duration of vowels and pauses play a more important role than a pitch contour.

The observations cited above show that in various languages the semantics–based syntactic structure must be inevitably taken into account in modeling prosody.

Accordingly, it is of both theoretical and practical importance to propose a linguistic framework that succinctly specifies the interplay of both prosodic and syntactic information. By contrast, the Japanese sentential prosody has hitherto been derived exclusively on the basis of what I call A–Structure which only involves a sequence of regular expressions.

3 A Modular Approach to Prosody

3.1 A CUG–based Solution

[Whitelock, 1991] proposes to handle the 'bracketing paradox' in Japanese sentential structures within the framework of Categorial Unification Grammar [Uszkoreit, 1986]. He posits phrase structure rules to form structures that are a result of a compromise between A–Structure and C–Structure. Then he stipulates prosody–related information by feature constraints. Figure 25.1 depicts how the PSG rules analyze the subject NP *kirei–na ie ga* (a beautiful house–NOM) consisting of two AP's in example (1a–b).

This set of rules assigns a parsing tree deviating from the standard ones (see (1a)), whenever combination of two adjacent words is given priority for the sake of forming an AP. This happens when the phrase to be formed is made up of multiple AP's (as in *kirei–na ie ga*) and the grammatical word (e.g. *ga*) first concatenates with just one full word, possibly followed by (a) grammatical word(s), which stands immediately to the left of it (e.g. *ie*).

In order to produce such syntactic structures partly reflecting A–Structure, FORWARD COMPOSITION, BACKWARD COMPOSITION, and BACKWARD TYPE–RAISING rules are posited.[2] In Figure 25.1, the noun *ie* (house), to which a category N is assigned in the lexicon, is turned into N\(N/N) in order to be combined with *ga* by the Backward Type–raising rule below (application of the rule is indicated by **BT** in the Figure).

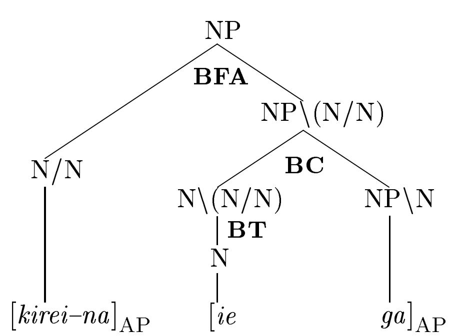


Figure 25.1: Analysis of *kirei–na ie ga*

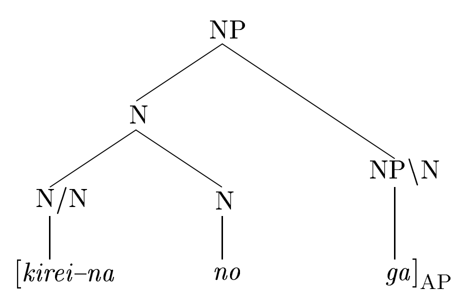


Figure 25.2: Analysis of *kirei–na no ga*

(3) Backward Type–raising: $T\backslash(T/X) \Leftrightarrow\!\!\rightarrow X$

Instead of cancellation rules standard in Categorial Grammars, here I lay down the rules in the form of PS–rules. N\(N/N) in turn can be paired up with NP\N, the category of *ga*, by the Backward Composition rule (indicated by **BC** in the Figure):

(4) Backward Composition: $X\backslash Z \Leftrightarrow\!\!\!\rightarrow Y\backslash Z \;\; X\backslash Y$

In applying this rule, an AP status is given to the phrase *ie ga* as a result of feature unification. Furthermore, the Backward Functional Application rule (**BFA** in the Figure) is used to concatenate the two AP's into an NP.

One of the problems with the approach by [Whitelock, 1991] is that its syntactic structure does not reflect the semantic structure (i.e. C–Structure) faithfully and cause counterintuitive complications. For example, a noun phrase (5) undergoes an analysis in Figure 25.2 which is different from that in Figure 25.1 for the NP *kirei–na ie ga*, although both phrases are of the same C–Structure. This is because the nominalizer *no*, in spite of being a head semantically, is phonologically dependent on the adnominal full word immediately before it, unlike normal nouns, and accordingly the Backward Type–raising rule is not applied.

(5)	kirei–na	**no**	ga
	beautiful–COPL–ADNM	NOMINALIZER	NOM
	'a beautiful one–NOM'		

Evidently, the Composition and Type–raising rules are an artefact of the grammar architecture to serve as an interface with the phonological structure. It is true that we need an interface; however, it must be examined where it should be posited and how it should look like.

Besides the Composition and Type–raising rules, this approach increases the number of syntactic rules. The PATR–II formalism Whitelock adopts necessitates each different set of feature constraints to be associated with an independent PS–rule. This means that the information on the metrical boost and other relevant phonological phenomena cannot be represented independently; rather, it must be repeated over all of the PS–rules. Combinatory Categorial Grammar by [Steedman, 1991], which adopts similar syntax to cope with English prosody, theoretically encounters the same kind of difficulties. I shall return to this point in 3.3.

3.2 A TU–based Approach

The solution I propose in this paper is to overcome the paradox by specifying two mutually independent modules of syntax. A sentence is given both a semantics–based structure, which corresponds to the C–Structure discussed in section 2, and a structure compatible with the phonological segmentation, an analogue of the A–Structure. According to this approach, every Japanese sentence is represented as follows:

(6)

$$
{}_{sentence}\left[\;\right] \Longrightarrow
\left[\begin{array}{ll}
\text{PHON} & \boxed{1} \\
\text{C-STRUCTURE} & \left[\begin{array}{ll}
\text{PHON} & \boxed{1} \\
\text{SYNTAX} & {}_{syntax}\left[\;\right] \\
\text{SEMANTICS} & \boxed{2} \\
\text{DTRS} & {}_{dtrs}\left[\;\right]
\end{array}\right] \\
\text{A-STRUCTURE} & \left[\begin{array}{ll}
\text{PHON} & \boxed{1} \\
\text{APS} & {}_{aps}\left[\;\right]
\end{array}\right] \\
\text{SEMANTICS} & \boxed{2}
\end{array}\right]
$$

One module (or type specification in Typed Unification formalism (hereafter TU formalism) by [Aït–Kaci, 1984]), the value of C–STRUCTURE in the feature structure above, corresponds to the ${}_{sign}[\;]$ in the standard version of HPSG, to which the Principles are applied to construct the semantic structure. The values of PHONOLOGY and SEMANTICS unify with those of the whole feature structure.[3] The module for the A–Structure builds a sequence of feature structures representing AP's, containing their pitch information. Although the two structures are not isomorphic, their PHONOLOGY information must be identical with each other (and with that of the total feature structure).

The metrical boost is also handled by the two syntactic structures. Figure A–1 in Appendix diagrams how this is done. In constructing this information, the module for the C–Structure calculates the location of adjunct words in the modification nesting. On the basis of the Head–Adjunct Schema [Pollard & Sag, 1994], the value of DEPTH is obtained. The specification below constrains the DEPTH value of the daughters to be larger than that of the mother by one.

(7)

$$
{}_{head\text{-}adj\text{-}str}\left[\;\right] \Longrightarrow
\left[\begin{array}{ll}
\text{C-STR} & \left[\begin{array}{ll}
\text{SYN|LOC|DEPTH} & \boxed{1} \\
\text{DAUGHTERS} & \left[\begin{array}{ll}
\text{ADJ-DTR|SYN|LOC|DEPTH} & \boxed{2} \\
\text{HEAD-DTR|SYN|LOC|DEPTH} & \boxed{2}
\end{array}\right]
\end{array}\right] \\
\multicolumn{2}{l}{\text{Condition:}\quad \text{add}(\boxed{1},1) = \boxed{2}}
\end{array}\right]
$$

The DEPTH value is used to obtain the RELATIVE–DEPTH value, an integer indicating how deep the word is located in the tree relative to the first word of the phrase. The RELATIVE–DEPTH value r_n of a word w_n with its depth value d_n is computed from the RELATIVE–DEPTH value r_{n-1} and the DEPTH value d_{n-1} of the preceding word w_{n-1} by the following formula:

(8) $r_n = r_{n-1} + (d_n \Leftrightarrow d_{n-1})$

The RELATIVE–DEPTH value of the initial word w_1 is 0.

Information on an AP is constructed by a type specification ${}_{ap}[\;]$ in the A–Structure by combining the phonological information of a full word with that of grammatical words. In forming an AP, the information on pitch is also achieved.

A function *get–boost* outputs the BOOST value of an AP from the RELATIVE–DEPTH value. BOOST values are 1, b1, and b2 ($1 < \text{b1} < \text{b2}$) when RELATIVE–DEPTH values are 0, 1, and 2, respectively. For convenience, the pitch value is represented in the TRANSFORMED VALUE by [Pierrehumbert & Beckman, 1988], a normalized value between 0 and 1 encoding relative tonal prominences, which can be inverted to the corresponding hertz pitch.

The transformed value is the product of the BOOST value by that of REGISTER. The latter value depends on whether the immediately preceding AP is accented or unaccented: the pitch range of an AP is lowered (i.e. CATATHESIS takes place, according to [Poser, 1984]) when the preceding AP is accented. Following [Pierrehumbert & Beckman, 1988], I model catathesis by multiplying the high–tone line (the upperlimit), on which particular tones depend, by the constant c (< 1), and this can be iterated within the same Intonational Phrase (IP), in order to cope with Poser's discovery.

(9)

$$ {}_{ap}[\quad] \Longrightarrow \left[\begin{array}{l} \text{PHON|APROPERTY} \begin{bmatrix} \text{REGISTER} & \boxed{1} \\ \text{REL-DEPTH} & \boxed{2} \\ \text{BOOST} & \boxed{3} \\ \text{TRANSFORM-VALUE} & \boxed{4} \end{bmatrix} \end{array} \right] $$

$$ \text{Conditions:} \quad \textit{get-boost}(\boxed{2}) = \boxed{3}, \quad \textit{multiply}(\boxed{1},\boxed{3}) = \boxed{4} $$

As an interface mediating information on the RELATIVE-DEPTH feature between the two syntactic structures, a full word, the main body of an AP and a syntactic domain shared by both of the modules, is defined as follows:

(10)

$$ {}_{\textit{full-word}}[\quad] \Longrightarrow \begin{bmatrix} \text{C-STRUCTURE|SYN|LOC|REL-DEPTH} & \boxed{1} \\ \text{A-STRUCTURE|PHON|APROPERTY|REL-DEPTH} & \boxed{1} \end{bmatrix} $$

The question may now arise why the A–Structure is not included in phonology. I regard it as a module in syntax, since, first, it is also indispensable in inserting interjections in colloquial speech. In the following utterance,

(11)	Kirei–	na	**ne**,	ie	ga	**ne**,	at–te	**ne**, ...
	beautiful	COPL–ADNM	INTJ	house	SBJ	INTJ	exist	INTJ

'There is, you see, a beautiful house, and ...'

the repetition of the interjection *ne* is used to 'draw the hearer's attention to something or to confirm that the hearer has understood what has been said up to that point' [Makino & Tsutsui, 1986]. This type of interjection can occur at any right–most position of an AP and accordingly must be combined with the preceding phrase in the A–Structure.

What is more, in colloquial speech any AP or a sequence of AP's can constitute an 'elliptical sentence', often accompanied by an auxiliary verb *da* especially in the latter case.

(12) a.	Dare	ni	nani	wo	age–	ta	n desu	ka?
	who	DAT	what	ACC	give	PAST	EXPL–POLT	INTR

'To whom did you present what?'

b.	Ken	ni	pen	wo	**da**.
	NAME	DAT	pen	ACC	COP

'To Ken a pen.'

Here is involved a sequence of AP's that does not constitute constituents, analogous to the structure in English discussed by [Steedman, 1991]. Nevertheless, the auxiliary verb *da* gives the utterance an independent sentence status by assigning it an assertive speech act meaning. In order to process such a sentence, we need a specification in syntax that explains the interaction between the A–Structure and C–Structure.

3.3 Comparison

As discussed in 3.1, the approach by [Whitelock, 1991] and [Steedman, 1991] is problematic in that they make counterintuitive complications by assigning structures as a kind of compromise between the A–Structure and C–Structure.

Equally important, this proposal increases the number of syntactic rules. Let K be a set of syntactic rules in the PATR–II formalism, L, M, and N sets of prosodic rules (represented as feature constraints attached to a syntactic rule) for the construction and concatenation of AP's, for metrical boost, and for catathesis. Then the total rules are a subset of $K \times L \times M \times N$. Roughly estimated, we need 6 rules for K, and 2 for each of L, M, and N. Since two of the syntactic rules are only applied to either a full word or a grammatical word, the number of rules we need is $4 \times 2 \times 2 \times 2 + 2 \times (1 \times 1 \times 2 \times 2) = 40$. Needless to say, these rules contain a lot of overlapping information. The large number of the rules and their redundancy make the theory less tenable and its implementation less encouraging owing to the difficulty in debugging.

According to my solution, repetition of the same kind of information can be completely avoided as a result of modularizing the grammar. Accordingly, the grammar to deal with the Japanese prosody is $K' \wedge L' \wedge M' \wedge N'$, where K' is a set of the HPSG Principles, and L', M', and N' are HPSG analogues of L, M, and N above. Again roughly estimated, the number of specificatons we need is $6 + 1 + 2 + 1 = 10$. Note that the difference between the two approaches gets even wider if other prosody–determining factors such as focus and the location of an accent is taken into account.

Thus, in my solution the two syntactic modules, represented as types which can independently produce feature structures, exactly reflect the C–Structure and A–Structure and as a result the number and complexity of rules can be reduced to a minimum. It refutes an argument by [Steedman, 1991, p. 262] that postulating two autonomous levels of structure 'complicates the theory considerably,' and his pessimistic expectation for communication between the two levels.[4, 5]

4 Paradox in Compounds

[Shibatani & Kageyama, 1988] have revealed that Japanese has a group of compound nouns which on syntactic criteria are interpreted as a single noun, but behave as two distinct words with respect to prosody — each element, separated by a short pause, maintains its own accent pattern. This contradicts the general condition that an AP is a domain larger than a word. More embarassingly, when one or more grammatical words follow a compound, they constitute an AP together with the latter part of the compound. Thus, the whole phrase is split into two AP's.

(13) a.	[**Hánshin**–]$_{AP}$	[**daishínsai**	wa]$_{AP}$
	the Osaka–Kobe area	great earthquake	TOPIC/CONTRASTIVE

b.	[**shinkúukoo–**]$_{AP}$	[**kensetsu**	ní	mo]$_{AP}$
	new airport	construction	DATIVE	ADDITIVE

CUG–based rules will have to handle this issue by producing a tree like the one in Figure 25.1:

(14) $[[\text{Hánshin–}]_{N/N}\ [[\text{daishínsai}]_{N\backslash(N/N)}\ [\text{wa}]_{NP\backslash N}\ ]_{NP\backslash(N/N)}\ ]_{NP}$

According to this analysis, first the latter part of the compound *daishínsai* is combined with the topic or contrastiveness marker *wa* and then the other part *Hánshin–* is concatenated with *daishínsai wa*.

This approach involves the same kind of difficulties as pointed out in 3.1 and 3.3 — it both complicates and increases syntactic and lexical rules. Still worse, it must face theoretical dilemmas: it neglects the word boundary between *Hánshin–daishínsai* and *wa*, and by so doing also neglects the distinction between the word and the larger syntactic domain. As [Kageyama, 1993] has elucidated, this distinction must be maintained strictly in Japanese grammar, because a morphological unit can only under very restricted conditions behave like a syntactic unit in terms of dislocation and modification of an inner element and anaphoric reference to its constituent.[6]

The framework I propose assigns a bimodular analysis to these cases. See Figure A–2 in Appendix. In order to gain this analysis, all we need is a lexical rule that produces a feature structure corresponding to the well–formed compound noun *Hánshin–daishínsai* from its two elements. The outcome of the rule is presented below.

(15)

$$\begin{bmatrix} \text{PHON} & \boxed{1} \\ \text{C-STRUCTURE} & {}_{n}\begin{bmatrix}\text{PHON} & \boxed{1}\\ \text{SEM} & \boxed{2}\end{bmatrix} \\ \text{A-STRUCTURE} & {}_{ip}\begin{bmatrix} \text{PHON} & \boxed{1} \\ \text{APS} & \left\langle \begin{array}{l} {}_{ap}\begin{bmatrix}\text{PHON} & \boxed{3}\left\langle\text{hánshin}\right\rangle \\ \text{FULLWD} & \begin{bmatrix}\text{PHON} & \boxed{3}\\ \text{SEM} & \boxed{4}\,\mathit{hanshin'}\end{bmatrix}\end{bmatrix}, \\ {}_{ap}\begin{bmatrix}\text{PHON} & \boxed{4}\left\langle\text{daishínsai}\right\rangle \\ \text{FULLWD} & \begin{bmatrix}\text{PHON} & \boxed{4}\\ \text{SEM} & \boxed{5}\,\mathit{daishinsai'}\end{bmatrix}\end{bmatrix} \end{array} \right\rangle \end{bmatrix} \\ \text{SEM} & \boxed{2}\end{bmatrix}$$

Conditions: $\mathit{append}(\boxed{3}, \boxed{4}) = \boxed{1}$
$\mathit{get\text{–}compn\text{–}sem}(\boxed{4}, \boxed{5}) = \boxed{2}$

Phrase (13a) undergoes the C–Structure analysis in Figure A–2, since the compound is defined as a single noun in the C–Structure in (15). There is no problem in assembling the A–Structure in the figure either, because the A–Structure in (15) is divided into two AP's, the latter of which can be freely suffixed by a grammatical word and form an independent AP. In this way, given (15), there exists no need to complicate syntactic or lexical rules or to blur the word/phrase distinction in order to obtain phrases such as (13a)–(13b).

5 Conclusions

A modular approach to a bracketing paradox in Japanese prosody has been proposed. Although Autolexical Syntax [Sadock, 1991] also assigns bimodular analysis to the cases in question, it recognizes as modules only those components, such as morphology, syntax, and semantics, in the conventional linear–hierarchical models of grammar; by contrast, my theory has enough flexibility to separate syntax into modules. Moreover, in my TU/HPSG–based approach each module has the ability to process information, which is a computer–linguistically advantageous property that Sadock lacks, drawing on Generalized Phrase Structure Grammar [Gazdar et al., 1985]. The difference in the two frameworks brings about different ways in defining an interface between two modules. Autolexical Syntax, in one hand, parses a sentence by applying two different sets of rules consecutively. Accordingly, an interface can be defined only at the sentence level (i.e. the constraint that the same string is accepted by the two sets of rules). According to my approach, on the other hand, an interface can reflect speakers' linguistic knowledge directly. For example, an interface, which is motivated by experiment results, can be deifined between an Intonational Phrase (IP), a domain smaller than a sentence and larger than an AP, and a C–Structure constituent.

An approach along these lines can resolve similar paradoxical issues found in other languages (see [Sadock, 1991]) in an effective and succinct way. At the same time, it offers an instance of to what extent the potential descriptive power of TU/HPSG can be exploited.

Notes

[**1**] Throughout this paper, a simplified, purely syntactic definition of AP is adopted. In fact, an AP may be a larger domain containing a number of units of the kind treated in this paper. In defining it, phonological factors must also be taken into account.

[**2**] I adopt here the terms by [Steedman, 1991] to explain how Japanese sentences are processed, for Whitelock's original explication is elliptical.

[**3**] In this paper, I follow the older version of HPSG [Pollard & Sag, 1987] in distinguishing the attributes SYNTAX and SEMANTICS.

[**4**] The PSG–based approach may be partly justified by its decidability. Since the intersection of two context free languages is not in general a context free language [Hopcroft & Ullman, 1969], either the C–Structure or A–Structure must be represented as feature structures, if the whole thing should be kept within a context free language. By contrast, the universal recognition problem for attribute–value grammars is undecidable [Johnson, 1988], which is the price we must pay for this expressive formalism. I agree, however, with the comment by [Johnson, 1988, p. 95] that 'formal undecidability results of the kind just presented might have only minimal importance for the study of human language processing.'

[**5**] An alternative approach is to avoid redundancy by generating the fullfledged PS–rules with feature constraints from a small set of ID rules and feature specifications on the basis of the Generalized Phrase Structure Grammar [Gazdar et al., 1985] framework. In this solution, the C–Structure is derived by PS–rules and the A–Structure is represented by feature structures. This line of study will not be further pursued in this paper. It should

be noted, however, that the simplicity in the rules is brought about by their resemblance to my TU/HPSG–based proposal.

[**6**] [Kageyama, 1993] also gives a similar analysis of the examples on the basis of GB, assuming that the compound formation takes place at the last stage of syntax. This analysis faces the same kind of difficulties as pointed out here.

Appendix

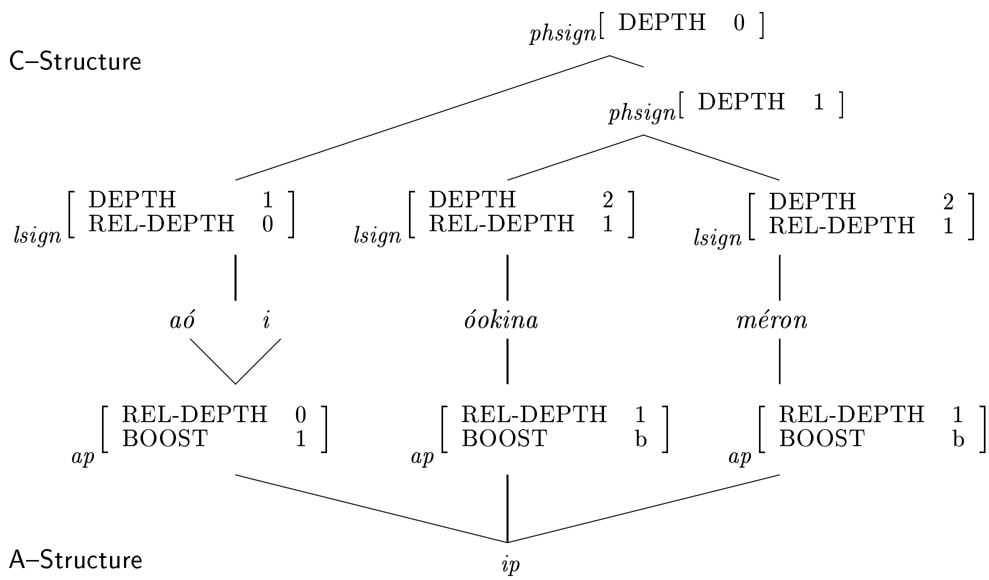
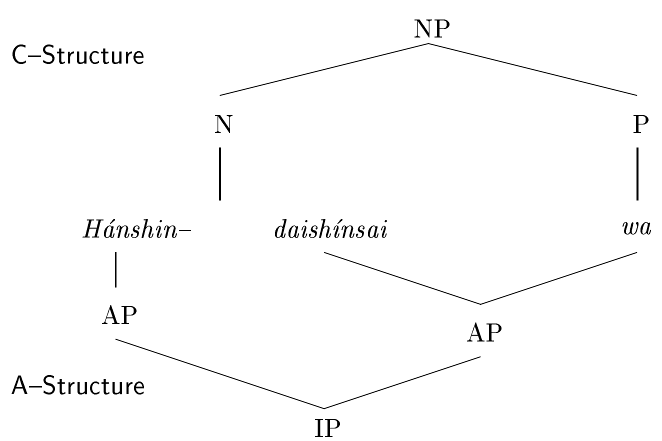


Figure A–1: Bimodular Analysis of Phrase (2a)



Figire A–2: C–Structure and A–Structure for (13a)

Bibliography

[Aït–Kaci, 1984] Aït–Kaci, H. (1984) "A Lattice–Theoretic Approach to Computation Based on a Calculus of Partially Ordered Types." University of Pennsylvania Ph.D. thesis.

[Choi, Satō & Min, 1995] Choi, Y.–S., S. Satō and G.–J. Min (1995) "Tōgo–teki ni Aimaina Bun no Seisei ni okeru Inritsu–teki Yōso no Bunseki (The Analysis of Prosody in Syntactically Ambiguous Sentences)." *Proceedings of the Phonetic Society of Japan 1995 Annual Convention.* 26–31.

[Gazdar et al., 1985] Gazdar, G. et al. (1985) *Generalized Phrase Structure Grammar.* Oxford: Basil Blackwell.

[Hopcroft & Ullman, 1969] Hopcroft, J., and J. Ullman (1969) *Formal Languages and their Relation to Automata.* Reading, Mass.: Addison–Wesley.

[Johnson, 1988] Johnson, M., (1988) *Attribute–Value Logic and the Theory of Grammar.* Stanford: Center for the Study of Language and Information.

[Kageyama, 1993] Kageyama, Tarō. (1993) *Bunpō to Go–Keisei.* Tokyo: Hituzi Syobō.

[Kubozono, 1987] Kubozono, H. (1987) "The Organization of Japanese Prosody." University of Edinburgh Ph.D. thesis.

[Makino & Tsutsui, 1986] Makino, S., and M. Tsutsui (1986) *A Dictionary of Basic Japanese Grammar*. Tokyo: The Japan Times.

[Pierrehumbert & Beckman, 1988] Pierrehumbert, J. B. and M. E. Beckman (1988) *Japanese Tone Structure*. Cambridge, Mass.: The MIT Press.

[Pollard & Sag, 1987] Pollard, C., and I. Sag (1987) *Information–based Syntax and Semantics.* Stanford: Center for the Study of Language and Information.

[Pollard & Sag, 1994] Pollard, C., and I. Sag (1994) *Head–Driven Phrase Structure Grammar*. Chicago: The University of Chicago Press.

[Poser, 1984] Poser, W. J. (1984) "The Phonetics and Phonology of Tone and Intonation in Japanese." Massachusetts Institute of Technology Ph.D. thesis.

[Sadock, 1991] Sadock, J. (1991) *Autolexical Syntax*. Chicago: The University of Chicago Press.

[Shibatani & Kageyama, 1988] Shibatani, M., and T. Kageyama (1988) "Word Formation in a Modular Theory of Grammar." *Language* **64**, 451–484.

[Steedman, 1991] Steedman, M. (1991) "Structure and Intonation." *Language* **67**, 260–296.

[Uszkoreit, 1986] Uszkoreit, H. (1986) "Categorial Unification Grammars." *Proceedings of COLING 1986*.

[Whitelock, 1991] Whitelock, P. (1991) "What Sort of Trees Do We Speak?—A Computational Model of the Syntax–Prosody Interface in Tokyo Japanese." Fifth Conference of the European Chapter of the ACL.

Chapter 26

Morphosyntactic Paradoxa in Fox

An analysis in linearisation-based morphology

Berthold Crysmann

Abstract.
In this paper[1], I shall discuss an apparent paradox in the morphology and syntax of Fox (Mesquakie)[2] complex verbs. In Fox, verbs can be modified by one or more of a variety of preverbs including modals, aspectuals, manner adverbials, numerals, quantifiers, as well as preverbs which increase the valence of the main verb ([Dahlstrom, 1997a]). While preverb and verb can be separated by words, phrases, or even embedded sentences, suggesting a status as syntactically independent words, inflection (cf. [Dahlstrom, 1997a]) and derivation (cf. [Ackerman and LeSourd, 1994]) appear to treat preverb-verb complexes as a single morphological unit. Following the basic assumptions of lexicalist syntax, I claim that Fox preverb-verb combinations are indeed morphologically derived and that inflectional affixes are attached to complex morphological objects in the word-formation component already. In order to account for the syntactic effects, I propose an analysis in Linearisation HPSG ([Reape, 1994], [Kathol, 1995]), which builds on the assumption that Fox preverb-verb complexes introduce more than one domain object into syntax (cf. [Kathol, 1996] for German, [Crysmann, 1997] for European Portuguese). Further morphological material will then be distributed across preverb and verb by imposing partial morphological (order) constraints on PHON-values.

1 Introduction

Fox verbal morphology is characterised by an extremely rich set of inflectional paradigms (26 in total, cf. [Goddard, 1994]), which encode syntactic (i.e. matrix vs. embedded) and semantic (e.g. tense) information. Within these paradigms, verbs are inflected for both subject and object agreement. Although in most paradigms, agreement information is realised by suffixation alone, some paradigms, e.g. the INDEPENDENT INDICATIVE, exhibit prefixation in addition to suffixation, with person and number agreement information being split between prefix and suffix.

(1) a. ne- nowi:
1 go.out

[1]This work has been financed by a scholarship from the Deutsche Forschungsgemeinschaft 'German Science Foundation' (DFG). Due to space limitations, discussion of the interaction between inflectional morphology and reduplication had to be omitted. I am gratefully indepted to Farrell Ackerman and three anonymous reviewers for their helpful comments. I would also like to thank my colleagues at the University of the Saarland, and, in particular, Martine Grice and Wojciech Skut, for discussing various aspects of the approach presented here.

[2]Fox (Mesquakie) is an Algonquin language spoken in Iowa. The data cited in this paper are based on [Dahlstrom, 1997a], [Dahlstrom, 1997b], and [Ackerman and LeSourd, 1994].

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'I go out'

b. ke- nowi:
2 go.out

'you(sg) go out'

c. nowi: -wa
go.out 3

'(s)he goes out'

d. ne- nowi: -pena
1 go.out (1)pl

'we(excl) go out'

e. ke- nowi: -pena
2 go.out (1)pl

'we(incl) go out'

f. ke- nowi: -pwa
2 go.out (2)pl

'you(pl) go out'

g. nowi: -waki
go.out 3pl

'they go out'

As the contrast in (1e,f) shows, person information cannot always be determined on the basis of the prefix alone: 1st plural inclusive and 2nd plural forms can only be distinguished on the basis of the suffix. In morphological terms, this can be seen as an instance of multiple exponence.

When the main verb is modified by a preverb, the prefix obligatorily surfaces on the preverb, and realisation on the main verb is blocked ([Dahlstrom, 1997b]). Similarly, the suffixal part of the person/number inflection can only appear on the main verb.

(2) a. i:tepi net- oči nowi: -pena
there 1 from go out 1pl(incl)

'We went out from there.'

b. * i:tepi oči ne- nowi: -pena

c. * i:tepi net- oči ne- nowi: -pena

Likewise, if the verb is modified by more then one preverb, the agreement prefix will only get realised on the first preverb with the suffix staying attached to the verb. As a first generalisation, we may conclude that verbs in the INDEPENDENT INDICATIVE are sandwiched between pieces of inflectional material, regardless of whether the verb is simple or complex.

In contrast to the INDEPENDENT INDICATIVE, some inflectional paradigms in Fox are identified by a change of the first vowel in addition to suffixation. INITIAL CHANGE only affects short vowels, replacing /a/,/e/,/i/ with a long [e:], and short /o/ with [we:].

(3) a. mahkate:wi: -č -i
fast 3 PLAIN CONJUNCT
'He would fast.'

b. mehkate:wi: -č -i
IC.fast 3 CHANGED CONJUNCT
'when he fasted'

c. mehkate:wi: -č -ini
IC.fast 3 ITERATIVE
'whenever he fasted'

d. a:kwi mahkate:wi: -č -ini
not fast 3 NEGATIVE
'He didn't fast.'

e. e:h- mahkate:wi: -č -i
AORIST fast 3 AORIST
'that he fasted'

If we have a closer look at the contrasts in (3), it becomes apparent that neither INITIAL CHANGE (glossed with IC) nor the mode suffix (*-i* vs. *-ini*) can be attributed a consistent interpretation on its own.

Again, in the context of preverb-verb combinations, INITIAL CHANGE affects the first vowel of the (first) preverb (4), parallel to the prefixes in the INDEPENDENT INDICATIVE (2).

(4) i:tepi we:či nowi: -č -i
there IC.from go out 3 CHANGED CONJUNCT
'when he went out from there'

Turning now to the syntactic distribution of these elements, we find that preverb and verb can be separated by an arbitrary amount of other syntactic material, including multiple words (5a), or even phrases (5b).[3]

(5) a. ne- ki:ši te:pi tasenwi kano:na:w -a
1 PERFECT enough so many times speak to 3/IND-IND
'I have spoken to him enough times.'

b. e:h ki:ša:koči: -či: -meko na:hka [na:wi -meko
AORIST extremely EXCLAM EMPH again middle of EMPH
nenoswahkiwe] sekiši -ki
buffalo herd lie 3/AORIST
'She was again lying in the middle of a buffalo herd.'

To conclude the description of the basic empirical pattern, it is safe to say that Fox confronts us with diverging evidence concerning the status of separable preverbs: under a morphological perspective, one is inclined to assume that preverb and verb constitute a single unit, while syntactic evidence suggests that preverb and verb should be conceived of as independent terminal nodes.

[3][Dahlstrom, 1997a] also presents an example in which an adjunct sentence intervenes between the preverb and the verb. For the sake of clarity, however, I omitted this datum, as the adjunct "sentence" — due to the polysynthetic nature of the language — only consisted of a finite verb.

2 The lexical status of preverb-verb complexes

The evidence which I have summarised in support of a morphosyntactic paradoxon might still be found to be not fully conclusive, especially when adopting the WEAK LEXICALIST HYPOTHESIS, which assumes that inflection, as opposed to derivation, takes place in syntax.

Interestingly enough, it has been shown by [Ackerman and LeSourd, 1994] that preverb-verb combinations can also be input to derivational processes. While some preverbs can be combined with both verbs and nouns, adverbial and aspectual preverbs are restricted to verbal contexts. Despite the general syntactic incompatibility of adverbs and nouns, adverbial preverbs do cooccur with deverbal nominalisations, as evidenced in (6):

(6) a. menwi pema:tesiwa
well live.3s
'He lives well.'

b. menwi pema:tesiweni
well live.NOMINALISATION.INANIMATE-S
'good life'

If we assume, with [Ackerman and LeSourd, 1994], that the whole preverb-verb complex is nominalised, rather than just the main verb which carries the derivational morphology, no exceptionality has to be stipulated.

Further evidence in favour of the morphological derivation of preverb-verb complexes has been contributed by [Goddard, 1990a, Goddard, 1990b]. First, with completive aspectual preverbs, some verbs are realised as a bound morpheme rather than as a separable word, while other stems, which do not possess such a bound allomorph, surface in the by now familiar separable preverb-verb construction.

(7) a. wi:seni -wa
eat 3s
'(s)he eats'

b. ki:s- -isenye: -wa
finish eat.suff 3s
'(s)he has finished eating'

c. meno -wa
drink 3s
'(s)he drinks'

d. ki:si meno -wa
finish drink 3s
'(s)he drinks'

To summarise, whether a given preverb-combination is realised analytically or synthetically, is partially a matter of lexical idiosyncrasy.

Second, Goddard discusses some cases where morphotactic constraints between certain preverbs determine analytic or synthetic realisation: while *we:pi* 'start' and *pemi* 'along' exist as both bound and free forms, *pemi* always precedes *we:pi* when the two are combined. Moreover, *we:pi* is realised as a bound morpheme in these cases. Obviously, surface order (and boundedness) disobeys semantic scope here:

(8) a. pem- ose: -wa
along walk 3s

'(s)he walks along'

b. pemi we:p- ose: -wa
along begin walk 3s

'(s)he begins to walk along'

c. * we:pi pem- ose: -wa
begin along walk 3s

Under the assumption that both separable and inseparable variants of a particular preverb are represented at the same level of grammatical description (i.e. morphology) the phenomena described above find a natural explanation.

Apart from the evidence just described, recall that some Fox preverbs also serve the purpose of augmenting the main verb's argument structure. For lexicalist frameworks, this constitutes additional support for a morphological perspective on preverb-verb constructions.

3 The morphological status of Fox inflectional morphology

We have seen in the preceding section that there is ample support for the assumption that preverb-verb complexes, though separable in syntax, are represented as such at a morpholexical level already. In this section, I investigate more thoroughly the role of Fox verbal inflection with respect to its morphosyntactic status.

3.1 Syntactic approaches

Fox inflectional paradigms, as I have argued in section 1, display various instances of multiple exponence, lending support to a morphological rather than syntactic perspective on these entities. However, one might object that multiple encoding of a grammatical distinction (e.g. person/number specification) can, alternatively, be regarded as an instance of syntactic agreement.

[Halle and Marantz, 1993] suggest that first and second person prefixes in Potawatomi, another language of the Algonquian family, should be conceived of as clitics rather than proper inflectional affixes. If this were indeed the case, they argue, then what appears as multiple exponence should better be analysed as ordinary syntactic agreement between a first or second person pronominal and the main verb. I am not in a position to judge whether this assumption is indeed warranted by Potawatomi morphology, however, they do not appear to provide any morphophonological evidence to substantiate the distinction between clitic and affixal status in this language. Person inflection in Fox, on the other hand, can be clearly distinguished morphophonologically from true clitics. Fox /e/-initial stems are neutralised to [i] when realised word-initially ([Dahlstrom, 1997b]): with "true" postlexical clitics like AORIST *eh* or FUTURE *wih*, the stem-initial /e/ is neutralised (cf. [Dahlstrom, 1997b, p. 216]) just like ordinary word-initial /e/ (cf. *ina:pi-wa* '(s)he looks'). With inflectional prefixes, however, the underlying segment is preserved (cf. ne-t-enapi-wa). [Dahlstrom, 1997b] argues convincingly that the presence vs. absence of a word boundary will account for the observed pattern, and that a strict distinction between clitics and inflectional prefixes, such as *ne-* and *ke-*, should therefore be maintained.

Having a second look at the data involving "initial change", it is clear that an analysis in terms of cliticisation is unavailable there: neither is it the case that the abstract IC-morpheme comes with a fixed identifiable meaning, nor is it plausible to assume that such a tight phonological integration with a host can still be regarded as a syntactic or prosodic phenomenon.

3.2 Arguments in favour of syntactically complex morphological objects

In order to resolve the kind of morphosyntactic paradoxon described here, it is conceivable[4] in lexicalist frameworks such as HPSG to assume that preverb and verb get inflected independently of each other by means of lexical rules, and to ensure the right distribution by means of subcategorisation for preverbs of a particular lexical type or feature specification. Yet, such an approach misses a number of important generalisations which I would briefly like to outline:

1. Inflectional prefixes and suffixes are unique for every preverb-verb complex, e.g. no matter how many preverbs are added to a single main verb, in the INDEPENDENT INDICATIVE there is at most one prefix and one suffix for a particular grammatical function. Inflecting prefixes and main verb independently of each other, the uniqueness has to be stipulated. If we assume that the whole preverb-verb complex gets inflected as one unit, it is not surprising that only one instance of a particular morpheme can be found.

2. Inflectional prefixes in Fox are always positioned at the left-periphery, both locally, i.e. with respect to their morphological host, i.e. the verb or the preverb, and globally, i.e. they are always realised on the leftmost preverb, if any. Again, having preverbs and verbs in separate morphological domains misses this generalisation. The same holds for the inflectional suffixes.

3. Fox inflectional morphology reveals an interesting asymmetry with respect to verbs and preverbs: while verbs can be inflected with both suffixes and prefixes, preverbs cannot be suffixed. Assuming verb and preverb to constitute a morphological complex headed by a verb, an explanation follows directly.

4. In the case of paradigms involving INITIAL CHANGE, one would either have to subcategorise for a [+IC] preverb, thereby violating the principle of "phonology-free" syntax ([Pullum and Zwicky, 1988]), or, alternatively, subcategorise for morphological categories like e.g. ITERATIVE, CHANGED CONJUNCT, CHANGED UNREAL and the like. As a drawback, however, INITIAL CHANGE (and the absence thereof) would introduce a high degree of ambiguity. This ambiguity can easily be avoided, provided that circumfixation to a preverb-verb complex is assumed.

5. The inflectional prefixes in Fox are always the same, regardless of where they are attached. Deriving them separately for main verbs and preverbs is bound to treat the identity as purely accidental. Under an approach which attaches

[4] Cf., however, section 2 for some possible obstacles.

one and the same prefix to a (syntactically complex) morphological entity, this property is a mere corollary.

Apart from its empirical shortcomings, an approach which separates prefixation and suffixation is uneconomical in that it triples the number of lexical rules or types constraints: one rule for suffixation to the verb, one rule for prefixation to a verb or preverb, and another one which introduces subcategorisation for a prefixed preverb. Thus, this kind of analysis will lead to a proliferation of descriptive devices.

I therefore conclude that it is safe to assume that preverb and verb are best represented as a single unit at some level of morphology.

4 An account in linearisation-based morphology

In the analysis that I am going to propose, I build on the assumption that Fox preverb-verb complexes constitute a single morphological object which introduces more than one domain object into syntax. As such, this approach is akin to the analysis of German separable prefix verbs assumed in [Kathol, 1996]. As already noted above, German separable prefix verbs contrast with the Fox data under discussion in one important respect: while the former does not allow further morphology to target the prefix-verb complex, affixes in Fox do get distributed over the separable preverb and the main verb. Thus, it is necessary to tie the introduction of domain objects to the morphological derivation, rather than just assuming them to be provided by fully specified lexical entries.

Following proposals by [Pollard *et al.*, 1993], I will assume that linguistic objects, or, more precisely, HPSG signs, generally introduce a list-valued feature DOM of domain objects. The set of features appropriate for word-level signs is further assumed to contain a MORPH-feature which assembles information about the morphological formatives ([Bird and Klein, 1993, Riehemann, 1994]). In order to allow for a convenient representation of templatic morphology, the MORPH-feature is defined as a list of objects of type *morph*.[5] Subtypes of *morph* are familiar morphological entities, like *stem*, *prefix*, *suffix* etc.

Morphological derivations are specified using morphological schemata [Riehemann, 1994]. In addition to manipulations of syntacto-semantic information, these schemata introduce a new morphological object on the morphs list which is specified for both a PHON value and a (possibly empty) DOM value. In a sense, this constitutes the key mechanism in generalising Kathol's (1996) approach to German separable prefix verbs to the domain of Fox morphosyntax.

To start with, let us consider the morphological schema introducing a modifying preverb on a given Fox verb (cf. Fig. 26.1): apart from specifying a value for its contribution to the phonological string, it also introduces an additional DOM-object into the morphological structure which is anchored to its own phonology. Furthermore, a morphophonogical LP-constraints is attached to the PHON value in an essentially [Bird and Klein, 1993] fashion. The syntacto-semantic effect of the compounding is captured in the modification to the SYNSEM value, basically adding a subcategorisation requirement for a locative expression.

[5] In contrast to [Inkelas, 1993] and [Orgun, 1996] I adhere to the more traditional view that morphology in polysynthetic languages is characterised by an essentially flat structure (cf. e.g. [Simpson and Withgott, 1986] who assume non-adjacency as a major feature of non-layered morphology).

$$\begin{bmatrix} \text{m}\ \boxed{3} \bigcirc \left\langle {}_{\text{stem}}\begin{bmatrix}\text{ph} & \boxed{2}\\ \text{dom} & \langle[\text{ph}\ \boxed{2}]\rangle\end{bmatrix} \right\rangle \bigcirc \langle\, \rangle \\ \text{ss}\,|\,\text{loc}\,|\,\text{cat} \begin{bmatrix}\text{hd}\ \textit{verb}\\ \text{sc}\ \boxed{4} \oplus \langle \text{XP}[\textit{loc}]\rangle\end{bmatrix}\end{bmatrix}$$

Figure 26.1: The preverb *oči*

$$\begin{bmatrix} \text{m}\ \boxed{3} \bigcirc {}_{\text{pref}}\begin{bmatrix}\text{ph}\ \boxed{1}\ \langle\text{ke}\rangle\\ \quad \wedge\ \boxed{1} \prec [\,]\\ \text{dom}\ \langle\ \rangle\end{bmatrix} \bigcirc {}_{\text{suff}}\begin{bmatrix}\text{ph}\ \boxed{2}\ \langle\text{pena}\ \rangle\\ \quad \wedge\ [\,] \prec \boxed{2}\\ \text{dom}\ \langle\ \rangle\end{bmatrix} \\ \text{ss}\,|\,\text{loc}\,|\,\text{cat}\,|\,\text{hd}\ {}_{\text{verb}}\begin{bmatrix}\text{agr}\ \begin{bmatrix}\text{person} & \textit{1st\_incl}\\ \text{number} & \textit{plural}\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

Figure 26.2: The 1st plural (incl) agreement circumfix

As we have seen in section 1, parts of inflectional affixes, in particular the ones involving INITIAL CHANGE, cannot always be interpreted in isolation. Using morphological schemata, we can introduce both the prefix and the suffix simultaneously, yet represent them as morphological objects subject to different linearisation requirements. Again, these requirements are attached to the respective PHON values stating that both the prefix and the suffix have to be realised at the edge of the morphological complex. In contrast to compounding, agreement affixes in Fox do not introduce an independent domain object.

Having established a representation of the morphemic and morphotactic constraints in Fox separable preverb constructions, we finally have to specify how the phonological information contributed by morphemic structure get represented on syntactic domain objects. To achieve this, all we have to do is to assemble the DOM values of the elements on the MORPHS list and map them onto the DOM list of the top-level lexical sign. In this step, phonological information contributed by morphs which do not specify a DOM object on their own will be picked up by morphological domain objects in accordance with the morphophonological constraints. In the present case, the first preverb will pick up the phonological information of the agreement prefix as this is the only morph with a non-empty DOM list that is compatible with a left peripheral realisation of the agreement prefix. Similarly, agreement suffixes are always picked up by the main verb. Under a more general perspective, this mapping can be viewed as a morphosyntactic counterpart of compaction.

4.1 Implications for Lexical Integrity

The approach outlined in this paper makes crucial use of devices (e.g. LP constraints on sublexical material) which have hitherto been exclusively identified with the level of syntactic description. One might therefore wonder whether such a move is not at odds with well-motivated assumptions about Lexical Integrity.

Lexical Integrity is generally assumed to disallow any syntactic operation to target parts of (morphologically derived) lexical words. In this sense, the present approach clearly violates the letter of morphological lexicalism. Yet, if we try to pin down the basic intuitions behind the formulation of the integrity hypothesis, we can identify two major factors. First, morphological and syntactic entities typically involve quite distinct principles of composition: while syntax is usually purely concatenative, morphology need not be. Moreover, morphological processes are often sensitive to the phonological shape of the participating elements (with reduplication being a prototypical example), whereas syntax is assumed to be completely blind in this respect. Second, syntactic operations are usually considered to obey semantic compositionality. Morphology, as a lexical level, is subject to semantic idiosyncrasy, usually attributed to semantic drift of lexicalised material. Thus, it is undesirable to have morphological objects represented as legitimate syntactic signs.

The current approach, however, though it certainly relaxes the mapping from morphological to syntactic objects, does not include any of these side-effects. Morphological objects (e.g. stems, affixes and the like) never participate in syntactic operations. Rather, morphological is mapped to syntactic terminals (dom-obj) which fully obey morphological integrity. Furthermore, syntax can only target exactly those objects which are made available by the morphological component as domain objects. Likewise, the choice of using domain objects rather than fully-fledge signs enables us to hide undesirable semantic idiosyncrasies from the syntactic component. Encapsulation into syntactic objects ensures a clean modular organisation of syntax and morphology, one of the core ideas of lexicalist syntax.

5 Conclusion

Based on paradoxical morphosyntactic data from complex verb inflection in Fox, an analysis has been proposed which tries to reconcile diverging evidence by assuming that morphological objects can introduce more than one syntactic atom (domain object). As such, it is clearly inspired by related studies on German separable prefix verbs ([Kathol, 1996]). The approach adopted here also shares a certain degree of similarity with the analysis of European Portuguese cliticisation proposed in [Crysmann, 1997]. It would be interesting to see whether the specific mapping between morphological constituents and syntactic domain objects can be fruitfully used to account for other morpho-syntactic mismatches as well.

Bibliography

[Ackerman and LeSourd, 1994] Farrell Ackerman and Phil LeSourd. Preverbs and Complex Predicates: Dimensions of Wordhood. In *Proceedings of the 12th Western Conference on Linguistics (WECOL), October 16–18, 1992, Tucson, AZ*, 1994.

[Bird and Klein, 1993] Steven Bird and Ewan Klein. *Enriching HPSG Phonology.* Research Paper EUCCS/RP-56, Centre for Cognitive Science, University of Edinburgh, 1993.

[Crysmann, 1997] Berthold Crysmann. Cliticization in European Portuguese Using Parallel Morpho–Syntactic Constraints. In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of the LFG97 Conference*, Stanford, 1997. CSLI Publications.

[Dahlstrom, 1997a] Amy Dahlstrom. *Discontinuity in Morphology and Syntax: Separable Preverbs in Fox (Mesquakie).* paper presented at the 2nd Annual Conference on Lexical Functional Grammar (LFG97), University of Califonia at San Diego, CA, 1997.

[Dahlstrom, 1997b] Amy Dahlstrom. Fox Reduplication. *International Journal of American Linguistics*, 63(2):205–226, 1997.

[Goddard, 1990a] Ives Goddard. Paradigmatic Relationships. In *General Topics in American Indian Linguistics*, Berkeley, CA, 1990. Berkeley Linguistic Society.

[Goddard, 1990b] Ives Goddard. Primary and Secondary Stem Derivation in Algonquian. *International Journal of American Linguistics*, 56(4), 1990.

[Goddard, 1994] Ives Goddard. *Leonard Bloomfield's Fox Lexicon: Critical Edition.* Algonquian and Iroquoian Linguistics Publications, Winnipeg, 1994.

[Halle and Marantz, 1993] Morris Halle and Alec Marantz. Distributed Morphology and the Pieces of Inflection. In Kenneth Hale and Samuel J. Keyser (eds.), *The View from Building 20. Essays in Linguistics in Honor of Sylvain Bromberger*, volume 24 of *Current Studies in Linguistics*, pages 111–176. The MIT Press, Cambridge, Massachusetts, 1993.

[Inkelas, 1993] Sharon Inkelas. Nimboran Position Class Morphology. *Natural Language and Linguistic Theory*, 11:529–624, 1993.

[Kathol, 1995] Andreas Kathol. *Linearization-Based German Syntax.* PhD thesis, Ohio State University, 1995.

[Kathol, 1996] Andreas Kathol. *Discontinuous Lexical Entries.* manuscript, paper presented at the Third International Conference on HPSG, Marseille, 1996.

[Orgun, 1996] C. Orhan Orgun. *Sign-Based Morphology and Phonology (with special attention to Optimality Theory).* PhD thesis, University of California at Berkeley, 1996.

[Pollard *et al.*, 1993] Carl Pollard, Robert Levine and Robert Kasper. *Studies in Constituent Ordering: Toward a Theory of Linearization in Head-Driven Phrase Structure Grammar*, 1993. Grant Proposal to the National Science Foundation, Ohio State University.

[Pullum and Zwicky, 1988] Geoffrey Pullum and Arnold Zwicky. The Syntax-Phonology Interface. In Frederick J. Newmeyer (ed.), *Linguistics: The Cambridge Survey*, volume 1, pages 255–280, New York, 1988. Cambridge University Press.

[Reape, 1994] Mike Reape. Domain Union and Word Order Variation in German. In John Nerbonne, Klaus Netter and Carl Pollard (eds.), *German in Head-Driven Phrase Structure Grammar*, number 46 in Lecture Notes, pages 151–197. CSLI Publications, Stanford University, 1994.

[Riehemann, 1994] Susanne Riehemann. *Morphology and the Hierarchical Lexicon.* manuscript, CSLI, Stanford, 1994.

[Simpson and Withgott, 1986] J. Simpson and M. Withgott. Pronominal Clitic Clusters and Templates. In Hagit Borer (ed.), *The Syntax of Pronominal Clitics*, volume 19 of *SYNTAX and SEMANTICS*, pages 149–174. Academic Press, New York, 1986.

Chapter 27

Unidirectional Inheritance of Indices

A Weakly Context Free Facet of LIGs

Jens Michaelis and Christian Wartena

Abstract. In this paper a restricted type of linear indexed grammar (LIG) is defined, called *unidirectional indexed grammar (UIG)*. This is done essentially by demanding that the inheritance of an index stack is either strictly rightmost or strictly leftmost as long as the stack is not empty. Although they turn out to be weakly equivalent to context free grammars (CFGs), UIGs give rise to structural descriptions that are not generatable by any CFG, but seem to be suitable for linguistic purposes. Moreover, the parsing problem for UIGs is shown to be solvable in $O(n^3)$–time. Thus, also in this respect, UIGs constitute an interesting restriction of LIGs, the latter known to be of parsing complexity $O(n^6)$–time in general.

1 Motivation

Structures of natural language sentences are commonly described in terms of trees. Corresponding (formal) grammars usually provide a set of admissible local subtrees. But such grammars should additionally include mechanisms to describe non–local dependencies, as these apparently show up in human languages. The potentials of indexing mechanisms to account for such dependencies were first exploited in Gazdar 1988, which brought up the formalism of linear indexed grammar (LIG). The class of languages generated by LIGs is known to be a proper superclass of the class of context free languages (CFLs). However, in Michaelis & Wartena 1997 we have argued that almost all of the expressive power of LIGs useful for the description of natural languages is already provided by a proper subclass of LIGs. Relying on the observation that extraction in almost all languages is only possible out of objects and assuming some kind of common X–bar scheme we concluded that the path from a moved element to its base position can always be recovered by successively descending the rightmost branch at each node. We defined a corresponding restricted form of LIGs, right LIGs (RLIGs), in which a stack of indices always has to be passed on from a mother to her rightmost daughter. For X–bar schemes in which a complement is allowed to precede its head we defined a slightly weakened, but still restricted form of LIGs, extended RLIGs (ERLIGs). We have shown that the weak generative capacity of ERLIGs lies properly in between that of context free grammars (CFGs) and LIGs, whereas RLIGs generate exactly the class of CFLs. In this paper we will address the issue concerning restrictions on inheritance of indices from a more technical point of view and try to gain a deeper understanding of the kind of restrictions that, if added to the LIG–formalism, make grammars of the resulting grammar class generate CFLs only. For this purpose we define the formalism of *unidirectional indexed grammar* (UIG). In a UIG index symbols can be inherited either to the left or to the right. But once that a stack of index symbols

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is passed on to a rightmost (leftmost) daughter this stack can only be hosted by rightmost (leftmost) descendants until it is empty. Thus the UIG–formalism can be considered as a generalization of each, RLIGs as well as their primarily technical counterpart, left LIGs (LLIGs) (Michaelis & Wartena 1997), resulting from combining these two formalisms in a limited way. UIGs allow for more structural descriptions than plain RLIGs (LLIGs), while the property of RLIGs (LLIGs) to be weakly equivalent to context free grammars (CFGs) is preserved. From a linguistic point of view some rare examples of non–local dependencies along left branches (cf. Gazdar 1988, p. 77), which could not be accounted for within the RLIG–formalism, might get an appropriate formalisation now. Moreover, we show that the parsing problem for UIGs, that has not yet been examined for RLIGs in particular, can be solved in $O(n^3)$–time. Thus, also w.r.t. parsing, UIGs constitute an interesting restriction of LIGs, the latter known to be of parsing complexity $O(n^6)$–time in general. Further we briefly mention some connections to general LIG–parsing and to other research in constraining mildly context sensitive grammar formalisms so as to identify weakly context free subclasses.

2 Constraining LIGs

Definition 2.1 A *unidirectional indexed grammar (UIG) G* is a five–tuple (N, Σ, I, P, S), where N, Σ and I are finite sets, pairwise disjoint, which respectively denote the sets of *nonterminal*, *terminal* and *index symbols*. S denotes a distinguished nonterminal (the *start symbol*). P is a finite set of pairs, called *productions*, of the form: 1. $A[f...] \rightarrow \beta_l B[g...]\beta_r$ or 2. $A[\,] \rightarrow w$, for some $A, B \in N$, $f, g \in I \cup \{\epsilon\}$ with $|fg| \leq 1$,[1] $\beta_l, \beta_r \in (\Sigma \cup N)^*$ with $\beta_l = \epsilon$ or $\beta_r = \epsilon$, $w \in \Sigma^*$, and $[\,,...,\,]$ extra symbols not in $N \cup \Sigma \cup I$.

A production $p \in P$ of the 1st form is *right indexed* or *left indexed* in case that $\beta_r = \epsilon$ or $\beta_l = \epsilon$, respectively. Furthermore, any such p is either *index introducing* (if $g \in I$), *index absorbing* (if $f \in I$) or *constraint free* (if $fg = \epsilon$). The sets of right indexed, left indexed, index introducing, index absorbing and constraint free productions are denoted by P_{ri}, P_{li}, P_{in}, P_{ab} and P_{cf}, respectively.

Let $G = (N, \Sigma, I, P, S)$ be an UIG. The set NI^* is called the set of *nonterminal objects*. A string $\sigma \in (NI^* \cup \Sigma)^*$ is called a *sentential form*. A sentential form σ *directly derives right indexed (left indexed)* a sentential form τ, written $\sigma \overset{\mathrm{ri}}{\underset{G}{\Rightarrow}} \tau$ ($\sigma \overset{\mathrm{li}}{\underset{G}{\Rightarrow}} \tau$), if either (1) or (2):

$$\begin{array}{llcl}
(1) & \sigma = \gamma_l A f \zeta \gamma_r & (2) & \sigma = \gamma_l A \gamma_r \\
& A[f...] \rightarrow \beta_l B[g...]\beta_r \in P_{\mathrm{ri}} \ (\in P_{\mathrm{li}}) & & A[\,] \rightarrow w \in P \\
& \tau = \gamma_l \beta_l B g \zeta \beta_r \gamma_r & & \tau = \gamma_l w \gamma_r
\end{array}$$

for some $A, B \in N$, $f, g \in I \cup \{\epsilon\}$, $\beta_l, \beta_r \in (\Sigma \cup N)^*$, $w \in \Sigma^*$, $\zeta \in I^*$, and $\gamma_l, \gamma_r \in (NI^* \cup \Sigma)^*$.[2] It is helpful to think of a (maximal) nonterminal object

[1] For any set M and $\Sigma \in M^*$, M^* the set of finite strings in M including the empty string ϵ, $|\sigma|$ denotes the length of σ.

[2] Note that γ_r cannot start with an index. So, the terminal production $A[\,] \rightarrow w$ can only be applied, if no index appears immediately to the right of A.

occurring in a sentential form as a nonterminal associated with a stack of indices. Thus, we see that in case (1) such a stack of indices is passed on from the mother to exactly one daughter,[3] while possibly the topmost index symbol f is popped from, or a new index g is pushed onto the stack. In this case, with respect to the corresponding occurrences, $Bg\zeta$ is called the *distinguished child* of its mother $Af\zeta$.

We say, a sentential form σ *directly derives (unidirectional indexed in G)* a sentential form τ, written $\sigma \underset{G}{\Rightarrow} \tau$, if $\sigma \overset{\text{ri}}{\underset{G}{\Rightarrow}} \tau$ or $\sigma \overset{\text{li}}{\underset{G}{\Rightarrow}} \tau$. If $\sigma \underset{G}{\Rightarrow} \tau$ by applying $p \in P$, we also write $\sigma \overset{p}{\underset{G}{\Rightarrow}} \tau$. Now, generalizing $\underset{G}{\Rightarrow}$ we will inductively define a binary relation $\overset{\text{ui}}{\underset{G}{\Rightarrow}}$ on the set of sentential forms. But contrasting with the general LIG–case, $\overset{\text{ui}}{\underset{G}{\Rightarrow}}$ will characterize only a subset of the reflexive and transitive closure of $\underset{G}{\Rightarrow}$:[4] For each sentential form σ set $\sigma \overset{0}{\underset{G}{\Rightarrow}} \sigma$. For $n \in \mathbb{N}$ let $\sigma_0 \dots \sigma_{n+1}$ be a sequence of sentential forms such that $\sigma_i \underset{G}{\Rightarrow} \sigma_{i+1}$ for $0 \le i \le n$ and such that $\sigma_0 \overset{n}{\underset{G}{\Rightarrow}} \sigma_n$.[5] Thus, a particular occurrence of some $A_n\eta_n \in NI^*$ is rewritten in $\sigma_n \underset{G}{\Rightarrow} \sigma_{n+1}$ by applying some $p_n \in P$. Consider the case $\eta_n \neq \epsilon$ such that for some $0 \le i \le n$ the instance of $A_n\eta_n$, rewritten in $\sigma_n \overset{p_n}{\underset{G}{\Rightarrow}} \sigma_{n+1}$, has been introduced as a distinguished child in $\sigma_i \underset{G}{\Rightarrow} \sigma_{i+1}$ by applying some $p_i \in P_{\text{ri}}$ ($p_i \in P_{\text{li}}$). Then $\sigma_0 \overset{n+1}{\underset{G}{\Rightarrow}} \sigma_{n+1}$, only if $p_n \in P_{\text{ri}}$ ($p_n \in P_{\text{li}}$), as well. In all other cases, $\sigma_0 \overset{n+1}{\underset{G}{\Rightarrow}} \sigma_{n+1}$ without restriction. We say, a sentential form σ *derives (unidirectional indexed in G)* a sentential form τ, written $\sigma \overset{\text{ui}}{\underset{G}{\Rightarrow}} \tau$, if $\sigma \overset{n}{\underset{G}{\Rightarrow}} \tau$ for some $n \in \mathbb{N}$. The set $L(G) = \{w \in \Sigma^* \mid S \overset{\text{ui}}{\underset{G}{\Rightarrow}} w\}$ is the *unidirectional indexed language (UIL)* generated by G.

For $n \in \mathbb{N}$ let $d = \sigma_0 \dots \sigma_n$ be a sequence of sentential forms with $\sigma_0 \overset{\text{ui}}{\underset{G}{\Rightarrow}} \sigma_i$ for $0 \le i \le n$. In particular, $\sigma_i \overset{p_i}{\underset{G}{\Rightarrow}} \sigma_{i+1}$ for some $p_i \in P$. We sometimes write $\sigma_0 \overset{\pi}{\underset{G}{\Rightarrow}} \sigma_n$ instead of $\sigma_0 \overset{\text{ui}}{\underset{G}{\Rightarrow}} \sigma_n$, where $\pi = p_0 \dots p_{n-1} \in P^*$. d is called a *derivation (from σ_0 to σ_n in G)*, and π a *parse (from σ_0 to σ_n in G)*. In case that $\sigma_0 = S$ we also say, d is a *derivation of σ_n* and π a *parse of σ_n (in G)*.

To make the definition of $\overset{\text{ui}}{\underset{G}{\Rightarrow}}$ somewhat more transparent, we (informally) define a *spine* as a sequence of objects $A_0\eta_0 \dots A_k\eta_k$ in NI^* such that $A_{i+1}\eta_{i+1}$ is the distinguished child of $A_i\eta_i$ with respect to some derivation d in G. In this case, $A_k\eta_k$ is called a *distinguished descendant* of $A_0\eta_0$. Then, in terms of derivation trees, a spine necessarily coincides with the path from a node ν to the rightmost (leftmost) descendant of ν as long as the stack which is passed on along the spine is not empty.

Take $\overset{\text{ri}}{\underset{G}{\Rightarrow}}{}^*$, $\overset{\text{li}}{\underset{G}{\Rightarrow}}{}^*$ and $\underset{G}{\Rightarrow}{}^*$ to denote the reflexive and transitive closure of $\overset{\text{ri}}{\underset{G}{\Rightarrow}}$, $\overset{\text{li}}{\underset{G}{\Rightarrow}}$ and $\underset{G}{\Rightarrow}$, respectively. Note that $\overset{\text{ri}}{\underset{G}{\Rightarrow}}{}^* \cup \overset{\text{li}}{\underset{G}{\Rightarrow}}{}^* \subseteq \overset{\text{ui}}{\underset{G}{\Rightarrow}} \subseteq \underset{G}{\Rightarrow}{}^*$. Equality for both inclusions holds, if $I = \emptyset$, but also if all indexed productions, i.e. all productions of the 1st form, belong to P_{ri} (to P_{li}). The latter case corresponds to a *right LIG* (*left LIG*) as defined in Michaelis & Wartena 1997, and we have $\overset{\text{ri}}{\underset{G}{\Rightarrow}}{}^* = \overset{\text{ui}}{\underset{G}{\Rightarrow}}$ ($\overset{\text{li}}{\underset{G}{\Rightarrow}}{}^* = \overset{\text{ui}}{\underset{G}{\Rightarrow}}$). In case

[3]Namely, the nonterminal that immediately precedes $[g..]$ in the production.

[4]Up to here, the UIG–definition differs from the general LIG–definition (as presented e.g. in Vijay-Shanker & Weir 1994) only by establishing restrictions on the type of permissible productions of the following two kinds: At each derivation step index inheritance has to be either rightmost or leftmost, and in addition at most one index can be introduced or absorbed. From this perspective each UIG could just be considered as an LIG in a particular reduced form, while the class of grammars defined this way would be weakly equivalent to the proper superclass formed by all LIGs, as is well–known.

[5]$\mathbb{N}$ denotes the set of all non–negative integers.

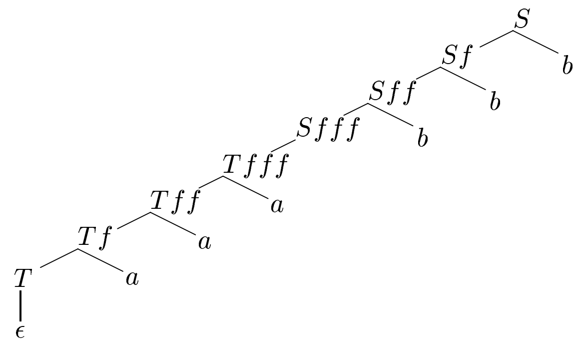

Figure 27.1: The (unique) derivation structure, as licensed by the grammar G of Example 2.2, belonging to the terminal string a^3b^3.

$I = \emptyset$ the UIG can simply be taken as a CFG.[6]

Example 2.2 The UIG $G = (\{S,T\},\{a,b\},\{f\},P,S)$ with production set $P=\{S[...]\to S[f...]b, S[...]\to T[...], T[f...]\to T[...]a, T[\,]\to\epsilon\}$, that is $\overset{\text{li}}{\underset{G}{\Rightarrow}}{}^{*} = \overset{\text{ui}}{\underset{G}{\Rightarrow}}$, generates $L(G) = \{a^nb^n | n \in \mathbb{N}\}$ in a "non–center–embedded" way, hence in a non–context free manner, exemplified by Figure 27.1 for $n = 3$.

Let $<_{\text{lex}}$ be the lexicographical order on $\mathbb{N}^*$. That is, $\omega <_{\text{lex}} \omega i\varphi$ and $\omega j\chi <_{\text{lex}} \omega k\psi$ for all $\omega,\varphi,\chi,\psi \in \mathbb{N}^*$ and $i,j,k \in \mathbb{N}$, where $j < k$. Then, w.r.t. $<_{\text{lex}}$ a particular (linear) derivation strategy can be defined for $\overset{\text{ui}}{\underset{G}{\Rightarrow}}$.[7] The strategy contrasts with the concept of a rightmost or a leftmost derivation, respectively, since it works "developing spines last". To achieve this, an address $\omega \in \mathbb{N}^*$ will be assigned to each instance of a nonterminal object $A\eta$ within a sentential form σ in a canonical way. We present this method in some more detail, since it will be of particular interest, when we prove G to be weakly equivalent to a CFG G' and to be parsable in $O(n^3)$–time. Within a derivation the corresponding addresses are defined inductively depending on the length of the derivation in the following way:

Consider $p \in P_{\text{ri}} \cup P_{\text{li}}$. Let $p = A[f...]\to\beta_l B[g...]\beta_r$ for some $A, B \in N$, $f, g \in I\cup\{\epsilon\}$ and $\beta_l, \beta_r \in (\Sigma \cup N)^*$. Set $m(p) = |\beta_l\beta_r|$. Then, there are $X_0, \ldots, X_{m(p)-1} \in N \cup \Sigma$ such that (ri) or (li) hold.

$$\text{(ri)} \quad \beta_r = \epsilon \text{ and } \beta_l = X_0 \ldots X_{m(p)-1} \qquad \text{(li)} \quad \beta_l = \epsilon \text{ and } \beta_r = X_{m(p)-1} \ldots X_0$$

Suppose that, for some $\zeta \in I^*$, p is applied to an instance of $Af\zeta$ with address $\omega \in \mathbb{N}^*$. In both cases, (ri) and (li), for $0 \le k < m(p)$ the address of the corresponding child X_k is ωk, and the address of the distinguished descendant $Bg\zeta$ is $\omega\, m(p)$.

Let σ be a sentential form such that for each instance of a nonterminal object in σ a unique address in $\mathbb{N}^*$ is defined. We also refer to such an address simply as an *address of* σ. Now, assume d to be a derivation in G starting with σ.[8] Then, according to the just mentioned method a (unique) address is assigned to each new

[6] Conversely, e.g. each CFG in Chomsky normal form can be interpreted as a UIG with $I = \emptyset$. Thus, each CFL turns out as a UIL.

[7] Like e.g. Boullier (1996) did for $\underset{G}{\Rightarrow}{}^{*}$ considering a "(canonical) two–form" of full LIGs.

[8] If not defined for some other reasons, in any derivation $\tilde{d}$ starting with a sentential form $\tilde{\sigma}$, $\tilde{\sigma}$ is tacitly assumed to be addressed in the same manner as σ here.

instance of a nonterminal object introduced in a derivation step. Say, $d = \sigma_0 \dots \sigma_n$ such that $\sigma_i \overset{p_i}{\underset{G}{\Rightarrow}} \sigma_{i+1}$ for some $p_i \in P$ applied to a particular occurrence of some $A_i\zeta_i \in NI^*$ with address $\omega_i \in \mathbb{N}^*$. Set $\pi = p_0 \dots p_{n-1}$. W.r.t. $<_{\text{lex}}$ the addresses ω_i form a (totally) linearly ordered set. We call the derivation d and the parse π *linear (w.r.t.* $<_{\text{lex}}$*)*, if $\omega_{i-1} <_{\text{lex}} \omega_i$ for $1 \leq i < n$. In this case, if $\sigma_n \in \Sigma^*$, and if ω_i is the highest address of σ_i, then $\sigma_i = u_i A_i \zeta_i v_i$ for some $u_i, v_i \in \Sigma^*$. Now, suppose that d is linear such that $\sigma_i = \tau_i B_i \eta_i$ ($\sigma_i = B_i \eta_i \tau_i$) for $0 \leq i < n$, where $B_i \eta_i \in NI^*$ and $\tau_i \in (NI^* \cup \Sigma)^*$. If, in addition, for $0 \leq i < n$ the highest address of σ_i belongs to the rightmost (leftmost) instance of $B_i \eta_i$, then d, just as π, is also called *weakly right linear (weakly left linear)*. In this case, if $\sigma_n \in \Sigma^*$, the rightmost (leftmost) occurrence of $B_i \eta_i$ can be rewritten only if $\tau_i \in \Sigma^*$.

Lemma 2.3 *Consider* $\sigma, \tau \in (NI^* \cup \Sigma)^*$. *If* $\sigma \overset{\text{ui}}{\underset{G}{\Rightarrow}}{}^{*} \tau$, *there is also a linear derivation from* σ *to* τ *in* G. $\square$

3 Weak Generative Capacity

Let $G = (N, \Sigma, I, P, S)$ be a UIG. We give a method to construct a CFG $G' = (N', \Sigma, P', S')$ which is weakly equivalent to G: First, the nonterminal set N' is defined as the set of all pairs (A, x) with $A \in N$ and $x \in P_{\text{ab}} \cup \{\epsilon\}$, (S, ϵ) the start symbol S'. Then, for all $A, B, C, D \in N$, $f \in I$, and $\gamma, \beta \in (N \cup \Sigma)^*$, $w \in \Sigma^*$ the production set P' is defined as[9]

(R1) $(A, x) \to (\gamma, \epsilon)(C, q)(\beta, \epsilon)(B, x) \in P'$ for all $x \in (P_{\text{ri}} \cap P_{\text{ab}}) \cup \{\epsilon\}$,
if $p, q \in P_{\text{ri}}$, where $p = A[...] \to \gamma C[f...]$ and $q = D[f...] \to \beta B[...]$

(L1) $(A, x) \to (B, x)(\beta, \epsilon)(C, q)(\gamma, \epsilon) \in P'$ for all $x \in (P_{\text{li}} \cap P_{\text{ab}}) \cup \{\epsilon\}$,
if $p, q \in P_{\text{li}}$, where $p = A[...] \to C[f...]\gamma$ and $q = D[f...] \to B[...]\beta$

(R2) $(A, x) \to (\gamma, \epsilon)(C, x) \in P'$ for all $x \in (P_{\text{ri}} \cap P_{\text{cf}}) \cup \{\epsilon\}$,
if $p = A[...] \to \gamma C[...] \in P_{\text{ri}}$

(L2) $(A, x) \to (C, x)(\gamma, \epsilon) \in P'$ for all $x \in (P_{\text{li}} \cap P_{\text{cf}}) \cup \{\epsilon\}$,
if $p = A[...] \to C[...]\gamma \in P_{\text{li}}$

(3) $(A, \epsilon) \to w \in P'$, if $p = A[\,] \to w \in P$

(R4) $(D, q) \to \epsilon \in P'$, if $q = D[f...] \to \beta B[...] \in P_{\text{ri}}$

(L4) $(D, q) \to \epsilon \in P'$, if $q = D[f...] \to B[...]\beta \in P_{\text{li}}$

The productions of the form (R1) and (R2) (the form (L1) and (L2)) build the set of *passing on rightmost (passing on leftmost)* productions, which is denoted by P'_{r} (by P'_{l}).[10]

[9] For $\alpha \in (N \cup \Sigma)^*$ the string $(\alpha, \epsilon) \in (N' \cup \Sigma)^*$ is inductively defined as follows: First, let $(\epsilon, \epsilon) := \epsilon$. Then, for $\beta \in (N \cup \Sigma)^*$, $a \in \Sigma$ and $A \in N$ set $(a\beta, \epsilon) := a(\beta, \epsilon)$ and $(A\beta, \epsilon) := (A, \epsilon)(\beta, \epsilon)$, respectively.

[10] The expression *passing on rightmost (passing on leftmost)* has been chosen, because the second component of the mother can be considered as being passed onto the rightmost (leftmost) child while applying such a production.

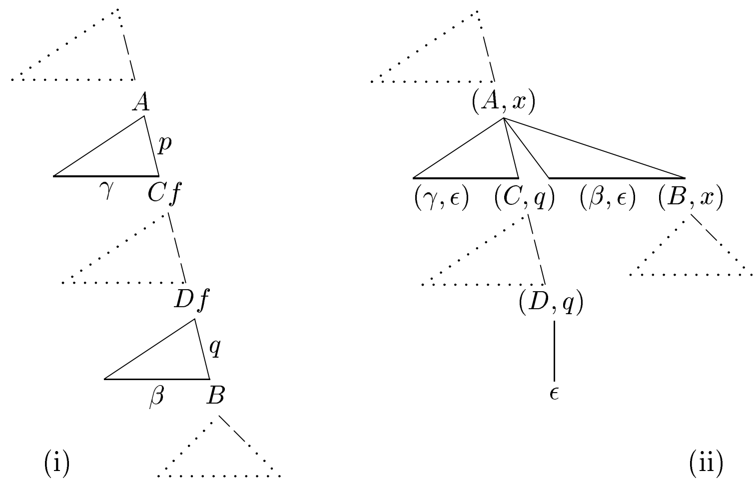

Figure 27.2: (i) A partial weakly right linear tree in G and (ii) the corresponding CFG-tree in G'.

In terms of trees, what G' does to a given UIG-tree in G is flatten the structure by recursively splitting up spines in a particular way without changing the yield of the original tree. I.e. productions of the form (R2), (L2) and (3) simply imitate the constraint free and terminal productions from the original UIG G. But, a $p' \in P'$ of the form (R1) or (L1) crucially imitates the introduction of an index and its absorption in one step (the "structure–flattening" step). The second component of the corresponding (C, q) stores the information that the index f introduced with C applying $p \in P_{\text{in}}$ has been popped applying $q \in P_{\text{ab}}$. Since $q \neq \epsilon$, no $(Z, q) \in N'$ can subsequently be rewritten as a terminal string, except by using a production of the form (R4) or (L4) at some derivation step. This kind of constraint ensures the "instant popping" of f to be a legitimate operation (see also Figure 27.2 indicating the case with regard to (R1) and (R4)).[11]

The linear derivation strategy for UIGs can be transferred to G' by means of the following: For any $p' = A' \rightarrow \alpha' \in P'_{\text{r}} \cup P'_{\text{l}}$ we define $m(p') = |\alpha'| \Leftrightarrow 1$. Then we fix existing $X_0, \ldots, X_{m(p')} \in (N' \cup \Sigma)^*$ such that $\alpha' = X_0 \ldots X_{m(p')}$ if $p' \in P'_{\text{r}}$ or such that $\alpha' = X_{m(p')} \ldots X_0$ if $p' \in P'_{\text{l}}$. If $\omega \in \mathbb{N}^*$ is the address of A', for $0 \leq k \leq m(p')$ the address of X_k is ωk. It should be clear what is meant when a derivation d' or a parse π' in G' is called *linear, weakly right linear* or *weakly left linear (w.r.t. $<_{\text{lex}}$).*

Lemma 3.1 *Let σ', τ' be sententialforms in G'. If $\sigma' \underset{G'}{\Rightarrow}^* \tau'$, there is also a linear derivation from σ' to τ' in G'.* $\square$

Proposition 3.2 *It can be shown that*

[11]Note that a less complex second component would actually be sufficient to prove $L(G) = L(G')$. All that has to be stored is the nonterminal of the left hand side of q and the information whether $q \in P_{\text{ri}}$ or $q \in P_{\text{li}}$. Storing the whole production is useful in order to solve the parsing problem for UIGs.

(a) $\quad A \overset{\text{ui}}{\underset{G}{\Rightarrow}} wX$ *weakly right linear iff* $(A,x) \underset{G'}{\Rightarrow^*} w(X,x)$ *weakly right linear,*

(b) $\quad A \overset{\text{ui}}{\underset{G}{\Rightarrow}} Yw$ *weakly left linear iff* $(A,y) \underset{G'}{\Rightarrow^*} (Y,y)w$ *weakly left linear,*

(c) $\quad \sigma \overset{\text{ui}}{\underset{G}{\Rightarrow}} w$ *linear iff* $(\sigma,\epsilon) \underset{G'}{\Rightarrow^*} w$ *linear,*

f.a. $A, X, Y \in N$, $\sigma \in (N \cup \Sigma)^*$, $w \in \Sigma^*$, *and f.a.* $x \in P_{\text{ri}} \cap P_{\text{ab}}$, $y \in P_{\text{li}} \cap P_{\text{ab}}$.

Thus $L(G) = L(G')$ by Lemma 2.3 and 3.1, since Proposition 3.2 (c) especially holds for $\sigma = S$. Note that a proof of Proposition 3.2 can be done simultaneously for (a),(b), and (c) by an induction on the length of a derivation in G for "only if"– and in G' for the "if"–part of the respective clauses. Loosely speaking, the crucial fact is the connection between partial weakly right (left) linear derivations in G and G' as indicated in Figure 27.2 displaying the weakly right linear case: applying $q \in P_{\text{ri}}$ to $Df \in NI$ absorbs the instance of $f \in I$ introduced by applying $p \in P_{\text{ri}}$ to $A \in N$.

4 Parsing Complexity

Parsing with a UIG G can be done rather straightforwardly in two steps: First, a linear parse of a string $w \in L(G)$ is found w.r.t. the weakly equivalent CFG G' obtained by the method given in Section 3. Then, each production of this parse is mapped to a production of G yielding a parse of w in the original UIG. We will argue that all this can be done in $O(|w|^3)$–time.

Let $G = (\Sigma, N, I, P, S)$ be a UIG and let $G' = (\Sigma, N', P', S')$ be the weakly equivalent CFG constructed as in Section 3. The function $h : P' \to P$ with $p' \mapsto p$ for $p' \in P'$ is defined by:

(h–R1) $p = A[...] \to \gamma C[f...]$, if $p' = (A,x) \to (\gamma,\epsilon)(C,q)(\beta,\epsilon)(B,x)$

(h–L1) $p = A[...] \to C[f...]\gamma$, if $p' = (A,y) \to (B,y)(\beta,\epsilon)(C,q)(\gamma,\epsilon)$

(h–R2) $p = A[...] \to \gamma C[...]$, if $p' = (A,x) \to (\gamma,\epsilon)(C,x)$

(h–L2) $p = A[...] \to C[f...]\gamma$, if $p' = (A,y) \to (C,y)(\gamma,\epsilon)$

(h–3) $p = A[\,] \to w$, if $p' = (A,\epsilon) \to w$

(h–R4), (h–L4) $p = q$, if $p' = (D,q) \to \epsilon$ and $q \neq \epsilon$

where the interpretation of all symbols is as in (R1)–(L4) from the previous section. h can be extended to a homomorphism $\bar{h} : P'^* \to P^*$ by setting $\bar{h}(\epsilon) = \epsilon$ and $\bar{h}(p'\pi') = h(p')\bar{h}(\pi')$ for all $p' \in P'$, $\pi' \in P'^*$. For $\bar{h}$ a somewhat strengthened version of the "if"–part of Proposition 3.2 (c) holds, stated here for the special case $\sigma = S$ as

Corollary 4.1 *If* $\pi' \in P'^*$ *is a linear parse of* $w \in \Sigma^*$ *in* G', *then* $\bar{h}(\pi') \in P^*$ *is a linear parse of* w *in* G.

Lemma 4.2 *For all* $w \in \Sigma^*$ *the parsing problem w.r.t.* G' *can be solved in* $O(|w|^3)$–*time such that: if* $w \in L(G')$, *a linear parse of* w *in* G' *is found.*

Proof. Earley's parsing algorithm, which is known to be executable in cubic time, can easily be modified without changing the complexity in order to give a linear parse as output instead of a right or left parse. The original algorithm, solving the recognition problem for some $w \in \Sigma^*$ of length $n \in \mathbb{N}$, can be adopted without modification. This algorithm constructs lists of items $I_0, \ldots, I_n$ such that for $0 \le i \le j \le n$ an item $[A' \rightarrow \alpha' \cdot \beta', i]$ is on list I_j iff $A' \rightarrow \alpha'\beta' \in P'$, $S' \overset{*}{\underset{G'}{\Rightarrow}} \gamma' A' \delta'$, $\gamma' \overset{*}{\underset{G'}{\Rightarrow}} a_1 \ldots a_i$ and $\alpha' \overset{*}{\underset{G'}{\Rightarrow}} a_{i+1} \ldots a_j$, where $w = a_1 \ldots a_n$. If $w \in L(G')$, a linear parse π' of w can be found from the parse lists, as exemplified below for cycle–free CFGs (Algorithm 4.3). □

Algorithm 4.3

Input (1) The cycle free CFG $G' = (N', \Sigma, P', S')$;
(2) An input string $w = a_1 a_2 \ldots a_n \in \Sigma^*$;
(3) The parse lists $I_0, I_1, \ldots I_n$ for w.

Output A linear(!) parse π' of w, or an error message.

Method IF no item of the form $[S' \rightarrow \alpha' \cdot, 0]$ is on I_n, THEN write "error"; halt. ELSE write (the result of) $\mathbf{F}([S' \rightarrow \alpha' \cdot, 0], n, \epsilon)$; halt.

$\mathbf{F}([A' \rightarrow \beta' \cdot, i], j, \omega)$:

$p' := A' \rightarrow \beta'$; $\pi' := \epsilon$; $\beta' = X_0 X_1 \ldots X_{m-1}$; $k := m \Leftrightarrow 1$; $l := j$;
IF $p' \in P'_{\mathrm{r}}$ THEN $\iota := m \Leftrightarrow 1$ ELSE $\iota := 0$
REPEAT until $k = \Leftrightarrow 1$:
  IF $X_k \in \Sigma$ THEN
    $k := k \Leftrightarrow 1$; $l := l \Leftrightarrow 1$;
    IF $p' \in P'_{\mathrm{r}}$ THEN $\iota := \iota \Leftrightarrow 1$ ELSE $\iota := \iota + 1$
  ELSE IF $X_k \in N'$ THEN
    find $[X_k \rightarrow \gamma' \cdot, r] \in I_l$ for some r such that
    $[A' \rightarrow X_0 X_1 \ldots X_{k-1} \cdot X_k \ldots X_{m-1}, i] \in I_r$;
    IF $p' \in P'_{\mathrm{r}}$ THEN
      $\pi' := \mathbf{F}([X_k \rightarrow \gamma' \cdot, r], l, \omega\iota)\ \pi'$;
    ELSE
      $\pi' := \pi'\ \mathbf{F}([X_k \rightarrow \gamma' \cdot, r], l, \omega\iota)$;
    $k := k \Leftrightarrow 1$; $l := r$;
    IF $p' \in P'_{\mathrm{r}}$ THEN $\iota := \iota \Leftrightarrow 1$ ELSE $\iota := \iota + 1$
RETURN $p'\pi'$

Proposition 4.4 *Let $G = (\Sigma, N, I, P, S)$ be a UIG, and let $w \in \Sigma^*$. Then, the parsing problem for w w.r.t. G is solvable in $O(|w|^3)$–time.*

Proof. First, we construct the weakly equivalent CFG $G' = (\Sigma', N, P', S')$ as given in (R1)–(L4) and compute $h : P' \rightarrow P$ as given in (h–R1)–(h–L4). This of course takes only constant time depending on the cardinality of N and P. According to Lemma 4.2 the parsing problem for w w.r.t. G' is solvable in $O(|w|^3)$–time such that, if $w \in L(G') = L(G)$, a linear parse π' for w is found. Since we may assume that $|\pi'|$ is in $O(|w|)$, we conclude that the computation of $\bar{h}(\pi')$ lasts $O(|w|)$–time. From Corollary 4.1 we conclude that $\bar{h}(\pi')$ is a parse of w in G. □

Comparing our parsing procedure with a strategy to parse full LIGs one might ask what is common to them. Looking at e.g. the LIG–parser of Vijay-Shanker and Weir (1991) we observe that, roughly speaking, a nonterminal object $Af\zeta$ and a distinguished descendant $B\zeta$ of $Af\zeta$ are stored as a pair, if the lower part ζ of the stack is unaffected while deriving $B\zeta$. The efficiency of the parser crucially depends on storing at most the topmost stack symbol together with the associated nonterminal instead of a complete nonterminal object. This is essentially the same as what is done by our transformation algorithm. The property, however, that takes responsibility for the smaller complexity of the UIG–parser is, informally speaking, that the correct position of the string which rewrites the distinguished descendant while popping the index f is already known at the moment f is introduced. This is obviously not the case for full LIGs.

5 Final Remarks

We have identified a weakly context free subclass of LIGs, namely UIGs, which still permits to characterize sets of structures that cannot be generated by any CFG (see e.g. Example 2.2). Further we have presented a parsing strategy for UIGs working in cubic time. Because the class of LIGs is weakly equivalent to the class of *tree adjoining grammars (TAGs)*,[12] our work is directly comparable to similar work of Rogers (1994) and of Schabes and Waters (1995). Both approaches constrain the original TAG–formalism yielding a cubic time parsable formalism which is weakly equivalent to CFGs.

Rogers' work contrasts with our result more generally. In particular he defines a subclass of TAGs such that each grammar (in terms of trees) generates a *recognizable set*, and thus is strongly equivalent *(modulo projection)* to some CFG (Thatcher 1967). Interesting parallels to the work of Schabes and Waters (1995) arise from their way of restricting the general relation of tree adjunction defined for TAGs obtaining the class of *tree insertion grammars (TIGs)*. There is arguably a strong connection between their constraints on left and right adjunction and our restrictions on index inheritance. But the classes of tree sets that can be characterized by TIGs and UIGs, respectively, are different. On the one hand, unlike in the case of TIGs, there exist e.g. ϵ– and cycle–free CFGs such that no UIG generates the same set of structures. This is due to the restricted form of the non–terminal productions in a UIG. Recall that, apart from index symbols, the rightmost (leftmost) element of the righthand side of a right (left) indexed production has to be a nonterminal. On the other hand, although it gives rise to various non–recognizable sets, the TIG-formalism as proposed in Schabes & Waters 1995 does not give rise to each such set of structures licensed by some UIG (e.g. the set of trees corresponding to Example 2.2). Up to nonterminal labeling this could be achieved adding TAG–like adjunction constraints to the TIG–formalism, allowing the adjunction of a tree from some distinguished set of trees at a particular node labeled A rather than the adjunction of an arbitrary auxiliary tree with root and foot labeled A. In the UIG–formalism, roughly speaking, this kind of constraints is already available by the index mechanism as defined.

[12] TAGs as defined e.g. in Vijay-Shanker & Weir 1994, where also a proof of the mentioned weak equivalence can be found.

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References

Boullier, Pierre. 1996. Another facet of LIG parsing. In: *34th Annual Meeting of the Association for Computational Linguistics (ACL '96)*, Santa Cruz, CA, pp. 87–94. ACL.

Gazdar, Gerald. 1988. Applicability of indexed grammars to natural languages. In: U. Reyle and C. Rohrer (editors), *Natural Language Parsing and Linguistic Theories*, pp. 69–94. D. Reidel Publishing Company, Dordrecht.

Michaelis, Jens and Christian Wartena. 1997. How linguistic constraints on movement conspire to yield languages analyzable with a restricted form of LIGs. In: *Proceedings of the Conference on Formal Grammar (FG '97)*, Aix en Provence, pp. 158–168.

Rogers, James. 1994. Capturing CFLs with tree adjoining grammars. In: *32th Annual Meeting of the Association for Computational Linguistics (ACL '94)*, Las Cruces, NM, pp. 155–162. ACL.

Schabes, Yves and Richard C. Waters. 1995. Tree insertion grammar: A cubic–time parsable formalism that lexicalizes context–free grammar without changing the trees produced. *Computational Linguistics*, 21:479–513.

Thatcher, James W. 1967. Characterizing derivation trees of context–free grammars through a generalization of finite automata theory. *Journal of Computer and System Sciences*, 1:317–322.

Vijay-Shanker, K. and David J. Weir. 1991. Polynomial parsing of extensions of context-free grammars. In: M. Tomita (editor), *Current Issues in Parsing Technology*, pp. 191–206. Kluwer Acadamic Publishers, Norwell, MA.

Vijay-Shanker, K. and David J. Weir. 1994. The equivalence of four extensions of context-free grammars. *Mathematical Systems Theory*, 27:511–546.

Chapter 28

A Formal Interpretation of Relations and Quantification in HPSG

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1 Introduction

This paper formalizes the language used for expressing the principles found in [P&S94].[1] In a sense, this is not a new language, but rather the language that [P&S94] and other HPSG linguists have already been using. There have been many logics proposed for the task of unification-based processing with constraint-based grammars such as HPSG, such as [H&S88], and [Car92]; but because of certain practical considerations, they have eschewed some of the formal devices that a declarative, formal specification of the constraints themselves requires. The major properties that distinguish our formal language will be described below.

The language is called RSRL, a relational extension of SRL [King89]. SRL is actually a logic that was proposed as a formalization and refinement of the language used in [P&S87]; and [P&S94] incorporated many of those refinements. SRL is nevertheless not an adequate formalism for [P&S94], pace [King95], as it crucially lacks an explicit means of quantification, which is necessary to express the quantification either understood or explicitly stated in many of the principles of [P&S94]. In fact, the principal contribution that RSRL makes is not its addition of relations but its formalization of what the quantification of [P&S94] really means: not quantification over some or all objects in a model, but over the substructures of a given object, such as a linguistic sign, that are accessible from that object by a finite path. This different notion of quantification gives RSRL the ability to formalize linguistic principles from the HPSG literature very naturally, and it has several very interesting formal properties, as well.

2 Relations

Relations are used prolifically in [P&S94] and elsewhere in the HPSG literature. Some are explicitly referred to as such, e.g., the `o-command` and `local o-command`

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relations of the binding theory, while others are implicitly required by the natural language descriptions of principles. The Subject Condition (p. 400), for example, says:

"If the initial element of the SUBCAT *value of a word is slashed, then so is some other element of that list."*

The consequent of this implication requires the use of a `member` relation to search the SUBCAT list for another slashed element. The recursive nature of lists requires the use of the relation.

RSRL is not the first extension of a feature logic to provide relations. [H&S88], for example, provides a restricted kind of relational extension that can be used for logic programming over a wide range of constraint languages, including several feature logics. This relational extension, however, does not permit relations to occur in the scope of negation, which includes the antecedents of implicational constraints. The Subject Condition above does not have the `member` relation in its antecedent; but the Relative Uniqueness Principle (p. 212) does:

"A member of the INHERITED REL *set*[2] *on a headed constituent may be inherited from ... at most one daughter."*

Perhaps the most famous instance of a negated HPSG relation can be found in principle B of HPSG's binding theory (p. 401), in which a personal pronoun is required to be locally o-free, i.e., not locally o-bound.

True negation, of course, is very difficult to compute with; so it is only natural for definite clause languages such as [H&S88] or systems such as ALE [C&P96] to rely on negation by failure or some other substitute. For a formal language with which we want to build models of our theories, however, these substitutes will not provide us with the usual set-theoretic interpretation of negation that matches its intended use in linguistic principles. Junk slots, the encoding of relations within feature structures themselves by means of extra features [Ait-Kaci84, Car92], cannot encode the negation of an instance of a relation either, and require the signature to contain uninteresting and unmotivated sorts.[3]

It has been suggested [KKP95] that we might be able to restrict our use of negated relations to an inventory of decidable ones that can be replaced by new (computable) relations that have the opposite meaning. For example, instead of using `(¬ member(x,y))` in a description, we might simply define a new relation, `non-member`, and use `non-member(x,y)` instead. The problem is that relations are often used with quantification over at least one of their arguments. Consider, as a simple example, the following constraint, taken from [A&G96], that assists in predicting the distribution of *avoir* and *être* in French:

$$\begin{bmatrix}\text{VFORM}\ \textit{part-passé}\\ \text{S-ARG}\ \ \langle \ldots\ \textit{aff\_r} \ldots \rangle\end{bmatrix} \rightarrow \begin{bmatrix}\text{V-AUX}\ \textit{etre}\end{bmatrix}$$

Formalized in RSRL, this says:

$$[:\text{VFORM}\sim\ \textit{part-passé} \wedge \exists x[x\sim\ \textit{aff\_r} \wedge \texttt{member}(x, :\text{S-ARG})]]$$
$$\rightarrow [:\ \text{V-AUX}\sim\ \textit{etre}]$$

If the VFORM value is of sort *part-passé*, and there exists a member of the S-ARG list which is of sort *aff_r*, i.e., which is a reflexive clitic, then the V-AUX value must be *etre*. Because `member` is in the antecedent of an implication, it occurs in the scope of a negation. It is also in the scope of an implicit existential quantifier, which is

[2] RSRL can also be used to encode finite sets and the necessary access relations, such as membership and union, for them.

[3] See below for further problems with a junk slot approach.

in the scope of the negation as well. If, in the disjunctive form of the implication, we simply used `non-member` for `member`, we would negate the relation but not the quantifier (which must be universal). Computability properties aside, introducing new relations with negation built-in simply will not preserve the intended meaning, even in straightforward principles such as this.

A formal language for HPSG must have true relations with true negation. We extend the usual SRL-style signatures with relational symbols and an arity function to express them:

Definition 1 *Σ is a signature iff*
Σ is a septuple $\langle \mathcal{G}, \sqsubseteq, \mathcal{S}, \mathcal{A}, \mathcal{F}, \mathcal{R}, \mathcal{AR} \rangle$,
$\langle \mathcal{G}, \sqsubseteq \rangle$ is a finite partial order,
$\mathcal{S} = \left\{ \sigma \in \mathcal{G} \middle| \begin{array}{l} \textit{for each } \sigma' \in \mathcal{G}, \\ \textit{if } \sigma' \sqsubseteq \sigma \textit{ then } \sigma = \sigma' \end{array} \right\}$,
$\mathcal{A}$ is a set,
$\mathcal{F}$ is a partial function from the Cartesian product of $\mathcal{G}$ and $\mathcal{A}$ to $\mathcal{G}$, and for each $\sigma_1 \in \mathcal{G}$, for each $\sigma_2 \in \mathcal{G}$ and for each $\alpha \in \mathcal{A}$, if $\mathcal{F}\langle \sigma_1, \alpha \rangle$ is defined and $\sigma_2 \sqsubseteq \sigma_1$ then $\mathcal{F}\langle \sigma_2, \alpha \rangle$ is defined and $\mathcal{F}\langle \sigma_2, \alpha \rangle \sqsubseteq \mathcal{F}\langle \sigma_1, \alpha \rangle$,
$\mathcal{R}$ is a finite set, and
$\mathcal{AR}$ is a total function from $\mathcal{R}$ to $\mathbb{N}^+$.

$\langle \mathcal{G}, \sqsubseteq \rangle$ is a sort hierarchy for a theory, and $\mathcal{S}$ is the set of maximally specific sorts that will partition the objects of our models. $\mathcal{A}$ is the set of attributes; and $\mathcal{F}$ encodes the appropriateness conditions on an HPSG signature. $\mathcal{R}$ and $\mathcal{AR}$ are for the relational symbols and their arities, respectively. We interpret RSRL signatures as follows:

Definition 2 *For each signature Σ, I is a Σ interpretation iff*
I is a quadruple $\langle U, S, A, R \rangle$,
U is a set of objects,
S is a total function from U to $\mathcal{S}$,
A is a total function from $\mathcal{A}$ to the set of partial functions from U to U, and for each $\alpha \in \mathcal{A}$ and each $u \in U$, if $A(\alpha)(u)$ is defined then $\mathcal{F}\langle S(u), \alpha \rangle$ is defined, and $S(A(\alpha)(u)) \sqsubseteq \mathcal{F}\langle S(u), \alpha \rangle$, and for each $\alpha \in \mathcal{A}$ and each $u \in U$, if $\mathcal{F}\langle S(u), \alpha \rangle$ is defined then $A(\alpha)(u)$ is defined,
R is a total function from $\mathcal{R}$ to the powerset of U^*, and for each $r \in \mathcal{R}$, $R(r) \subseteq U^{\mathcal{AR}(r)}$.

S partitions objects according to their maximal sorts. A provides an interpretation of attributes as functions that map from objects to their object values at that attribute, along with conditions to enforce appropriateness. R interprets a relation as a set of n-tuples of objects, where n is the arity of that relation.

In a definite clause extension of a constraint language, we would define descriptions for that constraint language, and then an additional stratum of descriptions in which relations could be used. Because we want to use relations on a par with other descriptions in our formal language, for example, in the scope of negation and/or quantification, relations in RSRL are part of the core description language itself. Var is a countably infinite set of symbols.

Definition 3 *For each signature Σ, $\mathcal{T}^\Sigma$ and $\mathcal{D}^\Sigma$ are the smallest sets such that*
$: \in \mathcal{T}^\Sigma$,

for each $v \in \mathsf{Var}$, $v \in \mathcal{T}^{\Sigma}$, *and*
for each $\alpha \in \mathcal{A}$ *and each* $\tau \in \mathcal{T}^{\Sigma}$, $\tau\alpha \in \mathcal{T}^{\Sigma}$,
for each $\sigma \in \mathcal{G}$, *for each* $\tau \in \mathcal{T}^{\Sigma}$, $\tau{\sim}\sigma \in \mathcal{D}^{\Sigma}$,
for each $\tau_1 \in \mathcal{T}^{\Sigma}$, *for each* $\tau_2 \in \mathcal{T}^{\Sigma}$, $\tau_1{\approx}\tau_2 \in \mathcal{D}^{\Sigma}$,
for each $\rho \in \mathcal{R}$, *for each* $x_1 \in \mathsf{Var}$, ... , *for each* $x_{\mathcal{AR}(\rho)} \in \mathsf{Var}$,
$\rho(x_1, \ldots, x_{\mathcal{AR}(\rho)}) \in \mathcal{D}^{\Sigma}$,
for each $\delta \in \mathcal{D}^{\Sigma}$, $\neg\delta \in \mathcal{D}^{\Sigma}$,
for each $\delta_1 \in \mathcal{D}^{\Sigma}$, *for each* $\delta_2 \in \mathcal{D}^{\Sigma}$, $[\delta_1 \vee \delta_2] \in \mathcal{D}^{\Sigma}$,
for each $x \in \mathsf{Var}$, *for each* $\delta \in \mathcal{D}^{\Sigma}$, $\exists x\, \delta \in \mathcal{D}^{\Sigma}$.

$\mathcal{T}^{\Sigma}$ is a set of terms, consisting of variables, finite feature paths, and : , which refers to the structure being described. The set of formulae, $\mathcal{D}^{\Sigma}$, can then describe sort labelling, path equations, and relations, closed under negation, disjunction and a restricted form of existential quantification (to which we return shortly). Universal quantification, conjunction and implication can be obtained by combinations of these. Relations are expressed as tuples over variables. By using this restricted quantification, and by requiring theories to consist only of descriptions with no free variables, *relations can only hold among substructures of a single feature structure.* This allows us to interpret relations under the scope of negation, by restricting the set of objects in the denotation of a negated relation to exclude those over whose designated substructures the relation holds. The interpretation of the negation of relations is thus achieved, as elsewhere, by set complement.

In the HPSG literature, some relations over lists have been used that violate the substructure restriction, of course. Consider the following description of a German verb phrase, adapted from [K&P95, p. 176]:

`compaction` compacts the complement daughter, $\boxed{1}$, into a single domain object, $\boxed{2}$, at the mother. `shuffle`, a relation between three lists, shuffles the lists in its first two arguments into the list in its third argument, preserving the relative order of their members. Under a strictly substructural perspective, all the list arguments of `shuffle` must be present in the described object for the relation to hold. With the given order of the elements on $\boxed{4}$, this is unproblematic: `shuffle`'s first argument is list $\boxed{0}$. If $\boxed{4}$ is reversed, however, the described structure no longer contains a list such as the one designated by $\boxed{0}$, a list whose single element is a domain object with the phonology *das Buch*. Thus, in the conceivable structure with the list $\boxed{4}$ reversed, `shuffle` would not hold. RSRL can be extended to provide *chains*, a kind of "virtual list," which can be constructed from a finite number of substructures, over which relations can then be defined and which can be navigated by logical operators. These are omitted for simplicity here, but adding them solves problems with lists of the kind exemplified here.

3 Quantification

As mentioned above, we only use a restricted form of quantification in RSRL, by restricting it to substructures of the described feature structure, specifically to those that are accessible by finite paths. We will call the objects corresponding to such substructures *components*. The vast majority of linguistic principles are not concerned with whether some particular kind of object exists somewhere in the universe, but with whether a particular object within the same unembedded sign

exists in order to license that sign. The Trace Principle (p. 400) is an excellent example:
"The SYNSEM *value of any trace must be a (noninitial) member of the* SUBCAT *list of a substantive word."*

Which substantive word could that be? This principle, in fact, is not meant to be a constraint on traces, but rather a constraint on signs that contain traces. What [P&S94] meant to say is that for every sign, if there is a finite path from its root node to a trace, then there must also be a finite path from the root node to some substantive word on whose SUBCAT list the SYNSEM value of the trace appears as a noninitial member. It is irrelevant whether the trace's SYNSEM value appears on some other unrelated word's SUBCAT list. This principle is working, so to speak, inside an unembedded sign. Within that scope, of course, it is easy to formalize this principle. This perspective can be most saliently observed in [P&S94] in the Trace Principle, the Control Theory (which looks for potential controlled *local* objects), the Quantifier Binding Condition (which excludes occurrences of a quantifier's index not captured by the quantifier) and the Binding Theory (which looks for potential o-commanders). We may also notice that the quantification in the *être* example from [A&G96] above is an instance of quantification over components as well.

There are a few proposed linguistic principles that have appealed to quantification over the world of objects, rather than over some particular sign, or more generally, over the components of a particular object. A crucial example is that of polarity items. At least in the tradition of [Baker70] and [Linebarger87], the grammaticality of a sentence that contains a Negative Polarity Item (NPI) may depend on the well-formedness of another sentence. The NPI *give a damn* in (1a) is licensed because it stands in the scope of a negation in the same sentence. In (1b), on the other hand, no such negation is present. In a Baker/Linebarger approach, the grammaticality of the sentence is accounted for indirectly by pragmatic licensing. (1b) has (1a) as one of its conventional implicatures. In this implicated sentence, the NPI is directly licensed, which also renders (1b) grammatical.

(1) a. John doesn't give a damn.
    b. John is too tired to give a damn.

From this brief characterization of the theory of NPI-licensing, it can be seen that the grammaticality of one sentence can possibly depend on the grammaticality of a second sentence. Should we, therefore, admit quantification over the universe of objects into our formal language for HPSG?

The relation between these two sentences is not arbitrary, but one of what Linebarger calls conventional implicature.[4] It has been argued in [P&S94, p. 27] that implicatures of exactly this kind should be part of the object that represents a given sentence. Conventional implicatures, in that approach, are explicitly mentioned as candidates for appearing as members of the BACKGROUND value. The existence of that value is motivated on independent grounds to account for the use of proper names and honorific forms. In our view, what few cases there are that would necessitate the more standard quantification can, and according to the philosophy of signs presented in [P&S94], should be reduced to instances of component quantification using this kind of approach.

[4]The precise connection between the two sentences is, however, hard to state. See the differences among [Baker70] and [Linebarger87] as well as the criticism and alternative explanation put forward in [Ladusaw80] and [Giannakidou97] among others.

An alternative to explicit quantification in the description language could be the use of junk slots. On the one hand, this technique shares the assumption that linguistic theories need only to be able to talk about substructures of a given object. In the context of junk slots, however, this assumption lacks any empirical force, because even relations become components of a described object. On the other hand, even simple formal systems such as SRL [King89, King94] can provide a means for a junk slot encoding of relations, including a junk slot encoding of "quantification". The basic problem, however, lies in the fact that junk slots cannot differentiate between the linguistically interesting parts of an object and its junk parts. This is more than just a problem of aesthetics. In a straightforward junk-slot encoding of `member`, for example, any element can be a member of any infinite list, as witnessed by the object consisting of an infinite embedding of *unfinished-member* objects:

$:\sim$ *finished-member* $\rightarrow$:ELT $\approx$:LIST FIRST

$:\sim$ *unfinished-member* $\rightarrow$:ELT $\approx$:REC ELT $\wedge$:LIST REST $\approx$:REC LIST

Here, the sort *member* has two subsorts, *finished-member* (*f-mem*) and *unfinished-member* (*u-mem*). The attributes ELT and LIST are appropriate to *member*, with the values *top* and *nelist*, respectively. *f-mem* and *u-mem* inherit these specifications from *member*; and *u-mem* has an additional attribute, REC, with value *member*.

In principle, linguistic objects can have an infinite number of substructures. In a Hinrichs-Nakazawa-style analysis [H&N89], nothing prevents the SUBCAT list of an argument raising verb, for example, from being infinite, if the argument from which it inherits SUBCAT elements is itself another argument raising verb. In RSRL, unlike junk slots, infinite objects will not result from the negation of encodings of relations over finite objects, but only from relations over genuinely infinite objects.[5] If the value of the LIST attribute above, for example, is not properly equated to a non-junk substructure of a described object, anything might appear as its value, including infinite lists. By this, it may happen that a "linguistically" finite object is not constrained in the desired way because of non-standard effects caused by infinite junk slots.

We are now ready to interpret our formulae:

Definition 4 *For each signature* Σ*, for each* Σ *interpretation* $I = \langle U, S, A, R\rangle$*,* $Ass_I = U^{\mathsf{Var}}$ *is the set of variable assignments in* I*.*

Definition 5 *For each signature* $\Sigma = \langle \mathcal{G}, \sqsubseteq, \mathcal{S}, \mathcal{A}, \mathcal{F}, \mathcal{R}, \mathcal{AR}\rangle$*, for each* Σ *interpretation* $I = \langle U, S, A, R\rangle$*, for each* $\mathrm{ass} \in Ass_I$*,* T_I^{ass} *is the total function from* $\mathcal{T}^\Sigma$ *to the set of partial functions from* U *to* U*, and* D_I^{ass} *is the total function from* $\mathcal{D}^\Sigma$ *to the powerset of* U *such that, for each* $u \in U$*,*

$T_I^{\mathrm{ass}}(:)(u)$ *is defined and* $T_I^{\mathrm{ass}}(:)(u) = u$*,*

for each $v \in \mathsf{Var}$*,* $T_I^{\mathrm{ass}}(v)(u)$ *is defined and* $T_I^{\mathrm{ass}}(v)(u) = \mathrm{ass}(v)$*,*

for each $\tau \in \mathcal{T}^\Sigma$*, for each* $\alpha \in \mathcal{A}$*,*

$T_I^{\mathrm{ass}}(\tau\alpha)(u)$ *is defined iff* $T_I^{\mathrm{ass}}(\tau)(u)$ *is defined and* $A(\alpha)(T_I^{\mathrm{ass}}(\tau)(u))$ *is defined, and if* $T_I^{\mathrm{ass}}(\tau\alpha)(u)$ *is defined then* $T_I^{\mathrm{ass}}(\tau\alpha)(u) = A(\alpha)(T_I^{\mathrm{ass}}(\tau)(u))$*,*

$$Co_I^u = \left\{ u' \in U \;\middle|\; \begin{array}{l} \textit{for some } \mathrm{ass} \in Ass_I, \\ \textit{for some } \pi \in \mathcal{A}^*, \\ \quad T_I^{\mathrm{ass}}(:\pi)(u) \textit{ is defined, and} \\ \quad u' = T_I^{\mathrm{ass}}(:\pi)(u) \end{array} \right\},$$

[5] We can even impose a constraint that all linguistic objects contain only a finite number of substructures; but see the remarks in section 4.

for each $\tau \in \mathcal{T}^{\Sigma}$, *for each* $\sigma \in \mathcal{G}$,

$$D_I^{\text{ass}}(\tau \sim \sigma) = \left\{ u \in U \;\middle|\; \begin{array}{l} T_I^{\text{ass}}(\tau)(u) \textit{ is defined, and} \\ S(T_I^{\text{ass}}(\tau)(u)) \sqsubseteq \sigma \end{array} \right\},$$

for each $\tau_1 \in \mathcal{T}^{\Sigma}$, *for each* $\tau_2 \in \mathcal{T}^{\Sigma}$,

$$D_I^{\text{ass}}(\tau_1 \approx \tau_2) = \left\{ u \in U \;\middle|\; \begin{array}{l} T_I^{\text{ass}}(\tau_1)(u) \textit{ is defined,} \\ T_I^{\text{ass}}(\tau_2)(u) \textit{ is defined, and} \\ T_I^{\text{ass}}(\tau_1)(u) = T_I^{\text{ass}}(\tau_2)(u) \end{array} \right\},$$

for each $\rho \in \mathcal{R}$, *for each* $x_1 \in \mathsf{Var}$, ... , *for each* $x_{\mathcal{AR}(\rho)} \in \mathsf{Var}$,

$D_I^{\text{ass}}(\rho(x_1, \ldots, x_{\mathcal{AR}(\rho)})) = \left\{ u \in U \;\middle|\; \langle \text{ass}(x_1), \ldots, \text{ass}(x_{\mathcal{AR}(\rho)}) \rangle \in R(\rho) \right\}$,

for each $\delta \in \mathcal{D}^{\Sigma}$, $D_I^{\text{ass}}(\neg\delta) = U \backslash D_I^{\text{ass}}(\delta)$,

for each $\delta_1 \in \mathcal{D}^{\Sigma}$, *for each* $\delta_2 \in \mathcal{D}^{\Sigma}$, $D_I^{\text{ass}}([\delta_1 \vee \delta_2]) = D_I^{\text{ass}}(\delta_1) \cup D_I^{\text{ass}}(\delta_2)$,

for each $v \in \mathsf{Var}$, *for each* $\delta \in \mathcal{D}^{\Sigma}$,

$$D_I^{\text{ass}}(\exists v\, \delta) = \left\{ u \in U \;\middle|\; \begin{array}{l} \textit{for some } u' \in Co_I^u, \\ u \in D_I^{\text{ass}\frac{u'}{v}}(\delta) \end{array} \right\}.$$

T_I^{ass} interprets terms as objects in the model. D_I^{ass} interprets formulae as sets of objects in the model. Notice that an n-ary relation symbol with its arguments can simply be interpreted as the set of objects whose n-tuples of substructures, as determined by variable assignment, are in the denotation of that relation. Co_I^u is the set of components of an object, u, in an interpretation, I. Notice also the appeal to Co_I^u in the interpretation of quantification. This is where the restriction to quantification over components is made. Negation, of course, corresponds to set complement.

We restrict relations and variables to components by requiring that, in grammatical principles, no free variables occur in formulae. Let $\mathcal{D}_0^{\Sigma}$ be the set of Σ formulae without free variables. We can easily prove that the denotation of each member of $\mathcal{D}_0^{\Sigma}$ is independent of variable assignments. Thus the following definition is well-formed:

Definition 6 *For each signature* Σ, *for each* Σ *interpretation* $I = \langle U, S, A, R \rangle$, D_I *is the total function from* $\mathcal{D}_0^{\Sigma}$ *to the powerset of* U, *and* Θ_I *is the total function from the powerset of* $\mathcal{D}_0^{\Sigma}$ *to the powerset of* U *such that*

for each $\delta \in \mathcal{D}_0^{\Sigma}$, $D_I(\delta) = \left\{ u \in U \;\middle|\; \begin{array}{l} \textit{for each } \text{ass} \in Ass_I, \\ u \in D_I^{\text{ass}}(\delta) \end{array} \right\}$,

for each $\theta \subseteq \mathcal{D}_0^{\Sigma}$, $\Theta_I(\theta) = \left\{ u \in U \;\middle|\; \begin{array}{l} \textit{for each } \delta \in \theta, \\ u \in D_I(\delta) \end{array} \right\}$.

Every object in our models must satisfy every description in a theory θ:

Definition 7 *For each signature* Σ, *for each* $\theta \subseteq \mathcal{D}_0^{\Sigma}$, *for each* Σ *interpretation* $I = \langle U, S, A, R \rangle$,
I *is a* $\langle \Sigma, \theta \rangle$ *model iff* $\Theta_I(\theta) = U$.

As [King95] observes, the linguistically intended model is one that contains instances of all objects that are permitted by the theory. Thus the intended model is, in a linguistically significant sense, the largest possible model of the grammar. This is called an *exhaustive model*:

Definition 8 *For each signature* Σ, *for each* $\theta \subseteq \mathcal{D}_0^{\Sigma}$, *for each* Σ *interpretation* I, I *is an exhaustive* $\langle \Sigma, \theta \rangle$ *model iff*

I is a $\langle \Sigma, \theta \rangle$ model, and
for each $\theta' \subseteq \mathcal{D}_0^{\Sigma}$, for each Σ interpretation I',
if I' is a $\langle \Sigma, \theta \rangle$ model and $\Theta_{I'}(\theta') \neq \emptyset$, then $\Theta_I(\theta') \neq \emptyset$.

The following important result has been proven for RSRL with chains.

Theorem 3.1 *For each signature Σ, for each Σ theory θ, there exists a Σ interpretation I such that I is an exhaustive $\langle \Sigma, \theta \rangle$ model.*

4 Computation

RSRL was designed as a formal language for the specification of HPSG grammars, not for computations such as parsing per se. For the purposes of developing a practical implementation based on RSRL, we would probably need to compromise on several characteristics. These problems are problems not just with RSRL, but with the requirements put forth by [P&S94] and other HPSG literature, simply taken at face value. Any other formalism that served justice to these requirements would face the same problems.

The first such requirement is negation. Computing with true negation is notoriously difficult in the general case; and can perhaps be replaced with a negation-by-failure mechanism, in the case of negated relations. Other instances of negation reduce to quantifier inversion, DeMorgan's laws, path inequations or sort disjunction. One could additionally attempt to reduce all instances of relations in practical grammars to the composition of a fixed inventory of primitive relations, the data structures and application of which could be heavily pre-compiled. This is the suggestion made in [KKP95]. Our proposal differs in that we believe the relations, although fixed and primitive, must still be RSRL-style relations for their proper interpretation.

The second is quantification over components. The restriction of quantification to substructures itself does not seem problematic. In fact, it is necessary in order to ensure the existence of exhaustive models. The restriction to components, objects corresponding to substructures accessible from the root node by a *finite* path, however, is cause for some concern. This, plus appropriateness, allows one to specify theories in which every object must have only finitely many substructures. The quantification proposed here cannot be used to restrict the number of disconnected objects; and neither SRL nor RSRL is powerful enough even to restrict the number of token objects that are indistinguishable by descriptions. If this were the case, then RSRL's ability to describe the finiteness of an object would make it non-compact, thus excluding the possibility of ever finding a finite proof theory for RSRL. As it stands, the question of exactly how powerful RSRL is in this regard is still an open one. The exhaustive models theorem, (Theorem 3.1), that we have for RSRL has been proven using quantification over components (and chains of components). For the purposes of computation, it may be preferable to change this to quantification over substructures. The former, however, is still what suits the use of quantification in HPSG the best — linguists are not specifying theories in consideration of objects with infinite paths; and these they would not be able to avoid in the latter. RSRL quantification allows the linguist to build theories whose models are populated by exactly the objects about which they are reasoning. Other restrictions on the use of quantification (level of nesting, normal forms for implications etc.) could also be envisaged to improve its computational properties.

5 Conclusion

The task of this paper was threefold: First, by quoting examples from [P&S94] and others, we intended to bring to the reader's attention that an adequate formal language for HPSG grammars not only needs a means to express true relations and true negation, but also explicit quantification over substructures. Second, we defined a formal language, RSRL, that provides these means and has the linguistically desired kinds of models, namely exhaustive models. Third, we pointed to some potential mismatches between the apparent intended use of feature-based languages in current HPSG theory and computational considerations for languages underlying practical systems. For HPSG, conceived of as a theory of language rather than as a theory of parsing, RSRL is the formal language which is by far the closest to the language implicitly used by most HPSG linguists.

Bibliography

[A&G96] Abeillé, A. and D. Godard (1996, juin). La complémentation des auxiliaires français. *Langages 122*, 32–61.

[Ait-Kaci84] Ait-Kaci, H. (1984). *A Lattice Theoretic Approach to Computation Based on a Calculus of Partially Ordered Type Structures.* Ph. D. thesis, University of Pennsylvania.

[Baker70] Baker, C. L. (1970). Double negatives. *Linguistic Inquiry 1*, 69–96.

[Car92] Carpenter, B. (1992). *The Logic of Typed Feature Structures.* Cambridge University Press. Cambridge, Massachusetts, USA.

[C&P96] Carpenter, B. and G. Penn (1996). Efficient parsing of compiled typed attribute value grammars. In H. Bunt and M. Tomita (Eds.), *Recent Advances in Parsing Technology.* Kluwer.

[Giannakidou97] Giannakidou, A. (1997). *The Landscape of Polarity Items.* Ph. D. thesis, University of Groningen.

[H&N89] Hinrichs, E. and T. Nakazawa (1989). *Flipped out: AUX in German.* Chicago Linguistic Society 25.

[H&S88] Höhfeld, M. and G. Smolka (1988). Definite relations over constraint languages. LILOG Report 53, IBM Deutschland.

[KKP95] Kasper, R., A. Kathol, and C. Pollard (1995). A relational interpretation of linear precedence constraints. *Paper presented at MOL4, Philadelphia.*

[K&P95] Kathol, A. and Pollard, C. (1995). Extraposition via complex domain formation, *Proceedings of the 33rd Annual Meeting of the ACL*, 174–180.

[King89] King, P. J. (1989). *A logical Formalism for Head-Driven Phrase Structure Grammar.* Ph. D. thesis, University of Manchester.

[King94] King, P. J. (1994). An expanded logical formalism for Head-Driven Phrase Structure Grammar. Arbeitspapiere des SFB 340, Nr. 59, Universität Tübingen.

[King95] King, P. J. (1995). From unification to constraint. Unpublished lecture notes, Universität Tübingen.

[Ladusaw80] Ladusaw, W. (1980). *Polarity Sensitivity as Inherent Scope Relations.* Garland Press.

[Linebarger87] Linebarger, M. C. (1987). Negative polarity and grammatical representation. *Linguistics and Philosophy 10*, 325–387.

[P&S87] Pollard, C. and I. Sag (1987). *Information Based Syntax and Semantics. Vol.1: Fundamentals.* CSLI Lecture Notes 13.

[P&S94] Pollard, C. and I. Sag (1994). *Head-Driven Phrase Structure Grammar.* University of Chicago Press.

Appendix A

We illustrate the applicability of RSRL to HPSG by a straightforward formalization of principle B of the binding theory as given in the appendix of [P&S94]. We proceed by quoting the verbal descriptions of the components of principle B from [P&S94], followed by their formalization in RSRL.

Principle B relies on the auxiliary notions *member*, *more oblique than*, *locally o-command* and *locally o-bind*, which are defined in turn.[6]

The relation `member` is defined as usual:

$$\forall x \forall y[\texttt{member}(x,y) \leftrightarrow [x \approx y\text{FIRST} \lor \texttt{member}(x,y\text{REST})]\ ]$$

"One *synsem* object is more oblique than another provided it appears to the right of the other on the SUBCAT list of some word." [P&S94, p. 401] In the formalization, x is more oblique than y on list z.

$$\begin{aligned}&\forall x \forall y \forall z[\ \texttt{more-oblique}(x,y,z) \leftrightarrow\\ &\quad x \sim \textit{synsem} \land y \sim \textit{synsem}\\ &\quad \land [[y \approx z\text{FIRST} \land \texttt{member}(x,\ z\text{REST})]\\ &\qquad \lor [\neg\ y \approx z\text{FIRST} \land \texttt{more-oblique}(x,y,z\text{REST})]]]\end{aligned}$$

"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." [P&S94, p. 401]. In the formalization, x locally o-commands y with respect to list z.

$$\begin{aligned}&\forall x \forall y \forall z[\texttt{loc-o-command}(x,y,z) \leftrightarrow\\ &\quad x\text{LOC CONT INDEX} \sim \textit{ref} \land y\text{LOC CONT INDEX} \sim \textit{ref} \land \neg\ x\text{LOC} \approx y\text{LOC}\\ &\quad \land [\texttt{more-oblique}(y,x,z)\\ &\qquad \lor \exists v[\texttt{member}(y,v\text{LOC CAT SUBCAT}) \land \texttt{more-oblique}(x,v)\ ]]]\end{aligned}$$

"A referential *synsem* object *locally o-binds* another provided it locally o-commands and is co-indexed with the other." [P&S94, p. 401] The use of the relation `loc-o-command` in the definition of `loc-o-binds` makes sure that x and y are referential *synsem* objects.

[6] According to the definitions above, only variables are allowed as arguments in relation calls. In this section, we use the following abbreviatory notation, where $\mathtt{r}$ is an n-place relation symbol, $\tau_1, \ldots, \tau_n$ are terms, at least one τ_i is not a variable, and $v_1, \ldots, v_n$ are distinct variables that are not free in $\tau_1, \ldots, \tau_n$: $\mathtt{r}(\tau_1, \ldots, \tau_n) \equiv \exists v_1 \ldots \exists v_n[\tau_1 \approx v_1 \land \ldots \land \tau_n \approx v_n \land \mathtt{r}(v_1, \ldots, v_n)]$

$\forall x \forall y \forall z[\texttt{loc-o-binds}(x, y, z) \leftrightarrow$
$\quad \texttt{loc-o-command}(x, y, z) \wedge x\text{LOC CONT INDEX} \approx y\text{LOC CONT INDEX}]$

With these definitions to hand, we can formalize principle B of the binding theory directly: "Principle B: A personal pronoun must be locally o-free." [P&S94, p. 401]

$: \sim \textit{word} \rightarrow$
$\quad \forall x \forall y[\ x\text{LOC CONT} \sim \textit{ppro} \rightarrow$
$\quad\quad \neg\ \texttt{loc-o-binds}(y, x, :\text{SYNSEM LOC CAT SUBCAT})\ ]$

For each word *w*, for each SYNSEM value, x, of a personal pronoun that is a component of *w*, and for every other component y of *w*, y does not locally o-bind x with respect to the word's SUBCAT list.

Chapter 29

Island Effects in Type Logical Approaches to the Minimalist Program

THOMAS L. CORNELL

ABSTRACT. Categorial approaches to the minimalist program have problems with cyclic movement and island effects, where the island is induced by a feature that has been checked. Chomsky [2] proposes a single solution to both problems: "interpretable" features do not delete even when checked, and therefore (a) they can be reused in cyclic movement and (b) they induce more persistent islands. We propose an implementation of Chomsky's Minimal Link Condition (MLC) in a multimodal categorial grammar and show how interpretable features can be given (very limited) access to contraction and weakening so as to prevent MLC violations even after they have been checked. Since interpretable features only appear negatively in the sequent antecedent, giving them access to contraction does not threaten the decidability of the logic.

1 The Problem

Categorial minimalist systems [7, 3, 1] run into a problem in handling island effects. These are typically induced by expressions all of whose features have already been checked. If feature checking is to be implemented as a logical elimination rule, then these expressions are gone from the proof at the point where they are needed to block communication between a higher functor and a lower argument.

(29.1) *(guess) to whom they remembered *which book* to give

(29.2) *John seems that *it* was told that IP

In (29.1), the Wh feature of *which book* should have been cancelled against the Wh feature of the complementizer selected by *remember*. In (29.2) the "Extended Projection Principle" (EPP) feature of *it* should have been cancelled against the finite Tense node in its clause. But if they were, then nothing would be left to block the movements of *to whom* and *John*, respectively.

Problems also arise in dealing with successive cyclic movement.

(29.3) We are likely t_3 to be asked t_2 to t_1 build airplanes.

The problem is that the same feature of *we* (again, the EPP feature) is being cancelled in several places. For example, the pronoun *we* must be so constituted that all of the following sentences are grammatical.

(29.4) We build airplanes.

(29.5) We have been asked to build airplanes.

(29.6) We are likely to be asked to build airplanes.

(29.7) We seem to be likely to be asked to build airplanes.

We assume, pursuing a standard transformational account of such examples, that raising is to be analyzed as the combination of *we* as an argument with a number of distinct functors. We assume as well, pursuing this account within a resource-sensitive, type-logical framework, that this is to be accomplished by assigning *we* some sort of product type, or *chain* type [3], each of whose members is a resource that must be used up during the derivation. To deal with cyclic movement (and island effects, as we will see) this product must contain a number of instances of the same feature, worse, a number which cannot be determined in advance and recorded permanently in the lexicon.

2 Chomsky's Solution

Chomsky's analysis of both island effects and successive cyclic movement in [2] is based on the same essential idea: that a certain class of features—Chomsky identifies them as the *interpretable* features—do not delete during a derivation, even if they have been checked, and, as a result, they can be used over again. In fact, as a result, they do not even ever have to be checked. So for example there is now no syntactic motivation for covert Wh-movement in multiple Wh questions. In a sentence like the following,

(29.8) Who gave the lucky couple which coffee maker?

there is evidently no necessity for *which coffee maker* to raise to Comp to check its Wh feature: it is an interpretable feature and as such is tolerated at LF, so it does not have to be checked, and the Wh feature of Comp itself has already been checked by *who*. These ideas about the syntactic treatment of "interpretable" features make it appear that the minimalist program, which elsewhere seems to fall squarely in the camp of linearly resource sensitive approaches to grammar, radically departs from a program of strict resource sensitivity.

The Wh feature of the Comp node itself still does have to be checked by something, so Wh in situ is still ruled out (in English) for simple Wh questions. This offers a key to "having one's resources and consuming them too." Chomsky's claim is that the features of the functional categories that attract moving expressions are formally [–interpretable], and therefore, in general, they will delete once checked. So, in effect, the resources which a numeration makes available for syntactic construction remain fixed on one side of the ledger, which in turn strictly limits the degree to which the computational system can access a single resource multiple times on the other side of the ledger.

This use of interpretable features yields a solution to the problem of island effects as well. The claim is that the features of the island-offender which are being attracted belong to the interpretable class (Wh in the case of $\bar{A}$-movement, D in the case of A-movement). Therefore these features of the island-inducer have not deleted after having been checked. Furthermore, they are technically speaking closer to the attracting functional head than are the respective island-violators. Accordingly, movement out of the island is blocked by the Minimal Link Condition.

3 Chomsky's Proposals in Type Logical Terms

Like much of the minimalist program, Chomsky's proposals here can be straightforwardly embedded within a type-logical deductive framework. However, the relative insensitivity to resources evident in these proposals clearly forces the embedding outside the "categorial" type logics, i.e., outside the bounds of multiplicative intuitionistic linear logic. Clearly, we will need to give certain resources (corresponding to the "interpretable" features) access to the structural rule of Contraction,

$$\frac{,\ [(\Delta, \Delta)] \vdash B}{,\ [\Delta] \vdash B}\ LC$$

which, read bottom-up, in the direction of proof search and grammatical derivation, allows for the multiplication of the resource structure Δ.

Furthermore, we will always need one more copy of a given interpretable feature than we can actually cancel, so that it remains available to induce island effects. Since it cannot be removed by a left slash rule (alias slash elimination), it must either be removed by Weakening,

$$\frac{,\ [\Delta_i] \vdash B}{,\ [(\Delta_1, \Delta_2)] \vdash B}\ LW_i$$

or else we need to tolerate axioms of the form

$$,\ [A] \vdash A$$

where , is required to contain only interpretable features, apart from A.

Devices to control access to these rules are already built into Linear Logic: this is what the exponentials $!A$ and $?A$ are used for. Essentially, our proposals amount to a more contextually restricted variant of an exponential couched within the logic of unary residuation rather than the basically S4 logic of the exponentials.

3.1 Minimalist derivations with strict resource sensitivity

Setting aside for a moment the problems introduced by Chomsky's treatment of interpretable features, we assume an implementation of the minimalist program based on [4] (and see also [3]) in type logical terms as follows.

1. We treat feature checking as type cancellation, i.e., via the use of left slash rules.

2. We treat minimalist derivations as proof searches (i.e., proofs read bottom-up) in a multimodal Gentzen sequent calculus. Goal sequents are to be read as "the given numeration (multiset of lexical formulas) derives the succedent type."

3. Movement is to be forced by the resource sensitivity of the system, according to Chomsky's Last Resort Principle. Therefore, lexical formulas which must have features checked in several places are implemented as product types. Here "formal features" are first class resources.

4. Contra Chomsky, we include categorial selection features in the syntax. (We allow category features, and selection features are their obvious logical dual [5].)

We assume the lexicon contains only first order formulas, that is: basic types, tuples of basic types and functions from basic types to tuples of basic types. We think of the basic types as being types of chain positions and product types as being the types of (XP) chains. A functional type takes several arguments to build up a phrase, which is then associated with the chain positions which are the type of the function's ultimate value.

We assume the base multimodal logic of residuation as presented, for example, by Moortgat [8]. This is essentially a multimodal version of the non-associative Lambek calculus [6], with the addition of "unary products", i.e., unary modal operators subject to the appropriate residuation law. The logical rules we employ are thus absolutely standard and we present here only the packages of structural rules we have superimposed on that logic.

The core operators that we will use will be the basic **NL** product $\bullet$ and two unary modals $\Diamond_0$ and $\Diamond_1$, together with their residuals. The $\bullet$ product will be used to glue features (i.e., chain positions) together and the two unary modals will be used to distinguish the use of a feature as a categorial selection feature ($\Diamond_0$) or as a formal feature ($\Diamond_1$). We will also make use of the following binary control modals: $\otimes, >, <, \triangleleft, \triangleright$, whose residuals we will typically not make use of.[1] These control modals supply crucial context in the definitions of various packages of structural rules.

We will use four distinct packages of structural rules. The first, the Numeration package (rules N1–N2), simply defines the numeration as a multiset, i.e., a sequent whose resources have free access to both permutation and association.[2] Another package, also simple, defines Merge, the operation which removes from numeration resources their freedom of movement (rule Mg). The Move package (rules Mv1–Mv3) implements the transformational component, allowing limited access to permutation and association to appropriately marked formulas. Finally, the Feature Checking package (rules F0c–F2) defines the checking configurations for formal and selectional features.

The $\otimes$ product is defined by the Numeration package to be the associative commutative product of **LP**.

$$N1: \; A \otimes B \Leftrightarrow\!\!\!\!\!\rightarrow B \otimes A \tag{29.9}$$

$$N2: \; A \otimes (B \otimes C) \longleftrightarrow (A \otimes B) \otimes C \tag{29.10}$$

[1] We assume that they are subject to the same logical rules as other residuals, i.e., they are present in the logic, but not in the lexicon. Since they do not appear in lexical type formulas, they will also not appear in grammatical derivations, and so we ignore them from now on.

[2] In [2], Chomsky distinguishes the numeration, which is and remains a multiset of lexical items, from the collection of *syntactic objects* which is essentially the working memory of the computational component. It is also a multiset. If one thinks of lexical items as trivial syntactic objects then there is no need to distinguish the numeration (proper) from the collection of syntactic objects. Here we refer to the combination of these two multisets simply as the numeration.

The main sequents of interest are sequents whose antecedents are pure numeration structures and whose consequents are basic categories, in particular c, the category of sentences.[3]

The numeration product can be "stiffened" by the Merge transformation, which converts substructures of the numeration into headed tree structures. We use $>$ and $<$ for building these "syntactic objects", with the narrow end taken to be pointing towards the head. (This phrase structure notation is borrowed from Stabler's work, e.g., [10]). That is, $A < B$ indicates that B is the complement of A and $A > B$ indicates that A is the specifier of B. It is only in these tree structures—the hypothesis goes—that movement transformations can be adequately controlled.

$$Mg: \; A \otimes B \Leftrightarrow\!\!\!\rightarrow \begin{cases} (A < B) & \text{, if } A \text{ is of the form } C/D; \\ (B > A) & \text{, if } A \text{ is of the form } A' < A'' \text{ or } A' > A''. \end{cases} \tag{29.11}$$

We use unary modals to distinguish two types of features: those involved in categorial selection, marked with $\Diamond_0$, and those involved in movement—Chomsky's "formal features"—marked with $\Diamond_1$. Only features marked with a $\Diamond_1$ are visible to the attraction system, i.e., only they can move. Note that if our functor types look like A/B for some atomic B, and our argument types looked like $\Diamond_i B$, then we would be in trouble since we have no way to get rid of the diamond. If we want to use unary modals to license access to structural rules then we must provide a way of removing them, either by making all of our functors look like $A/\Diamond_i B$ or by making our chain position types look like $\Diamond_i \Box_i^{\downarrow} B$. This latter is what we will assume, i.e., that all diamonds are ultimately "self-cancelling" by the use of the rules $L\Diamond$ and $L\Box^{\downarrow}$. This self-cancellation may seem vacous, but it is not. Formally,

$$\Diamond \Box^{\downarrow} A \Leftrightarrow\!\!\!\rightarrow A$$

by the residuation rule for unary operators, so the type denoted by $\Diamond \Box^{\downarrow} A$ must be a subset of the type denoted by A: in our case it is the proper subset which is subject to the various structural postulates that refer to the $\Diamond$ operator.

We also take it that in a formula $\Diamond_1 A \bullet B$, that is, a chain type whose first member is marked with a movable diamond, A can "pied pipe" B. In the following postulates we take $A^{\Diamond}$ to be a formula either whose main functor is $\Diamond_1$ or else whose main functor is $\bullet$ and whose leftmost proper subformula has main functor $\Diamond_1$. In the Move package we make use of a binary control modal $\lhd$ which connects the moving type to the rest of the structure. Transformational theory would have the movement accomplished in a single step, but here we must define it as the succession of very small steps. Accordingly the intermediate structures have no

[3] Observe that this means we do not get a language model of the sort made familiar in [9], in which the "prosodic" dimension of linguistic signs is supplied by a set of strings (**L**) or trees (**NL**) corresponding to the antecedents of the main grammar theorems. We still can get logical forms via the Curry-Howard morphism, but the "prosodic" dimension is harder to get, since we have not done anything to distinguish overt movement from covert movement.

status in the theory, so we so not want to use a product that has theoretical status.

$$Mv1: \ (B < A^{\diamond}) \Leftrightarrow\!\!\!\to (A^{\diamond} \lhd B) \tag{29.12}$$

$$Mv2: \ (A^{\diamond} > B) \Leftrightarrow\!\!\!\to (A^{\diamond} \lhd B) \tag{29.13}$$

$$Mv3: \ (C > (A^{\diamond} \lhd B)) \Leftrightarrow\!\!\!\to (A^{\diamond} \lhd (C > B)) \tag{29.14}$$

$$Mv4: \ (C < (A^{\diamond} \lhd B)) \Leftrightarrow\!\!\!\to (A^{\diamond} \lhd (C < B)) \tag{29.15}$$

$$Mv5: \ (C \otimes (A^{\diamond} \lhd B)) \Leftrightarrow\!\!\!\to (C \otimes (A^{\diamond} > B)) \tag{29.16}$$

Rule $Mv5$ implements the condition that all movement must be to the root (must "extend its target"). We can recognize the root of a syntactic object as the point at which we make contact with the numeration. For simplicity we subsume under this case the case where the numeration contains a single syntactic object, allowing C to be empty, in effect.

In the Feature Checking package, we must maneouver a single feature into a $\bullet$ configuration with the head of its structure. We have to consider two cases: for categorial selection features, complement position is a checking position, so a $\diamond_0$ marked feature in complement position can simply reassociate with the head to be in the appropriate configuration for the application of $L/$ ($F6$, $F7$). Specifier positions are checking configurations for both types of features. Specifiers require more complex handling, especially since Chomsky allows for the possibility of multiple specifiers in some languages. As a result we require a second "auxiliary product" $\rhd$, for building up structures that arise in intermediate stages of the feature cancellation process.

Rules $F1$ and $F2$ allow a feature (either singleton or part of a feature bundle) in any specifier position to cancel by placing it in the $\rhd$ relation with the head term. From there it is simply a matter of finding the ultimate head of the structure, either via rule $F4$ or $F5$.

$$F1: \ (\diamond_i A > B) \Leftrightarrow\!\!\!\to (\diamond_i A \rhd B) \tag{29.17}$$

$$F2: \ ((\diamond_i A \bullet B) > C) \Leftrightarrow\!\!\!\to (B > (\diamond_i A \rhd C)) \tag{29.18}$$

$$F3: \ (A \rhd (C > B)) \Leftrightarrow\!\!\!\to (C > (A \rhd B)) \tag{29.19}$$

$$F4: \ (A \rhd (B < C)) \Leftrightarrow\!\!\!\to ((A \bullet B) < C) \tag{29.20}$$

$$F5: \ (A \rhd B) \Leftrightarrow\!\!\!\to (A \bullet B), \ B \text{ unheaded.} \tag{29.21}$$

$$F6: \ (B < (\diamond_0 A \bullet C)) \Leftrightarrow\!\!\!\to ((B \bullet \diamond_0 A) < C) \tag{29.22}$$

$$F7: \ (B < \diamond_0 A) \Leftrightarrow\!\!\!\to (B \bullet \diamond_0 A) \tag{29.23}$$

3.2 The Minimal Link Condition

At the core of the theory of locality in the minimalist program lies the Minimal Link Condition (MLC). Let K range over functors (heads) and α and β over chain types.

> **The Minimal Link Condition.** K attracts α only if there is no β, β closer to K than α, such that K attracts β. ([2], p. 311)
>
> **Closeness.** If β c-commands α and τ is the target of raising, then β is closer to K than α unless β is in the same minimal domain as (a) τ or (b) α. ([2], p. 356)

Here "minimal domain" of a head essentially just means the expressions attached to a projection of that head, i.e., the "off-spine" members of its phrase. This definition entails that arguments in the target domain and the source domain cannot interfere with movement. Only members of domains properly between the source position and the target position can intervene.

Therefore, we must take some pains to distinguish for a moving expression whether it is still in its source domain, in some intermediate domain, or in its target domain. We therefore propose the following refinement of the movement package to allow a precise implementation of the MLC. We will split the auxiliary product $\lhd$ in three: $\lhd_1$, $\lhd_2$ and $\lhd_3$. Rules $Mv1$ and $Mv2$ must be modified so that they introduce $\lhd_1$, the initial "state" of this product. Movement rule $Mv4$ represents the configuration in which the moving expression $A^\diamond$ leaves one domain (B) and enters the domain of a new head (C), so $Mv4$ is where we change state:

$$Mv4: \ (C < (A^\diamond \lhd_i B)) \Leftrightarrow\!\!\!\rightarrow (A^\diamond \lhd_j (C < B)) \tag{29.24}$$

where, if $i = 1$ then $j = 2$ and if $i = 2$ then j can be either 2 or 3. Note that if $i = 3$ then the derivation crashes, since we are supposed only to enter state 3 in the target domain. $Mv5$ must then be modified to require $\lhd_3$.

That leaves us with $Mv3$, which is where we actually impose the MLC.

$$Mv3: \ (C > (A^\diamond \lhd_i B)) \Leftrightarrow\!\!\!\rightarrow (A^\diamond \lhd_i (C > B)) \tag{29.25}$$

Recall that any legitimate intervener must be found in a strictly intermediate domain, so while we are in state 2. Rule $Mv3$ will therefore operate for all $\lhd_i$, but when $i = 2$ it will be subject to the side condition that C not count as an intervener. That is, the leftmost feature of C must not be the same as the leftmost feature of $A^\diamond$. Recall that it is the leftmost feature of $A^\diamond$ that will be cancelled at the end of the movement step, so this is the feature that counts as what is being attracted. C could only be attracted by K if its leftmost feature could be cancelled by K as well.

Note that this condition rests crucially on the assumption that, at the point of the derivation at which $A^\diamond$ crosses C, C still has the relevant blocking feature. If that feature *can* be cancelled (by the head of B) then there is sure to be a derivation in which it *has* been cancelled at the point at which $A^\diamond$ passes by, and so is no longer available to block movement. We turn to this problem in the next subsection.

3.3 Controlling Access to Contraction and Weakening

Now we return to considering the difference, within formal features, between "[+interpretable]" and "[–interpretable]" features, and we introduce a further Interpretable Features package for handling controlled access to contraction and weakening. There are now essentially three types of features we must deal with: features which are not allowed to move but must be cancelled where they are merged into a structure, features which are allowed to move but not to multiply, and features which are allowed both to move and to multiply. We will introduce a new control modal, $\diamond_2$, to mark these [+interpretable] features. We redefine the movement rules so that $A^\diamond$ stands for a formula with a diamond of whichever movable sort—the movement rules themselves do not distinguish between the two types of formal features.

The two moveable diamonds differ in their behavior at the end of a movement transformation, however. Once we have placed a $\Diamond_2$ formula in a specifier position, instead of cancelling it, we cancel a *copy* of it.

$$I1: \ (\Diamond_2 A > B) \Leftrightarrow\!\!\!\rightarrow (\Diamond_2 A > (\Diamond_2 A \rhd B)) \tag{29.26}$$

$$I2: \ ((\Diamond_2 A \bullet C) > B) \Leftrightarrow\!\!\!\rightarrow ((\Diamond_2 A \bullet C) > (\Diamond_2 A \rhd B)) \tag{29.27}$$

In the case if $I2$, there is a further complication to consider: either we intend to move the formula to cancel A again (the case of successive cyclic movement), or we are done with A and wish to keep it around only to induce islands for other formulas' movements. The Feature Cancellation package assumes that the feature to be cancelled is left-most in its $\bullet$-tuple, so features that we are done with have to be gotten out of the way. We can do this by using the $\Diamond_2$ to allow permutation and association within a chain type.

$$I3: \ (\Diamond_2 A \bullet B) \Leftrightarrow\!\!\!\rightarrow (B \bullet \Diamond_2 A) \tag{29.28}$$

$$I4: \ ((B \bullet C) \bullet \Diamond_2 A) \Leftrightarrow\!\!\!\rightarrow (B \bullet (C \bullet \Diamond_2 A)) \tag{29.29}$$

The purpose of the $I3$ and $I4$ rules, once again, is to get used-up interpretable features out of the way of any remaining syntactically active features.

The rules $I1$ and $I2$ give us our controlled access to Contraction. Note that every application of Contraction introduces one feature which must be cancelled and one "generator" feature, from which more copies can be made. As a result we will always end up with one uncancelled—and uncancellable—generator feature, which we will have to account for by other means than a logical cancellation rule. We propose the following restricted weakening rules.

$$I5: \ (B < \Diamond_2 A) \Leftrightarrow\!\!\!\rightarrow B \tag{29.30}$$

$$I6: \ (B < (\Diamond_2 A \bullet C)) \Leftrightarrow\!\!\!\rightarrow (B < C) \tag{29.31}$$

$$I7: \ (\Diamond_2 A > B) \Leftrightarrow\!\!\!\rightarrow B, \ B \text{ unheaded.} \tag{29.32}$$

$$I8: \ ((\Diamond_2 A \bullet C) > B) \Leftrightarrow\!\!\!\rightarrow (C > B), \ B \text{ unheaded.} \tag{29.33}$$

The side condition on the second pair of weakening rules is meant to ensure a condition which we wish to hold in general, namely that we can only throw away a $\Diamond_2$ formula when it no longer c-commands anything. In that case we can be assured that it induces only a vacuous island, since there is nothing that could possibly move past it.

Note that it is possible to remove $\Diamond_2$ formulas too soon: $\Diamond_2 A$ in $I5$–$I8$ could conceivably be attracted by some higher head from such a configuration. However, if there is no closer instance of A to the attracting head (i.e., movement is possible in the first place) then there is no other formula in the structure which could cancel against the attracting head, and no derivation would be possible.

4 Concluding Remarks

Chomsky's theory of [+interpretable] features is one of the most fundamental points at which the minimalist program seems—at least at first glance—*not* to be like categorial grammar. These ideas heavily disrupt the perceived parallelism between feature checking in minimalist derivations and logical elmination rules in categorial derivations, in particular since it appears that most features of argument categories turn out to be [+interpretable] and therefore strictly outside of this neat, highly resource conscious derivation scheme. We hope to have shown here that the standard mechanisms of multimodal type logical grammar can be employed to rein in the excesses of this class of features. In particular, the introduction of (forms of) contraction does not threaten the decidability of the system, since they may only be applied to chain types, i.e., logically negative atoms of the sequent antecedent.

Nonetheless an explanatory debt is incurred which will be hard to pay off. We have here treated Chomsky's label "[+interpretable]" as nothing more than a label, but Chomsky clearly intends to offer an explanation for the reusability of this class of features. Namely, these are supposed to be exactly those features which are needed in the derivation in order to construct an LF. But our derivations are just type checking computations. There is no sense in which an LF is constructed directly out of the types in the goal sequent. Such a derivation produces an LF implicitly: it is to be read off the structure of the proof. For example, one could easily enough use something like the Curry-Howard morphism to construct a GB-style LF structure rather than a lambda-term, if that was desirable. But then the "interpretability" of a given type has to do with whether or not the chain position it types is used in that LF proof term. This is an altogether different relation than that which holds in the proof machinery itself among type formulas subject to structural inference rules.

Bibliography

[1] Robert C. Berwick and Samuel D. Epstein. Computational minimalism: The convergence of the minimalist syntactic program and categorial grammar. In *TWLT-10: Algebraic Methods in Language Processing*, Enschede, the Netherlands, 1995. AMAST, Faculty of Computer Science, University of Twente.

[2] Noam Chomsky. *The Minimalist Program*. MIT Press, Cambridge, MA, 1995.

[3] Thomas L. Cornell. A type-logical perspective on minimalist derivations. In *Proceedings of Formal Grammar '97*, Aix-en-Provence, France, August 1997.

[4] Thomas L. Cornell. A calculus for categories and transformations. Ms. in prep., University of Tübingen, 1998.

[5] J. Lambek. The mathematics of sentence structure. *American Mathematical Monthly*, 65:154–170, 1958.

[6] J. Lambek. On the calculus of syntactic types. In R. Jakobson, editor, *Structure of Language and Its Mathematical Aspects*, Providence, Rhode Island, 1961. Proceedings of the Twelfth Symposium in Applied Mathematics.

[7] Alain Lecomte. POM-nets and minimalism. In Claudia Casadio, editor, *Proceedings of the IV Roma Workshop: Dynamic Perspectives in Logic and Linguistics*. SILPS Group in Logic and Natural Languages, 1997.

[8] Michael Moortgat. Categorial type logics. In J. van Benthem and A. ter Meulen, editors, *Handbook of Logic and Language*, chapter 2. Elsevier, 1996.

[9] Glynn Morrill. *Type Logical Grammar*. Kluwer, Dordrecht, 1994.

[10] Edward Stabler. Derivational minimalism. In Christian Retoré, editor, *Logical Aspects of Computational Linguistics*, pages 68–95, Berlin, 1997. Springer. LNAI 1328.

Chapter 30

Towards Incremental Lexical Acquisition in HPSG

Markus Walther and Petra Barg*

Abstract. In this paper we present an implemented system for the incremental acquisition and revision of lexical entries in HPSG. As a byproduct of parsing, linguistic properties of unknown words are inferred from their sentential context. After parsing, the corresponding lexical entries are updated accordingly. A key idea of our approach is to employ a gradual, information-based concept of "unknownness", where lexical entries may contain unknown, i.e. revisable pieces of information. Revisable information is further classified into specializable and generalizable kinds. The overall approach is compatible with standard HPSG analyses and poses only a few extra demands on the grammar. These include marking revisable information with one of two distinguished formal types and specifying revisability clauses that provide access to the places of revisable information within the parse result. The update mechanism revises the corresponding places in the lexical feature structures iff the context actually provides new information. Revision translates to simple type intersection in the case of specializable information, whereas generalizable information requires type union. We demonstrate the inferential capacity of our system by illustrating in detail how verbal argument structure is incrementally acquired.

1 Introduction

No lexicon can ever be complete. Despite this fact many NLP systems still cannot handle unknown words and lack facilities for the automatic extension of the lexicon. Notable exceptions include Erbach (1990) and Hastings & Lytinen (1994). See Zernik (1989) for an introduction to the general issues involved.

This paper presents an HPSG-based system which incrementally learns properties of unknown words by parsing individual sentences. The system is applied to a fragment of German. It focusses on extracting linguistic properties, as compared to general concept learning (Hahn, Klenner & Schnattinger 1996). Unlike Erbach (1990), however, it is not confined to simple morpho-syntactic information but can also handle selectional restrictions, semantic types and argument structure. Finally, while statistical approaches like Brent (1991) can gather e.g. valence information from large corpora, they are often confined to batch-mode learning and tailored to the extraction of a single linguistic property. In contrast, we are more interested

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in full grammatical processing of individual sentences to maximally exploit each context. In the course of incremental acquisition, we are able to acquire several properties simultaneously.

The grammar is written in MicroCUF, a simplified version of the CUF typed unification formalism of Dörre & Dorna (1993) that we implemented in SICStus Prolog. MicroCUF inherits both the feature logic and the relational extensions, but substitutes a closed-world type system for CUF's open-world regime. A significant feature of our type system implementation is that type revision in internal feature structures (FSs) is easy.

2 Unknown information

A key idea of our approach is to employ a *gradual*, information-based conceptualization of "unknownness". Words are not unknown as a whole, but may contain *unknown, i.e. potentially revisable pieces of information*. Consequently, even known words can undergo revision e.g. to acquire new senses. This view replaces the binary distinction between open and closed class *words*. Furthermore, we share the common assumption that pieces of information can be organized in a hierarchy whose ordering is defined by subsumption. Hence, when a text containing unknown words is parsed, each sentence provides new *information* that can be either identical, more specific, more general, or even conflicting with respect to information supplied by previous contexts.

It makes sense to subdivide information into two basic categories, namely known or strict information, and unknown or revisable information. Strict information is never affected by contextual influence. An example of this category of known information would be the terminal value type of [synsem|loc|cont|ind|pers *third*] – no context can change the fact that German nouns invariably appear in third person. In contrast, revisable information in general exhibits both context-sensitive and non-uniform behaviour: new sentential contexts may e.g. succeed in narrowing down the gender of an unknown noun while simultaneously enlarging the range of possible argument structures that an unknown verb licenses. Hence, we require a further distinction here, namely that between *specializable* and *generalizable* information.[1] The *specializable* kind of information is exemplified by the gender and semantic type of nouns as well as their inflectional class (given a morphological component). If e.g. a non-feminine determiner agrees with an unknown German noun via unification, further contexts can only specialize the noun's gender to neuter or masculine. *Generalizable* kinds of information include argument structure, selectional restrictions, and predicative vs attributive usage of adjectives. Thus, an unknown verb that occurs with a subject of a semantic type τ must have selectional restrictions for the subject that are at least as general as τ, becoming more general as further contexts are encountered.

Note that specializable and generalizable information can cooccur in a given lexical entry. Also, a particular kind of information may figure in both classes, as e.g. the semantic type of nouns and selectional restrictions of verbs are both drawn from the same semantic ontology. Yet the former must be invariantly specialized, whereas

[1]The different behaviour underlying this classification has previously been noted by e.g. Erbach (1990) and Hastings & Lytinen (1994) but received either no implementational status or no systematic association with arbitrary *pieces of linguistic information*.

selectional restrictions on NP complements should only become more general with further contexts.

2.1 Representation of revisable information

While we wish to maintain compatibility with standard HPSG analyses, the special focus on revisability poses some extra demands on the grammar. First of all, we require all revisable or updatable information to be expressible by formal types. As relational clauses can be defined to map types to feature structures, this is not much of a restriction in practice. Our type hierarchy includes a fairly elaborate ontology of semantic types that was derived from a systematic corpus study of a biological domain, the description of nervous systems in Knodel (1980, 154-188). It also covers all valence classes encountered in the corpus. Figure 30.1 shows a relevant fragment. Whereas the combination of specializable information translates into

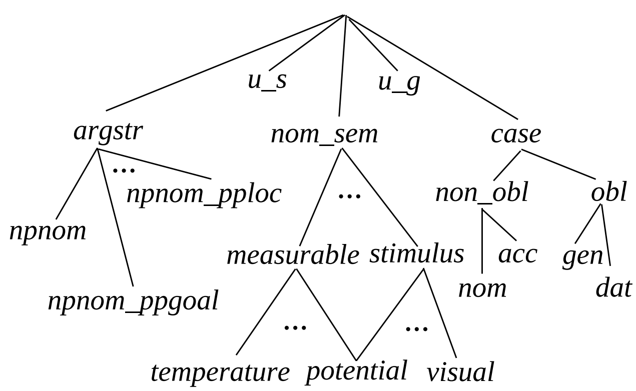

Figure 30.1: *Excerpt from type hierarchy*

simple type unification (e.g. $measurable \wedge stimulus = potential$), combining generalizable information requires *type union* (e.g. $dat \vee gen = obl$).[2] The latter might prove impractical for type systems requiring the explicit definition of all possible unions, corresponding to least common supertypes. However, type union is easy for (Micro)CUF and similar systems which allow for arbitrary boolean combinations of types.

In order to mark revisable information as such, we introduce two disjoint auxiliary types, namely *u_g* and *u_s*. Strict, i.e. non-revisable information has neither of these types and hence will not be considered for updating. In the case of generalizable information *u_g* serves the additional purpose of correctly specifying the initial unknown information state. This is because 'content' types like *case, nom, acc, dat, gen* are to be interpreted as recording what contextual information was encountered in the past. Thus, using any of these to prespecify the *initial* value would be wrong (cf. $case_{initial} \vee nom = case$, but $u\_g_{initial} \vee nom = u\_g \vee nom$).

Generalizable information raises another question: can we simply have types like those in fig. 30.1 within HPSG signs and do in-place type union, just like type unification? The answer is no, for essentially two reasons: First, we still want to rule

[2]Henceforth, we will use (type) unification and logical conjunction ($\wedge$) interchangeably. The same holds for union ($\cup$) and logical disjunction ($\vee$).

out ungrammatical constructions through (type) unification failure of coindexed values, so that generalizable types cannot *always* be combined by nonfailing type union. For example, $_{PP}[P_{\boxed{1}}[dat]\ NP_{\boxed{1}}[gen]]$ must be ruled out by $dat \wedge gen = \perp$, although case within a PP *argument* is generalizable. One might consider ordering all type unifications pertaining to a value before all unions, but this violates the order independence of constraint solving. Secondly, since a particular kind of information can figure in both revisability classes, it is unclear how to decide between in-place union and unification.

To avoid these problems and keep the declarative monotonic setting, we employ two independent features gen and ctxt. The feature ctxt is the repository of contextually unified information, where conflicts result in ungrammaticality. The feature gen holds generalizable information.[3] Since our grammar specification ensures that all gen values contain *u_g* as a type disjunct, they will always unify and thus are not restrictive during the parse. To nevertheless get correct gen values we perform type union *after* parsing, i.e. during lexicon update. We will see below how this works out.

Just like any other feature structure material, revisable information is unified by HPSG principles during a parse, thus appearing in various places of the parse result. Therefore, we need a further representational means to access embedded revisable information in the parse feature structure. For this purpose the grammar defines revisability clauses like the following:

$$\text{a. generalizable}(\boxed{1}, \boxed{2}) := \left[\mathsf{synsem} \mid \mathsf{loc} \mid \mathsf{cat} \left[\begin{array}{ll}\mathsf{head} & \textit{verbal}\\ \mathsf{arg\text{-}st} & \left[\begin{array}{l}\mathsf{gen} \mid \mathsf{type}\ \boxed{1}\\ \mathsf{ctxt} \mid \mathsf{type}\ \boxed{2}\end{array}\right]\end{array}\right]\right]$$

$$\text{b. specializable}(\boxed{1}) := \left[\mathsf{synsem} \mid \mathsf{loc} \left[\begin{array}{ll}\mathsf{cat} \mid \mathsf{head} & \textit{noun}\\ \mathsf{cont} \mid \mathsf{ind} \mid \mathsf{gend} & \boxed{1}\end{array}\right]\right]$$

Figure 30.2: Revisability clauses

2.2 Processing revisable information

Since the representation of revisable information does not make use of any special devices, parsing sentences with unknown or revisable words is conventional. Any HPSG-compatible parser may be used, subject to the obvious modification that lexical lookup must succeed even if a word's phonology is unknown. In this case a canonical entry is returned. For this purpose the grammar defines maximally underspecified generic lexical entries for nouns, adjectives and verbs. The actual updating of lexical entries takes place after the parse and consists of the following steps:

[3]Note that these feature values may themselves take the form of a complex feature structure; we will take liberty in sometimes abstracting from this internal structuring in what follows.

- **Determine update candidates:** The parse FS of the sentence is projected onto all participating word tokens.[4] This results in word FSs which are contextually enriched and disambiguated (choosing the compatible disjunct per parse solution if the entry was disjunctive). The set of word FSs is then filtered by unification with the right-hand side of revisability clauses like in fig. 30.2. The result is a list of update candidates for those words which were unifiable.

- **Determine update values:** For each matching *generalizable/2* clause we take the type union of the gen value of the old, lexical state of the word ($LexGen$) with the ctxt value of its parse projection ($Ctxt$): $TU = LexGen \cup Ctxt$. For each matching *specializable(Spec)* clause we take the parse value *Spec*.

- **Check necessity of update:** For each update candidate, we check whether updating would actually change the corresponding lexical entry. The condition to be met by generalizable information is that $TU \supsetneq LexGen$. For specializable information we similarly require $Spec \subsetneq LexSpec$. Both conditions can be implemented by type subsumption and inequality.

- **Modify lexical entries:** For all words that have to be updated we retract the old lexical entry, revise the entry and re-assert it. For words never encountered before, revision is preceded by making a copy of the generic unknown entry, but with the new word's phonology. Revision itself consists of the destructive modification of type information according to the determined values, at the places in a lexical FS pointed to by the revisability clauses.

Note that type revision is easy in MicroCUF, as types are implemented with the *attributed variable* mechanism of SICStus Prolog, which allows us to substitute a type in place (Holzbaur 1990). In comparison, general updating of Prolog-encoded FSs would typically require the traversal of large structures and be dangerous if structure-sharing between substituted and unaffected parts existed.

Also, we currently assume that lexical entries are expanded into disjunctive normal form, so that updates work on the contextually selected disjunct. This can be motivated by the advantages of working with presolved structures at runtime, avoiding description-level operations and incremental grammar recompilation.

3 Acquiring German verbs

Important subtasks of lexical acquisition include specializing and generalizing revisable information. The former task is easier, as it can be equated with unification. Since we have shown details of the revision of specializable information in Barg & Walther (1998), we now concentrate on generalizable information, illustrating the incremental lexical revision of verbal argument structure.

3.1 Representation of argument structure

We follow Manning & Sag (1997) in assuming an independent level of argument structure and Bouma (1997) in using argument structure to eliminate procedural

[4] In our implementation this is actually done on-the-fly during parsing.

lexical rules in favour of relational constraints. For technical reasons, however, we need to introduce two new features for the representation of argument structure. The two features are type and args, where the former specifies a formal type (hereafter: verbal class) compatible with $u\_g \vee argstr$ (fig. 30.1) and the latter includes the actual list of arguments. Verbal entries specify subtypes of $u\_g \vee argstr$ plus further idiosyncratic restrictions on the arguments themselves like the semantic type of NP arguments or case and form of PP arguments. The full instantiation of the argument list is accomplished outside the lexical entries, using a relational constraint that maps the verbal class to a list of arguments. Argument list and valence features subj and comps are connected via a further mapping principle.

The generic lexical entry for unknown verbs appears in fig. 30.3. As the verbal class must be *generalizable*, the initial value of gen|type is u_g. The corresponding value of ctxt|type, which stores the contextually inferred class, is not, as one might expect, left completely underspecified. Instead, we specify the value *open-arg-st-type*, the root type of all productive verbal classes. This rules out the acquisition of argument structures for unproductive verbal classes like auxiliaries. Revisable information concerning particular arguments is not specified in the generic entry itself but will be provided through later instantiation of the argument list.

$$\left[\text{synsem}\,|\,\text{loc}\,|\,\text{cat}\ \left[\begin{array}{ll}\text{head} & \textit{verbal}\\ \text{arg-st} & \left[\begin{array}{l}\text{gen}\,|\,\text{type}\ \ \textit{u\_g}\\ \text{ctxt}\,|\,\text{type}\ \textit{open-arg-st-type}\end{array}\right]\\ \text{spr} & \langle\rangle\end{array}\right]\right]$$

Figure 30.3: Generic entry for unknown verbs

3.2 Acquisition of argument structure

We will illustrate how incremental lexical revision works by going through the examples under (30.1)-(30.3). The relevant substructures of the updated lexical entry for the German verb *deszendiert* 'sink', regarded by us as unknown, are depicted in fig. 30.4 (path synsem|loc|cat|arg-st omitted).

(30.1) Die Kerntemperatur **deszendiert**.
'the core temperature **sinks**'

(30.2) Das Aktionspotential **deszendiert** unter den Schwellenwert.
'the action potential **sinks** below the threshold value'

(30.3) Das Aktionspotential **deszendiert** im Axon.
'the action potential **sinks** in the axon'

Sentence (30.1) provides the information that *deszendiert* can be used intransitively with a nominative subject, which is mapped to the only argument of arg-st|ctxt|args by the above-mentioned relational constraint. The parse derives the verbal class that can instantiate this singleton list, namely *npnom* as the value of arg-st|ctxt|type. As the generalizable clause in fig. 30.2a matches and the parse value differs from the lexical value u_g, the value of arg-st|gen|type is updated to $u\_g \vee npnom$ (fig. 30.4a). A further generalizable clause matches that identifies the semantic type of the first (i.e. subject) argument as potentially revisable. Since the parse value *temperature* differs from the initial u_g, updating yields $u\_g \vee temperature$. Note that, although information is accumulated in arg-st|ctxt during the parse, all updating of argument structure affects arg-st|gen alone and leaves the values of arg-st|ctxt unchanged.

In (30.2) *deszendiert* appears with a nominative subject and an accusative PP. The parse value of arg-st|ctxt|type that maps to this pattern is *npnom_ppgoal*. This new value is unioned with the old value $u\_g \vee npnom$, yielding $u\_g \vee npnom \vee npnom\_ppgoal$ (fig. 30.4b). The semantic type of the subject argument can be updated analogously to $u\_g \vee temperature \vee potential$. There are further revisability clauses which license an update of information of the second argument. The value of pcase as well as that of pform is generalizable. As both values differ from their lexical counterparts, the lexical entry is updated accordingly, yielding the values $u\_g \vee acc$ and $u\_g \vee unter$, respectively. Furthermore, the semantic type of the embedded NP can be generalized to $u\_g \vee value$.

a. $$\left[\begin{array}{l} \textsf{gen}\left[\begin{array}{l}\textsf{type}\ u\_g \vee npnom \\ \textsf{args}\ \left\langle\left[\textsf{loc}\,|\,\textsf{cont}\,|\,\textsf{restr}\,|\,\textsf{rel}\,|\,\textsf{gen}\ u\_g \vee temperature\right] \,|\, \_\right\rangle\end{array}\right] \\ \textsf{ctxt}\,|\,\textsf{type}\ open\text{-}arg\text{-}st\text{-}type\end{array}\right]$$

b. $$\left[\begin{array}{l} \textsf{gen}\left[\begin{array}{l}\textsf{type}\ u\_g \vee npnom \vee npnom\_ppgoal \\ \textsf{args}\left\langle\begin{array}{l}\left[\textsf{loc}\,|\,\textsf{cont}\,|\,\textsf{restr}\,|\,\textsf{rel}\,|\,\textsf{gen}\ u\_g \vee temperature \vee potential\right], \\ \left[\textsf{loc}\left[\begin{array}{l}\textsf{cat}\,|\,\textsf{head}\left[\begin{array}{l}\textsf{pcase}\,|\,\textsf{gen}\ u\_g \vee acc \\ \textsf{pform}\,|\,\textsf{gen}\ u\_g \vee unter\end{array}\right] \\ \textsf{cont}\,|\,\textsf{ref}\,|\,\textsf{gen}\ u\_g \vee value\end{array}\right]\right] \,|\, \_\end{array}\right\rangle\end{array}\right] \\ \textsf{ctxt}\,|\,\textsf{type}\ open\text{-}arg\text{-}st\text{-}type\end{array}\right]$$

c. $$\left[\begin{array}{l} \textsf{gen}\left[\begin{array}{l}\textsf{type}\ u\_g \vee npnom \vee npnom\_ppgoal \vee npnom\_pploc \\ \textsf{args}\left\langle\begin{array}{l}\left[\textsf{loc}\,|\,\textsf{cont}\,|\,\textsf{restr}\,|\,\textsf{rel}\,|\,\textsf{gen}\ u\_g \vee temperature \vee potential\right], \\ \left[\textsf{loc}\left[\begin{array}{l}\textsf{cat}\,|\,\textsf{head}\left[\begin{array}{l}\textsf{pcase}\,|\,\textsf{gen}\ u\_g \vee acc \vee dat \\ \textsf{pform}\,|\,\textsf{gen}\ u\_g \vee unter \vee in\end{array}\right] \\ \textsf{cont}\,|\,\textsf{ref}\,|\,\textsf{gen}\ u\_g \vee value \vee fibre\end{array}\right]\right] \,|\, \_\end{array}\right\rangle\end{array}\right] \\ \textsf{ctxt}\,|\,\textsf{type}\ open\text{-}arg\text{-}st\text{-}type\end{array}\right]$$

Figure 30.4: Update sequence for verbal argument structure

From sentence (30.3) the system learns that *deszendiert* also licenses a locative PP. The value of arg-st|gen|type receives a further update by union with *npnom_pploc*. Although there is a matching generalizable clause, the semantic type of the subject argument does not have to be updated this time because the update would not make any difference with respect to the old value. In contrast, all revisable information of the second argument must again be updated. The final argument structure for *deszendiert* is shown in fig. 30.4c.

4 Discussion

Our approach realizes an incremental, context-driven mechanism for the acquisition of lexical entries. It maximally exploits standard HPSG representations, requiring moderate rearrangements in grammars at best while keeping with the standard assumptions of typed unification formalisms. One noteworthy formal demand, however, is the need for a type union operation. While our model has been evaluated by parsing example sentences drawn from the corpus, a more realistic evaluation requires further extension of our grammar's coverage and the use of a more efficient parse strategy. Both topics form part of our current research.

Of course, some areas require further consideration. The first issue concerns how to keep track of alternative parses and their update hypotheses. In the context of argument structure, alternative hypotheses become most obvious if relational constraints for verbal alternations are involved (included in our grammar but not shown here). In this case the analysis of sentence (30.1) gives rise not only to the verbal class *npnom* but also to alternative classes licensing *optional* arguments. Details remain to be worked out on how to delay the choice between such alternative hypotheses until further contexts provide sufficient information.

Another question is how to treat dependencies between revisable pieces of information. In fig. 30.4c the system has *independently* generalized over properties of the second argument. However, there are clear cases where this leads to overgeneration: ??*Das Aktionspotential deszendiert* <u>*im Schwellenwert*</u> 'the action potential sinks in the threshold value' combines the preposition *im* and a noun of type *value* that did not cooccur in (30.1)-(30.3). An idea worth exploring is to have a partial, extensible list of type cooccurrences which is traversed by a recursive principle at parse time. Alternatively, an updatable version of distributed or dependent disjunctions (Griffith 1996) might be devised to capture the dependencies.

A more general issue is the apparent antagonism between the desire to have both sharp grammatical predictions and continuing openness to contextual revision. At the moment, all generalizable information is merely accumulated but not used to restrict parses. This is necessary because if, e.g. after parsing (30.1) we transferred the acquired semantic type of the subject argument (*temperature*) into the restricting ctxt feature, the parse of (30.2) would fail because *Aktionspotential* is of type *potential*. Future research must investigate strategies for when to consider information certain and when to make revisable information restrictive.

Finally, we employ a conservative form of generalization, taking the disjunction of actually observed values. While this has the advantage of not leading to overgeneralization, the requirement of having to see all subtypes in order to infer their common supertype is not realistic ('sparse-data problem'). Here the work of Li & Abe (1995), who use the MDL principle to generalize over the slots of observed case frames, might prove fruitful.

Bibliography

Barg, P. & M. Walther (1998). Processing Unknown Words in HPSG. In: *Proceedings COLING/ACL '98*, Montréal.

Bouma, G. (1997). Valence Alternation without Lexical Rules. In: J. Landsbergen, J. Odijk, K. van Deemter & G. V. van Zanten (Ed.), *CLIN 1996, Papers from the seventh CLIN Meeting 1996*, Eindhoven, 25–40.

Brent, M. R. (1991). Automatic Acquisition of Subcategorization Frames from Untagged Text. In: *Proceedings of 29th ACL*, Berkeley, 209–214.

Dörre, J. & M. Dorna (1993). CUF – A Formalism for Linguistic Knowledge Representation. In: J. Dörre (Ed.), *Computational Aspects of Constraint-Based Linguistic Description*. IMS, Universität Stuttgart. Deliverable R1.2.A, DYANA-2 – ESPRIT Project 6852.

Erbach, G. (1990). Syntactic Processing of Unknown Words. IWBS Report 131, Institute for Knowledge-Based Systems (IWBS), IBM Stuttgart.

Griffith, J. (1996). Modularizing Contexted Constraints. In: *Proceedings COLING '96*, 448–453.

Hahn, U., M. Klenner & K. Schnattinger (1996). Learning from Texts - A Terminological Meta-Reasoning Perspective. In: S. Wermter, E. Riloff & G. Scheler (Ed.), *Connectionist, Statistical, and Symbolic Approaches to Learning for Natural Language Processing*, 453–468. Berlin: Springer.

Hastings, P. M. & S. L. Lytinen (1994). The Ups and Downs of Lexical Acquisition. In: *Proceedings of AAAI'94*, 754–759.

Holzbaur, C. (1990). *Specification of Constraint Based Inference Mechanism through Extended Unification*. Ph.D. thesis, Dept. of Medical Cybernetics and AI, University of Vienna.

Knodel, H. (1980). *Linder Biologie – Lehrbuch für die Oberstufe*. Stuttgart: J.B. Metzlersche Verlagsbuchhandlung.

Li, H. & N. Abe (1995). Generalizing Case Frames Using a Thesaurus and the MDL Principle. In: *Proceedings of Recent Advantages in Natural Language Processing*, 239–248.

Manning, C. & I. Sag (1997). Dissociations between argument structure and grammatical relations. Ms., Stanford University.

Zernik, U. (1989). Paradigms in Lexical Acquisition. In: U. Zernik (Ed.), *Proceedings of the First International Lexical Acquisition Workshop*, Detroit.