Head-Driven Phrase Structure Grammar

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Head-Driven Phrase Structure Grammar (Background)

- developed in the 80s as a successor of GPSG
- main publications Pollard and Sag, 1987, 1994, many contributions since then
  - syntactic theory
  - language typology
  - computational linguistics, grammar development
    (German, Englisch, French, Norwegian, Japanese, Spanish, Persian, Maltese, Danish, Polish, Mandarin Chinese, . . .)
- Phonology, morphology, syntax, semantics, and pragmatics (information structure) are covered.
- since 1994 yearly conferences:
  conference volumes are published by CSLI online publications
- Web pages:
  http://hpsg.stanford.edu/ and
  http://hpsg.fu-berlin.de/HPSG-Bib/ (Literature)

Course Page and Material

- Web page with the slides and handouts of the two lectures:
  http://hpsg.fu-berlin.de/~stefan/Lehre/Utrecht-2009/
- The analyses are implemented.
  A CD rom image which contains the grammar development software and example grammars for German, Chinese, and Maltese can be downloaded from:
  http://hpsg.fu-berlin.de/Software/Grammix/

  If you have a writable CD, we can burn it here.
- Further reading:
  - Overview article in English: Müller, In Preparationc
  - Introduction to HPSG in German: Müller, 2008
  - Introduction to several frameworks and comparison: Müller, In Preparationb

Motivations for HPSG

- Increased Precision
- Framework for Integration
- Declarative, Constraint Satisfaction System
- Grammars that Scale Up
- Grammars that Can be Implemented
- Psycholinguistic Plausibility

Important Moments in the History of Linguistics – I

Chomsky (1968) speaking of early psycholinguistic findings in relation to the ‘derivational theory of complexity’ (DTC):

> *The results show a remarkable correlation of the amount of memory and number of transformations. (Chomsky, 1968)*

Important Moments in the History of Linguistics – II

Fodor, Bever and Garrett (1974):

> *Experimental investigations of the psychological reality of linguistic structural descriptions have [. . .] proved quite successful.*

Fodor, Bever and Garrett (1974):

> *Investigations of DTC [. . .] have generally proved equivocal.*
> *This argues against the occurrence of grammatical derivations in the computations involved in sentence recognition.*

HPSG as response to the Fodor, Bever, Garrett dilemma

- HPSG recognizes the ‘linguistic structural descriptions’ whose psychological reality is established, e.g. phonological representations, semantic representations.
- HPSG defines these descriptions via structural definitions and ‘interface constraints’ (Jackendoff), thus eliminating grammatical derivations in FBG’s sense.

General Overview of the Framework

- lexicalized (head-driven), but with some phrasal elements
- sign-based (Saussure, 1916)
- typed feature structures (lexical entries, phrases, principles)
- multiple inheritance
- phonology, syntax, and semantics are represented in one description:
  - Phonology
  - Syntax
  - Semantics

$$\begin{bmatrix} \text{PHON} & \langle \textit{Grammatik} \rangle \\ \text{SYNSEM|LOC} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{CASE} & \boxed{1} \\ \textit{noun} \end{bmatrix} \\ \text{SUBCAT} & \langle \text{DET}[\text{CASE } \boxed{1}] \rangle \\ \textit{cat} \end{bmatrix} \\ \text{CONT} & \ldots \begin{bmatrix} \text{INST} & X \\ \textit{grammatik} \end{bmatrix} \\ \textit{loc} \end{bmatrix} \\ \textit{word} \end{bmatrix}$$

Valency and Grammar Rules: PSG

- huge number of rules:

S → NP, V	*X schläft* (‘sleeps’)
S → NP, NP, V	*X Y liebt* (‘loves’)
S → NP, PP[*über*], V	*X über y spricht* (‘talks about’)
S → NP, NP, NP, V	*X Y Z gibt* (‘gives’)
S → NP, NP, PP[*mit*], V	*X Y mit Z dient* (‘serves’)

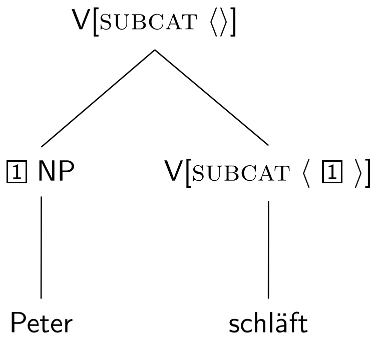
- verbs have to be used with the right rule

Valency and Grammar Rules: HPSG

- arguments represented as complex categories in the lexical entry of the head (similar to categorial grammar)
- Verb SUBCAT

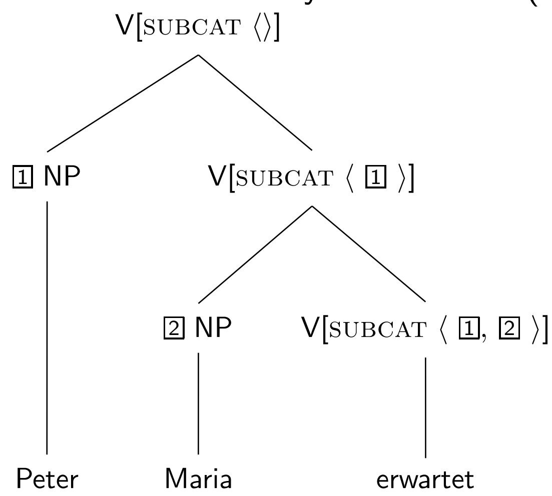
Verb	SUBCAT
schlafen	⟨ NP ⟩
lieben	⟨ NP, NP ⟩
sprechen	⟨ NP, PP[*über*] ⟩
geben	⟨ NP, NP, NP ⟩
dienen	⟨ NP, NP, PP[*mit*] ⟩

Example Tree with Valency Information (I)



V[SUBCAT ⟨ ⟩] corresponds to a fully saturated phrase (VP or S)

Example Tree with Valency Information (II)



Valency and Grammar Rules: HPSG

- specific rules for head argument combination:
  V[SUBCAT $\boxed{A}$] $\rightarrow$ $\boxed{1}$ V[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$]
- $\oplus$ is a relation that concatenates two lists:
  $\langle\, a,\, b \,\rangle = \langle\, a \,\rangle \oplus \langle\, b \,\rangle$ or
  $\langle\rangle \oplus \langle\, a,\, b \,\rangle$ or
  $\langle\, a,\, b \,\rangle \oplus \langle\rangle$
- In the rule above a list is split in a list that contains exactly one element ($\boxed{1}$) and a rest ($\boxed{A}$).
- Depending on the valency of the head the rest may contain zero or more elements.

Generalization over Rules

- specific rules for head argument combinations:
  V[SUBCAT $\boxed{A}$] $\rightarrow$ $\boxed{1}$ V[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$]
  A[SUBCAT $\boxed{A}$] $\rightarrow$ $\boxed{1}$ A[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$]
  N[SUBCAT $\boxed{A}$] $\rightarrow$ $\boxed{1}$ N[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$]
  P[SUBCAT $\boxed{A}$] $\rightarrow$ P[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$] $\boxed{1}$
- abstraction with respect to the order:
  V[SUBCAT $\boxed{A}$] $\rightarrow$ V[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$] $\boxed{1}$
  A[SUBCAT $\boxed{A}$] $\rightarrow$ A[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$] $\boxed{1}$
  N[SUBCAT $\boxed{A}$] $\rightarrow$ N[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$] $\boxed{1}$
  P[SUBCAT $\boxed{A}$] $\rightarrow$ P[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$] $\boxed{1}$
- generalized, abstract schema (H = head):
  H[SUBCAT $\boxed{A}$] $\rightarrow$ H[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$] $\boxed{1}$

Application of the Rules

- generalized, abstract shema (H = head):
  H[SUBCAT $\boxed{A}$] $\rightarrow$ H[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$] $\boxed{1}$
- possible instantiations of the schema:

V[SUBCAT $\boxed{A}$]	$\rightarrow$	V[SUBCAT $\boxed{A}$ $\langle\rangle \oplus \langle \boxed{1}\ \mathrm{NP} \rangle$]	$\boxed{1}$ NP
		Maria erwartet (Maria waits for)	Peter
		schläft (sleeps)	Peter
V[SUBCAT $\boxed{A}$]	$\rightarrow$	V[SUBCAT $\boxed{A}$ $\langle\ \mathrm{NP}\ \rangle \oplus \langle \boxed{1}\ \mathrm{NP} \rangle$]	$\boxed{1}$ NP
		erwartet (wait for)	Maria
N[SUBCAT $\boxed{A}$]	$\rightarrow$	N[SUBCAT $\boxed{A}$ $\langle\rangle \oplus \langle \boxed{1}\ \mathrm{Det} \rangle$]	$\boxed{1}$ Det
		Mann (man)	der (the)

Representation of Valency in Feature Descriptions

gibt ('gives', finite form):

$$\begin{bmatrix} \text{PHON} & \langle\ \textit{gibt}\ \rangle \\ \text{PART-OF-SPEECH} & \textit{verb} \\ \text{SUBCAT} & \left\langle \mathrm{NP}[\textit{nom}],\ \mathrm{NP}[\textit{acc}],\ \mathrm{NP}[\textit{dat}] \right\rangle \end{bmatrix}$$

NP[*nom*], NP[*acc*] and NP[*dat*] are abbreviations of complex feature descriptions.

Demo: Grammar 3

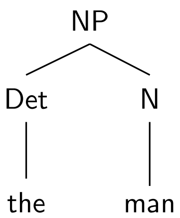
(1) a. der Mann schläft
the man sleeps
'The man sleeps'

b. der Mann die Frau kennt
the man the woman knows
'The man knows the woman.'

Representation of Grammar Rules (I)

- Feature Descriptions as uniform means for describing linguistic objects
  - morphological rules
  - lexical entries
  - syntactic rules
- separation of immediate dominance (ID) and linearer precedence (LP)
- dominance in DTR features (head daughters and non-head daughters)
- precedence is implicit in PHON

Part of the Structure in AVM Representation – PHON values (I)



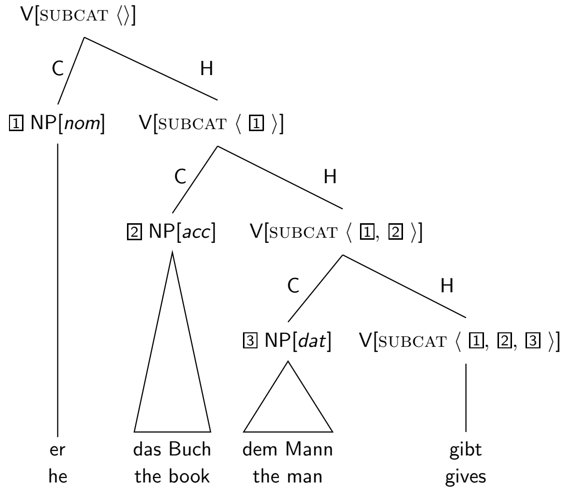
$$\begin{bmatrix} \text{PHON} & \langle \textit{the man} \rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{PHON} \ \langle \textit{man} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \begin{bmatrix} \text{PHON} \ \langle \textit{the} \rangle \end{bmatrix} \right\rangle \end{bmatrix}$$

- There is exactly one head daughter (HEAD-DTR).
  The head daughter contains the head.
  a structure with the daughters *the* and *picture of Mary* →
  picture of Mary is the head daughter, since *picture* is the head.
- There may be several non-head daughters
  (if we assume flat structures or in headless binary branching structures).

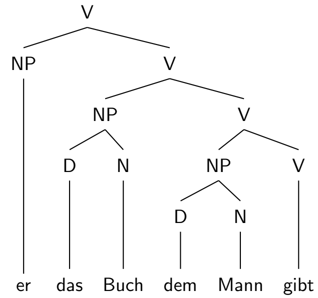
Representation of Grammar Rules

- Dominance Rule:
  head-argument-phrase →
  $$\begin{bmatrix} \text{SUBCAT} \ \boxed{A} \\ \text{HEAD-DTR}|\text{SUBCAT} \ \boxed{A} \oplus \langle \boxed{1} \rangle \\ \text{NON-HEAD-DTRS} \ \langle \boxed{1} \rangle \end{bmatrix}$$
  The arrow stands for implication
- alternative spelling, inspired by the $\overline{\text{X}}$ Schema:
  H[SUBCAT $\boxed{A}$]→H[SUBCAT $\boxed{A} \oplus \langle \boxed{1} \rangle$] $\boxed{1}$
  The arrow stands for replacement (rewriting)
- possible instantiations:
  N[SUBCAT $\boxed{A}$]→N[SUBCAT $\boxed{A}$ $\langle\rangle \oplus \langle$ DET $\rangle$] Det
  V[SUBCAT $\boxed{A}$]→V[SUBCAT $\boxed{A}$ $\langle\rangle \oplus \langle$ NP $\rangle$] NP
  V[SUBCAT $\boxed{A}$]→V[SUBCAT $\boxed{A}$ $\langle$ NP $\rangle \oplus \langle$ NP $\rangle$] NP

An Example



Part of the Structure in AVM Representation – PHON values (I)



$$\begin{bmatrix} \text{PHON} & \langle \textit{dem Mann gibt} \rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{PHON} \ \langle \textit{gibt} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \begin{bmatrix} \text{PHON} & \langle \textit{dem Mann} \rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{PHON} \ \langle \textit{Mann} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \begin{bmatrix} \text{PHON} \ \langle \textit{dem} \rangle \end{bmatrix} \right\rangle \end{bmatrix} \right\rangle \end{bmatrix}$$

Part of the Structure in AVM Representation – PHON values (II)

$$\begin{bmatrix} \text{PHON} \ \langle \textit{er das Buch dem Mann gibt} \rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{PHON} \ \langle \textit{das Buch dem Mann gibt} \rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{PHON} \ \langle \textit{dem Mann gibt} \rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{PHON} \ \langle \textit{gibt} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \begin{bmatrix} \text{PHON} \ \langle \textit{dem Mann} \rangle \\ \text{HEAD-DTR} \ \begin{bmatrix} \text{PHON} \ \langle \textit{Mann} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} \ \left\langle \begin{bmatrix} \text{PHON} \ \langle \textit{dem} \rangle \end{bmatrix} \right\rangle \end{bmatrix} \right\rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \begin{bmatrix} \text{PHON} \ \langle \textit{das Buch} \rangle \\ \text{HEAD-DTR} \ \begin{bmatrix} \text{PHON} \ \langle \textit{Buch} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} \ \left\langle \begin{bmatrix} \text{PHON} \ \langle \textit{das} \rangle \end{bmatrix} \right\rangle \end{bmatrix} \right\rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} \ \left\langle \begin{bmatrix} \text{PHON} \ \langle \textit{er} \rangle \end{bmatrix} \right\rangle \end{bmatrix}$$

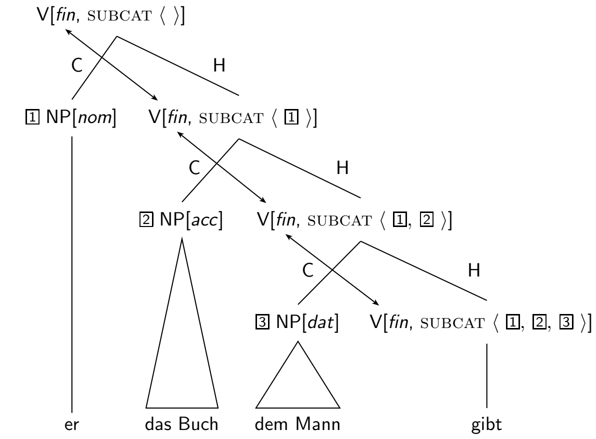
Partial Structure in Feature Structure Representation

$$\begin{bmatrix} \text{PHON} \ \langle \textit{dem Mann gibt} \rangle \\ \text{SUBCAT} \ \boxed{A} \ \langle \text{NP}[\textit{nom}], \text{NP}[\textit{acc}] \rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{PHON} \ \langle \textit{gibt} \rangle \\ \text{SUBCAT} \ \boxed{A} \oplus \langle \boxed{1} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \boxed{1} \begin{bmatrix} \text{PHON} \ \langle \textit{dem Mann} \rangle \\ \text{P-O-S} \ \textit{noun} \\ \text{SUBCAT} \ \langle\rangle \\ \text{HEAD-DTR} \ \ldots \\ \text{NON-HEAD-DTRS} \ \ldots \\ \textit{head-argument-phrase} \end{bmatrix} \right\rangle \\ \textit{head-argument-phrase} \end{bmatrix}$$

Partial Structure in Feature Structure Representation

PHON ⟨ *er das Buch dem Mann gibt* ⟩
SUBCAT [A] ⟨⟩
HEAD-DTR [PHON ⟨ *das Buch dem Mann gibt* ⟩, SUBCAT [A] ⊕ ⟨[1]⟩, HEAD-DTR . . ., NON-HEAD-DTRS . . ., *head-argument-phrase*]
NON-HEAD-DTRS ⟨ [1] [PHON ⟨ *er* ⟩, P-O-S *noun*, SUBCAT ⟨⟩, *word*] ⟩
head-argument-phrase

Projection of Head Properties



The finite verb is the head.

Feature Structure Representation: the HEAD Value

- possible feature geometry:
  [PHON *list of phoneme strings*, P-O-S *p-o-s*, VFORM *vform*, SUBCAT *list*]
- more structure, bundling of information that has to be projected:
  [PHON *list of phoneme strings*, HEAD [P-O-S *p-o-s*, VFORM *vform*], SUBCAT *list*]

Different Heads Project Different Features

- The feature VFORM makes sense for verbs only.
- German prenominal adjectives and nouns project case.
- Possible structure: a structure that contains all features:
  [P-O-S *p-o-s*, VFORM *vform*, CASE *case*]
  CASE has no value for verbs, VFORM has no value for nouns
- Better solution: different types of feature structures
  - for verbs:
    [VFORM *vform*, *verb*]
  - for nouns:
    [CASE *case*, *noun*]

A Lexical Entry with Head Features

- A lexical entry contains the following:
  gibt: ('gives')

$$\begin{bmatrix} \text{PHON} & \langle \textit{gibt} \rangle \\ \text{HEAD} & \begin{bmatrix} \text{VFORM} & \textit{fin} \\ \textit{verb} & \end{bmatrix} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}],\ \text{NP}[\textit{acc}],\ \text{NP}[\textit{dat}] \right\rangle \end{bmatrix}$$

  - phonological information
  - head information (part of speech, verb form, ...)
  - valency information: a list of descriptions of arguments

The Head Feature Principle

- In a headed structure the head features of the mother are identical to the head features of the head daughter.

$$\textit{headed-phrase} \rightarrow \begin{bmatrix} \text{HEAD}\ \boxed{1} \\ \text{HEAD-DTR}|\text{HEAD}\ \boxed{1} \end{bmatrix}$$

- *head-argument-phrase* is a subtype of *headed-phrase*
  → All constraints apply to structures of this type as well.
- *head-argument-phrase* inherits properties of/constraints on *headed-phrase*.

Demo: Grammar 4

(2) a. der Mann schläft
the man sleeps
'The man sleeps'

b. der Mann die Frau kennt
the man the woman knows
'The man knows the woman.'

Semantics

- Pollard and Sag (1987) and Ginzburg and Sag (2000) assume Situation Semantics (Barwise and Perry, 1983; Cooper, Mukai and Perry, 1990; Devlin, 1992).
- More recent work (in particular work in relation to computational implementations) uses *Minimal Recursion Semantics* (Copestake, Flickinger, Pollard and Sag, 2005).

The Representation of Relations with Feature Descriptions

love(e,x,y) book(x)

$$\begin{bmatrix} \text{ARG0} & \textit{event} \\ \text{ARG1} & \textit{index} \\ \text{ARG2} & \textit{index} \\ \textit{love} & \end{bmatrix} \qquad \begin{bmatrix} \text{ARG0} & \textit{index} \\ \textit{book} & \end{bmatrix}$$

Representation of the CONT Value

- possible data structure (CONT = CONTENT):

$$\begin{bmatrix} \text{PHON} & \textit{list of phoneme strings} \\ \text{HEAD} & \textit{head} \\ \text{SUBCAT} & \textit{list} \\ \text{CONT} & \textit{mrs} \end{bmatrix}$$

- more structure:
  partition into syntactic and semantic information (CAT = CATEGORY)

$$\begin{bmatrix} \text{PHON} & \textit{list of phoneme strings} \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{head} \\ \text{SUBCAT} & \textit{list} \\ \textit{cat} & \end{bmatrix} \\ \text{CONT} & \textit{mrs} \end{bmatrix}$$

- → it is now possible to share syntactic information only

Sharing of Syntactic Information in Coordinations

- symmetric coordination: the CAT value is identical

$$\begin{bmatrix} \text{PHON} & \textit{list of phoneme strings} \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{head} \\ \text{SUBCAT} & \textit{list} \\ \textit{cat} & \end{bmatrix} \\ \text{CONT} & \textit{mrs} \end{bmatrix}$$

- Examples:

(3) a. [the man and the woman]
 b. He [knows and likes] this record.
 c. He is [stupid and arrogant].

The Semantic Contribution of Nominal Objects

- semantic index + restrictions

$$\begin{bmatrix} \text{PHON} & \langle \textit{ Buch } \rangle \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{SUBCAT} & \left\langle \text{DET} \right\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{1} \begin{bmatrix} \text{PER} & \textit{3} \\ \text{NUM} & \textit{sg} \\ \text{GEN} & \textit{neu} \\ \textit{index} & \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{ARG0} & \boxed{1} \\ \textit{buch} & \end{bmatrix} \right\rangle \\ \textit{mrs} & \end{bmatrix} \end{bmatrix}$$

- Person, number, and gender are relevant for reference/coreference:

(4) Die Frau$_i$ kauft ein Buch$_j$. Sie$_i$ liest es$_j$.
 the woman buys a book she reads it

Abbreviations

$$\text{NP}_{[3,sg,fem]} \quad \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \\ \text{CONT}|\text{IND} & \begin{bmatrix} \text{PER} & \textit{3} \\ \text{NUM} & \textit{sg} \\ \text{GEN} & \textit{fem} \end{bmatrix} \end{bmatrix} \qquad \text{NP}_{\boxed{1}} \quad \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{1} \end{bmatrix} \end{bmatrix}$$

The Semantic Contribution of Verbs and Linking

- Linking of valency information and semantic contribution
  gibt (*gives*, finite Form):

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{VFORM} & \textit{fin} \\ \textit{verb} & \end{bmatrix} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}]_{\boxed{1}}, \text{NP}[\textit{acc}]_{\boxed{2}}, \text{NP}[\textit{dat}]_{\boxed{3}} \right\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{4}\ \textit{event} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{ARG0} & \boxed{4} \\ \text{ARG1} & \boxed{1} \\ \text{ARG2} & \boxed{2} \\ \text{ARG3} & \boxed{3} \\ \textit{geben} & \end{bmatrix} \right\rangle \\ \textit{mrs} & \end{bmatrix} \end{bmatrix}$$

- The referential indices of the NPs are identified with the semantic roles.

Semantics Principle (Part)

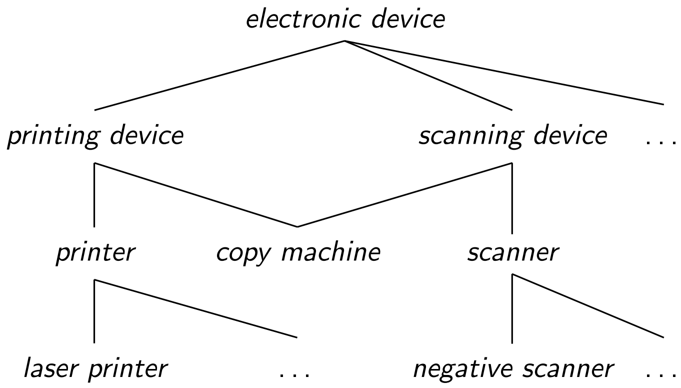
In headed strucutres the semantic index of the mother is identical to the semantic index of the head daughter.

The RELS list of the mother is the concatenation of the RELS lists of the daughters.

Demo: Berligram

(5) Jeder Sohn eines Beamten rennt.
every son of.a state.employee runs

Types: A Non-Linguistic Example for Multiple Inheritance



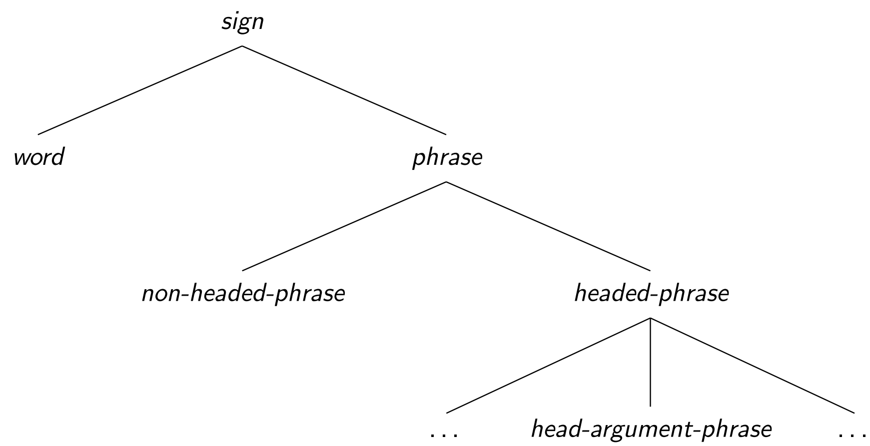
Properties of Type Hierarchies

- Subtypes inherits properties and constraints of their supertypes.
- Generalizations can be captured:
  General restrictions are represented at types that are high in the hierarchy.
- More special types inherit from their super types.
- We can represent information with no redundancy.

Linguistic Generalizations in the Type System

- Types are organized in a hierarchy.
- The most general type is on top.
- Information about properties of objects of a certain type are specified as constraints on this type.
- Subtypes inherit these properties.
- Example: Entries in an Encyclopedia.
  Entry refers to more general concepts,
  no repitition of information that is present at more general concepts.
- The upper part of the hierarchy is relevant for all languages ("universal grammar").
- More specific type can be relevant for certain classes of languages or even single languages only.

Type Hierarchy for *sign*



all subtypes of *headed-phrase* inherit restrictions

All Constraints for a Local Tree (Head-Argument)

$$\begin{bmatrix} \text{HEAD} & \boxed{1} \\ \text{SUBCAT} & \boxed{A} \\ \text{HEAD-DTR} & \begin{bmatrix} \text{HEAD} & \boxed{1} \\ \text{SUBCAT} & \boxed{A} \oplus \langle \boxed{2} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \langle \boxed{2} \rangle \\ \textit{head-argument-phrase} & \end{bmatrix}$$

Partial Structure in Feature Structure Representation

$$\begin{bmatrix} \text{PHON} \ \langle \textit{dem Mann gibt} \rangle \\ \text{HEAD} \ \boxed{1} \\ \text{SUBCAT} \ \boxed{A} \ \langle \text{NP}[\textit{nom}], \text{NP}[\textit{acc}] \rangle \\ \text{HEAD-DTR} \ \begin{bmatrix} \text{PHON} \ \langle \textit{gibt} \rangle \\ \text{HEAD} \ \boxed{1} \begin{bmatrix} \text{VFORM} \ \textit{fin} \\ \textit{verb} \end{bmatrix} \\ \text{SUBCAT} \ \boxed{A} \oplus \langle \boxed{2} \rangle \\ \textit{word} \end{bmatrix} \\ \text{NON-HEAD-DTRS} \left\langle \boxed{2} \begin{bmatrix} \text{PHON} \ \langle \textit{dem Mann} \rangle \\ \text{HEAD} \begin{bmatrix} \text{CAS} \ \textit{dat} \\ \textit{noun} \end{bmatrix} \\ \text{SUBCAT} \ \langle\rangle \\ \text{HEAD-DTR} \ \ldots \\ \text{NON-HEAD-DTRS} \ \ldots \\ \textit{head-argument-phrase} \end{bmatrix} \right\rangle \\ \textit{head-argument-phrase} \end{bmatrix}$$

The Lexicon

- lexicalization →
  enormous reduction of the number of dominance schemata
- but very complex lexical entries
- structuring and classification →
  capturing of generalizations & avoidance of redundancies
- type hierarchies and lexical rules

The Complexitiy of a Lexical Entry of a Count Noun

$$\begin{bmatrix} \text{PHON} & \langle \textit{Frau} \rangle \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} \end{bmatrix} \\ \text{SUBCAT} & \left\langle \text{DET} \right\rangle \\ \ldots & \ldots \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{1} \begin{bmatrix} \text{PER} & \textit{3} \\ \text{GEN} & \textit{fem} \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{INST} & \boxed{1} \\ \textit{frau} & \end{bmatrix} \right\rangle \end{bmatrix} \\ \ldots & \ldots \end{bmatrix}$$

Only a very small part of this is idiosyncratic.

Partitioning of the Information

a. all nouns

[CAT|HEAD *noun*
CONT *nom-obj*]

b. all referential non-pronominal Ns taking a determiner (in addition to a)

[CAT|SUBCAT ⟨DET⟩
CONT [IND 1 [PER *3*]
RELS ⟨[INST 1, *psoa*], ...⟩]]

c. all feminine nouns (in addition to a)

[CONT|IND|GEN *fem*]

The Complexity of a Lexical Entry for a Verb

helf- (Lexical entry (root)):

[PHON ⟨ *helf* ⟩
CAT [HEAD *verb*
SUBCAT ⟨NP[*nom*]1, NP[*dat*]2⟩]
CONT [IND 3
RELS ⟨[ARG0 3
ARG1 1
ARG2 2
helfen]⟩]]

Partitioning of the Information

a. all verbs

[CAT|HEAD *verb*
CONT [IND 3
RELS ⟨[ARG0 3, *relation*]⟩]]

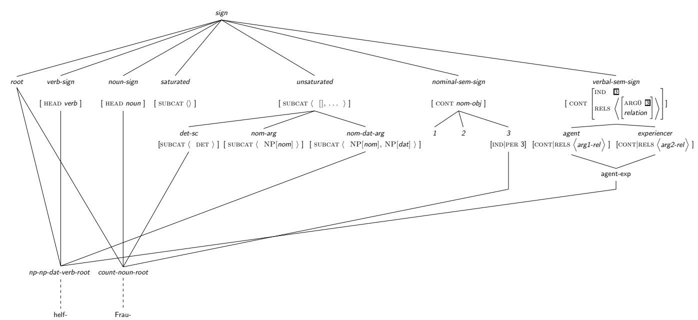
b. bivalent verbs with a dative object (in addition to a)

[CAT|SUBCAT ⟨NP[*nom*], NP[*dat*]⟩]

c. all bivalent verbs with ARG1 and ARG2 (in addition to a)

[CAT|SUBCAT ⟨[CONT|IND 1], [CONT|IND 2]⟩
CONT [RELS ⟨[ARG1 1
ARG2 2
arg1-arg2-rel]⟩]]

Part of a Possible Type Hierarchy



- appropriate paths have to be added:
  [SUBCAT ⟨⟩] is a shorthand for [CAT|SUBCAT ⟨⟩]
- Constraints on types hold for their subtypes as well (inheritance).
- Instances are connected via dashed lines.

Examples for Lexical Items

$$\begin{bmatrix} \textsc{phon} \ \langle \textit{ Frau } \rangle \\ \textsc{cont}|\textsc{rels} \ \langle \textit{ frau } \rangle \\ \textit{count-noun-root} \end{bmatrix}$$

$$\begin{bmatrix} \textsc{phon} & \langle \textit{ helf } \rangle \\ \textsc{cont}|\textsc{rels} & \langle \textit{ helfen } \rangle \\ \textit{np-np-dat-verb-root} & \end{bmatrix}$$

Horizontal and Vertical Generalizations

- Type hierarchies are used to cross-classify linguistic objects (lexical entries, schemata).
- We express generalizations over classes of linguistic objects.
- We are able to say what certain words have in common:
  - *woman* and *man*
  - *woman* und *salt*
  - *woman* und *plan*
- But there are other regularities:
  - *kick* and *kicked* as in *was kicked*
  - *love* und *loved* as in *was loved*
- We can use a hierarchy to represent the properties of *kicked* and *loved*, but this would not capture the fact that *kick* and *kicked* are related in the same way as *love* and *loved*.
- Remark: There are proposals in the literature to treat passive by inheritance, but this does not work in general (Müller, 2006, 2007).

Lexical Rules

- Instead of inheritance we use lexical rules.
  Jackendoff (1975), Williams (1981), Bresnan (1982), Shieber, Uszkoreit, Pereira, Robinson and Tyson (1983), Flickinger, Pollard and Wasow (1985), Flickinger (1987), Copestake and Briscoe (1992), Meurers (2000)
- Example passive:
  A lexical rule relates a stem to the corresponding passive form.
- There are different conceptions of lexical rules:
  Meta Level Lexical Rules (MLR) vs.
  Description Level Lexical Rules (DLR)
  See Meurers, 2000 for a detailed discussion.

Lexical Rule for the Passive

Lexical Rule for the passive:

$$\begin{bmatrix} \textsc{cat} & \begin{bmatrix} \textsc{head} & \textit{verb} \\ \textsc{subcat} & \left\langle \text{NP}[\textit{nom}],\ \text{NP}[\textit{acc}]_{\boxed{1}} \right\rangle \oplus \boxed{A} \end{bmatrix} \\ \textit{stem} & \end{bmatrix} \mapsto$$

$$\begin{bmatrix} \textsc{cat} & \begin{bmatrix} \textsc{head} & \begin{bmatrix} \textsc{vform} & \textit{passiv-part} \end{bmatrix} \\ \textsc{subcat} & \left\langle \text{NP}[\textit{nom}]_{\boxed{1}} \right\rangle \oplus \boxed{A} \end{bmatrix} \\ \textit{word} & \end{bmatrix}$$

(6) a. The man beats the dog.
    b. The dog was beaten.

Note: This is simplified, see Müller, 2002 for Haider's passive analysis in HPSG.

Conventions for the Interpretation of Lexical Rules

- Information that is not mentioned in the output, is carried over from the input.
- Example: Passive preserves meaning.
  The CONT values of input and output are identical.
  Linking information is preserved:

Active:

$$\begin{bmatrix} \text{CAT} & \left[\text{SUBCAT}\ \left\langle \text{NP}[\textit{nom}]_{\boxed{1}},\ \text{NP}[\textit{acc}]_{\boxed{2}} \right\rangle\right] \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{3} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{ARG0} & \boxed{3} \\ \text{ARG1} & \boxed{1} \\ \text{ARG2} & \boxed{2} \\ \textit{beat} & \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

Passive:

$$\begin{bmatrix} \text{CAT} & \left[\text{SUBCAT}\ \left\langle \text{NP}[\textit{nom}]_{\boxed{2}} \right\rangle\right] \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{3} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{ARG0} & \boxed{3} \\ \text{ARG1} & \boxed{1} \\ \text{ARG2} & \boxed{2} \\ \textit{beat} & \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

The Lexical Rule for the Passive in a Different Notation

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD}|\text{VFORM} & \textit{passiv-part} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}]_{\boxed{1}} \right\rangle \oplus \boxed{A} \end{bmatrix} \\ \text{LEX-DTR} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}],\ \text{NP}[\textit{acc}]_{\boxed{1}} \right\rangle \oplus \boxed{A} \end{bmatrix} \\ \textit{stem} & \end{bmatrix} \\ \textit{acc-passive-lexical-rule} & \end{bmatrix}$$

- like a unary projection, but restricted to the lexicon
- *word* ≻ *acc-passive-lexical-rule*
- Since lexical rules are typed, we can capture generalizations over lexical rules.
- This form of lexical rule is fully integrated into the HPSG formalism.

The Lexical Rule for the Passive with Morphology

$$\begin{bmatrix} \text{PHON} & f(\boxed{1}) \\ \text{CAT} & \begin{bmatrix} \text{HEAD}|\text{VFORM} & \textit{passiv-part} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}]_{\boxed{2}} \right\rangle \oplus \boxed{A} \end{bmatrix} \\ \text{LEX-DTR} & \begin{bmatrix} \text{PHON} & \boxed{1} \\ \text{CAT}|\text{SUBCAT} & \left\langle \text{NP}[\textit{nom}],\ \text{NP}[\textit{acc}]_{\boxed{2}} \right\rangle \oplus \boxed{A} \\ \textit{stem} & \end{bmatrix} \\ \textit{acc-passive-lexical-rule} & \end{bmatrix}$$

- *f* is a function that returns the passive form that corresponds to the PHON value of the LEX-DTR (*kick* → *kicked*)
- Alternative: Head Affix Structures
  (similar to binary branching structures in syntax)

Head Affix Structures vs. Lexical Rules

- Lexical Rules
  (Orgun, 1996; Riehemann, 1998; Ackerman and Webelhuth, 1998; Koenig, 1999; Müller, 2002)
- Head Affix approaches
  (Krieger and Nerbonne, 1993; Krieger, 1994; van Eynde, 1994; Lebeth, 1994)

- The approaches can be translated into each other in many cases (Müller, 2002).
- Sometimes it is regarded as an advantage that lexical rules make the stipulation of hundreds of empty affixes for zero inflection and conversion unnecessary.
- Subtractive morphemes are not needed in an LR-based approach.
- Some languages have affixal material that realizes more than one argument (Crysmann, 2002, Chapter 2.1.1.4 and p. 169–171).

Languages with Free(er) Constituent Order

- We will now look at German,
  since it is interesting in its reordering possibilities.
- German is an SOV language, however in declarative clauses the verb appears in second position and in matrix interrogative clauses, it appears in first position.
- How do we account for the serialization of arguments?
- How do we account for the verb position?

Relatively Free Constituent Order

- Arguments can be serialized in almost any order:

(7) a. weil der Mann der Frau das Buch gibt
because the man the woman the book gives
'because the man gives the book to the woman'
b. weil der Mann das Buch der Frau gibt
c. weil das Buch der Mann der Frau gibt
d. weil das Buch der Frau der Mann gibt
e. weil der Frau der Mann das Buch gibt
f. weil der Frau das Buch der Mann gibt

- (7b–f) require a different prosody and a more restrictive context than (7a) (Höhle, 1982).

Adjuncts in the Mittelfeld

- In addition to the arguments, adjuncts may be serialized in the Mittelfeld.
- These can be placed at arbitrary positions between the arguments:

(8) a. weil morgen der Mann das Buch der Frau gibt
because tomorrow the man the woman the book gives
'because the man gives the book to the woman tomorrow'
b. weil der Mann morgen das Buch der Frau gibt
c. weil der Mann das Buch morgen der Frau gibt
d. weil der Mann das Buch der Frau morgen gibt

Binary Branching Structures

- Sentences like (9) are unproblematic:

(9) weil [der Mann [das Buch [der Frau gibt]]]
because the man the book the woman gives

- The integration of adjuncts is straightforward as well:

(10) a. weil [morgen [der Mann [das Buch [der Frau gibt]]]]
b. weil [der Mann [morgen [das Buch [der Frau gibt]]]]
c. weil [der Mann [das Buch [morgen [der Frau gibt]]]]
d. weil [der Mann [das Buch [der Frau [morgen gibt]]]]

Permutation of Arguments in the Mittelfeld

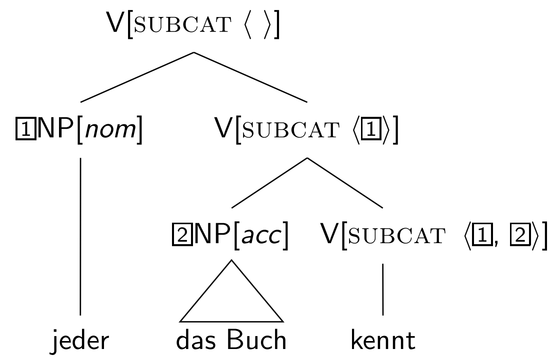
- Permutation of arguments is not explained yet.
- Thus far, we have combined the head with the last element in the SUBCAT list.
  head-argument-phrase →
  $$\begin{bmatrix} \text{CAT}|\text{SUBCAT } \boxed{A} \\ \text{HEAD-DTR}|\text{CAT}|\text{SUBCAT } \boxed{A} \oplus \langle \boxed{1} \rangle \\ \text{NON-HEAD-DTRS } \langle \boxed{1} \rangle \end{bmatrix}$$
- Generalization of the Head-Argument-Schema:
  We allow to take arguments from the middle of the list.

The Head-Argument-Schema

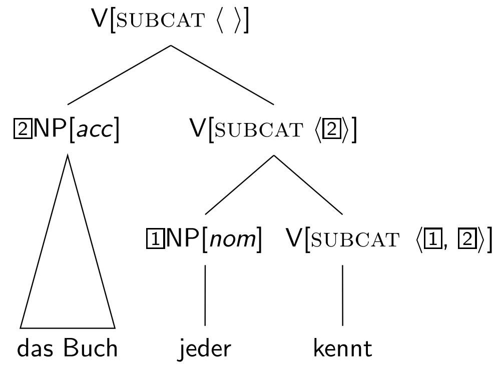
- old:
  head-argument-phrase →
  $$\begin{bmatrix} \text{CAT}|\text{SUBCAT } \boxed{A} \\ \text{HEAD-DTR}|\text{CAT}|\text{SUBCAT } \boxed{A} \oplus \langle \boxed{1} \rangle \\ \text{NON-HEAD-DTRS } \langle \boxed{1} \rangle \end{bmatrix}$$
- new:
  head-argument-phrase →
  $$\begin{bmatrix} \text{CAT}|\text{SUBCAT } \boxed{A} \oplus \boxed{B} \\ \text{HEAD-DTR}|\text{CAT}|\text{SUBCAT } \boxed{A} \oplus \langle \boxed{1} \rangle \oplus \boxed{B} \\ \text{NON-HEAD-DTRS } \langle \boxed{1} \rangle \end{bmatrix}$$
- Note: If we want binary branching for English: $\boxed{A} = \langle\rangle$

Example: Normal Order

(11) a. weil jeder das Buch kennt
because everybody the book knows
b. weil das Buch jeder kennt



Example: Reordering



The difference is the order in which the elements in SUBCAT get saturated.

See Gunji, 1986 for similar suggestions for Japanese.

See Fanselow, 2001 for an aequivalent suggestion in the Minimalist Program.

Demo: Grammar 9

(12) a. daß der Mann der Frau das Buch gibt
that the man$_{nom}$ the woman$_{dat}$ the book$_{acc}$ gives

b. daß der Mann das Buch der Frau gibt
that the man$_{nom}$ the book$_{acc}$ the woman$_{dat}$ gives

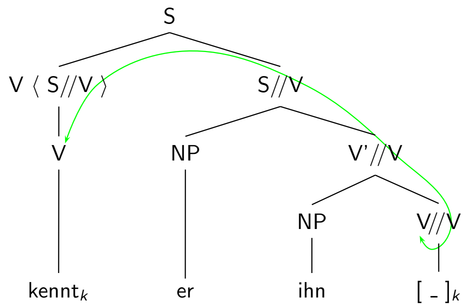
c. daß der Mann der Frau das Buch morgen gibt
that the man$_{nom}$ the woman$_{dat}$ the book$_{acc}$ tomorrow gives

d. daß der Mann der Frau morgen das Buch gibt
that the man$_{nom}$ the woman$_{dat}$ tomorrow the book$_{acc}$ gives

e. daß er oft nicht lacht
that he often not laughs

f. daß er nicht oft lacht
that he not often laughs

Verb Placement



- A trace takes the position of the finite verb in verb-initial sentences.
- A special form of the verb is in initial position.
  It selects the projection of the empty verb.
- The special lexical item is licensed by a lexical rule.
- Connection between verb and trace is established by percolation.

Demo: Grammar 9

(13) Gibt der Mann der Frau das Buch.
gives the man$_{nom}$ the woman$_{dat}$ the book$_{acc}$

Vorfeldbesetzung in German is a Nonlocal Dependency

- One constituent (adjunct, subject or complement) can be placed in the Vorfeld (Erdmann, 1886; Paul, 1919) → V2 language
- Fronting is a non-local dependency:

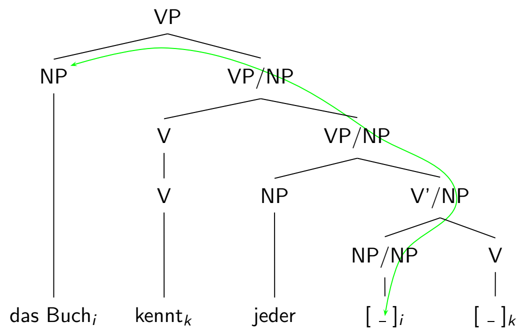
(14) a. [Um zwei Millionen Mark]$_i$ soll er versucht haben, [eine Versicherung _$_i$ zu betrügen].[1]

b. „Wer$_i$, glaubt er, daß er _$_i$ ist?“ erregte sich ein Politiker vom Nil.[2]

c. Wen$_i$ glaubst du, daß ich _$_i$ gesehen habe.[3]
who believes you that I seen have
'Who do you believe that I saw?'

[1] taz, 04.05.2001, p. 20.
[2] Spiegel, 8/1999, p. 18.
[3] Scherpenisse, 1986, p. 84.

Overview Fronting



- As in the example of head movement: Trace at "canonical" position
- percolation of information in the tree
- constituent movement is not local, verb movement is two different features for modelling (SLASH vs. DSL)

Properties of the Analysis

- percolation of non-local information
- structure sharing
- Information is simultaneously present at every node in the extraction path.
- Nodes in the middle of an unbounded dependency may access this information. (Bouma et al., 2001: Irish, Chamorro, Palauan, Icelandic, Kikuyu, Ewe, Thompson Salish, Moore, French, Spanish, and Yiddish)

Differenciation into Local and Nonlocal Information

- Differenciation between information that is locally relevant (LOCAL) and information that plays a role in nonlocal dependencies (NONLOCAL)

```
[ PHON    list of phoneme strings                         ]
[         [ CAT  [ HEAD    head                    ] ]    ]
[ LOC     [      [ SUBCAT  list of synsem objects  ] ]    ]
[         [      [ cat                             ] ]    ]
[         [ CONT cont                                ]    ]
[         [ loc                                      ]    ]
[ NONLOC  nonloc                                          ]
[ sign                                                    ]
```


Data Structure for Nonlocal Information

- NONLOC value has internal structure:

```
[ QUE    list of npros            ]
[ REL    list of indices          ]
[ SLASH  list of local structures ]
[ nonloc                          ]
```

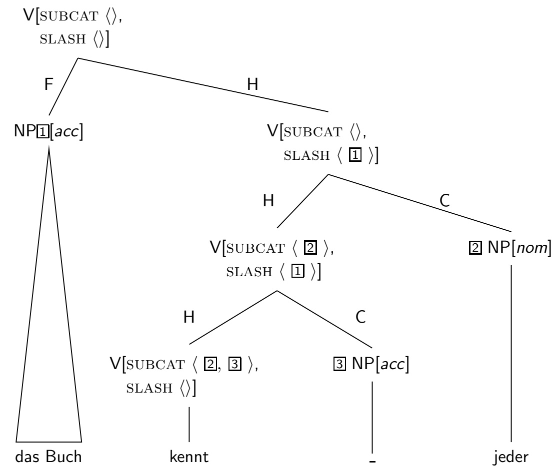
- QUE: list of indices of question words (interrogative clauses)
- REL: list of indices of relative pronouns (relative clauses)
- SLASH: list of *local* objects (Vorfeldbesetzung, relative clauses)
- We focus on SLASH and ignore the others.

A Trace for the Accusative Object of *kennen* ('know')

$$\begin{bmatrix} \text{PHON} & \langle\rangle \\ \text{LOC} & \boxed{1} \begin{bmatrix} \text{CAT} \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{CAS} & \textit{acc} \\ \textit{noun} & \end{bmatrix} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \end{bmatrix} \\ \text{NONLOC} & \begin{bmatrix} \text{SLASH} \ \langle \boxed{1} \rangle \end{bmatrix} \\ \textit{word} & \end{bmatrix}$$

- The trace does not contribute a phonology.
- The trace has the local properties that *kennen* requires.
- These are also represented under SLASH.

Percolation of Nonlocal Information (simplified → wrong verb position!)



The Head Filler Schema (Simplified)

head-filler-structure →

$$\begin{bmatrix} \text{NONLOC}|\text{SLASH} & \langle\rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{LOC}|\text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{VFORM} & \textit{fin} \\ \text{INITIAL} & + \\ \textit{verb} & \end{bmatrix} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \\ \text{NONLOC}|\text{SLASH} & \langle \boxed{1} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \begin{bmatrix} \text{LOC} & \boxed{1} \\ \text{NONLOC}|\text{SLASH} & \langle\rangle \end{bmatrix} \right\rangle \end{bmatrix}$$

- The head daughter is a finite clause with a verb in final position (INITIAL+) and an element in SLASH
- LOCAL value of the non-head daughter is identical to the element in SLASH
- nothing can be extracted from the non-head daughter

The Extraction Trace

$$\begin{bmatrix} \text{PHON} & \langle\rangle \\ \text{LOC} & \boxed{1} \\ \text{NONLOC} & \begin{bmatrix} \text{SLASH} \ \langle \boxed{1} \rangle \end{bmatrix} \\ \textit{word} & \end{bmatrix}$$

- The trace used as argument was specific, but we can generalize over all traces.
- We do not have to specify the LOCAL value of the trace since the verb specifies the LOCAL value of its arguments.

Why Prefer the Constraint-Based Analysis to the Movement-Based Alternative?

- Detailed, empirically adequate accounts
- Precisely formalized and theoretically motivated
- Psycholinguistic concerns
- Cross-linguistic sensitivity to extraction paths
- Lexical exceptions: obligatory gap selection
- Partial identity between filler and gap
- Coordinate Structure Constraint and Across-the-Board Exceptions

Cross-Linguistic Data: Extraction Path Sensitivity

- Irish complementizer selection (McCloskey 1978, 1989)
- French 'stylistic' inversion (Kayne and Pollock 1978).
- Spanish 'stylistic' inversion (Torrego 1984)
- Kikuyu downstep suppression (Clements 1984, Zaenen 1983)
- Chamorro verb agreement (Chung 1982, 1995)
- Yiddish inversion (Diesing 1990)
- Icelandic expletives (Zaenen 1983)
- Adyghe '*wh*-agreement' (Polinsky 2007)

Irish

(15) a. Shíl mé goN mbeadh sé ann.
thought I COMP would-be he there
'I thought that he would be there.'

b. Dúirt mé gurL shíl mé goN mbeadh sé ann.
said I goN.PAST thought I COMP would-be he there
'I said that I thought that he would be there.'

c. an fear aL shíl mé aL bheadh ann
the man COMP thought I COMP would-be __ there
'the man that I thought would be there'

d. an fear aL dúirt mé aL shíl mé aL bheadh ann
the man COMP said I COMP thought I COMP would-be __ there
'the man that I said I thought would be there'

e. an fear aL shíl goN mbeadh sé ann
[the man]$_j$ COMP thought __ COMP would-be he$_j$ there
'[the man]$_j$ that thought he$_j$ would be there'

f. an fear aL dúirt sé aL shíl goN mbeadh sé ann
the man COMP said he COMP thought __ COMP would-be he there
'the man that he said thought he would be there'

The Irish Complementizers

- No extraction:

$$\begin{bmatrix} \text{PHON} & \langle \textit{goN} \rangle \\ \text{LOC}|\text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{prt} \\ \text{SUBCAT} & \left\langle \begin{bmatrix} \text{LOC}|\text{CAT}|\text{HEAD TYPEVERB} \\ \text{NONLOC}|\text{SLASH } \langle\rangle \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

- Extraction:

$$\begin{bmatrix} \text{PHON} & \langle \textit{aL} \rangle \\ \text{LOC}|\text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{prt} \\ \text{SUBCAT} & \left\langle \begin{bmatrix} \text{LOC}|\text{CAT}|\text{HEAD } \textit{verb} \\ \text{NONLOC}|\text{SLASH } \langle \text{ X } \rangle \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

Filler-Gap Mismatches

(16) a. You can rely on Dominique's help.
b. Dominique's help, you can rely on __ .
c. * You can rely on that they will help you.
d. That they will help you, you can rely on __ .

How can movement turn an NP into a CP?

Certain Filler-Gap constructions involve constraints of **partial** identity, not total identity.

Coordinate Structure Constraint and ATB Exceptions – I

(17) a. * Which dignitaries do you think
[[Sandy photographed the castle] and [Chris visited __]]?
b. * Which dignitaries do you think
[[Sandy photographed __] and [Chris visited the castle]]?
c. Which dignitaries do you think
[[Sandy photographed __] and [Chris visited __]]?

The Movement-Based Analysis

(18) a. [$_S$ you think [$_{S'}$ [$_S$ Kim should help **who**$_i$]]
b. [$_S$ you think [$_{S'}$ **who**$_i$ [$_S$ Kim should help __ $_i$]]?
c. **who**$_i$ [$_S$ you think [$_{S'}$ **e**$_i$ [$_S$ Kim should help __ $_i$]]?
d. **who**$_i$ [$_S$ do you think [$_{S'}$ **e**$_i$ [$_S$ Kim should help __ $_i$]]?

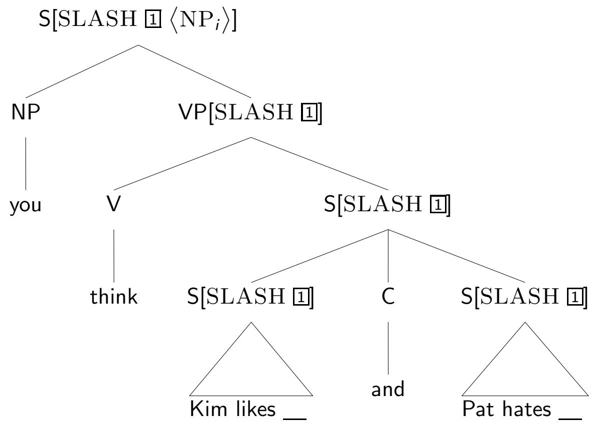
Across-the-Board Movement?

(19) **who**$_i$ [$_S$ do you think
[$_{S'}$ **e**$_i$ [[$_S$ Kim likes __ $_i$] and [$_S$ Pat hates __ $_i$]]]]?

There is no uniform movement algorithm that allows across-the-board movement. (Gazdar, Pullum, Sag and Wasow, 1982)

Across-the-Board Constraint

SLASH is among the features whose values are identified across conjuncts:



HPSG – The Frankenstein Theory

- Bob Carpenter (Mineur, 1995): HPSG is a Frankenstein Theory. Sewed together from various other theories. Influences:
  - GPSG (no surprise, authors overlap): nonlocal dependencies, ID/LP format
  - Categorial Grammar (valence, functor/argument relationships)
  - GB (parts of $\overline{\text{X}}$ Theory, parts of structural aspects)

HPSG vs. Transformational Grammar

- A lot of insights are taken over from GB analyses of the 80ies.
  - Categories are feature sets
  - $\overline{\text{X}}$ Theory (not all aspects)
  - verb position in German (Grewendorf, 1988)
- Differences:
  - No transformations
  - No explicit structuring of the category feature sets
  - Lexical integrity (Bresnan and Mchombo, 1995)
    → no IP node for German, no affixes in syntax → no movement of affixes
  - lexical analysis of passive (as in LFG, see Bresnan, 1982)
  - Scrambling is not movement (Gunji, 1986, see also Fanselow, 1993, 2001)
  - extraction is percolation of information

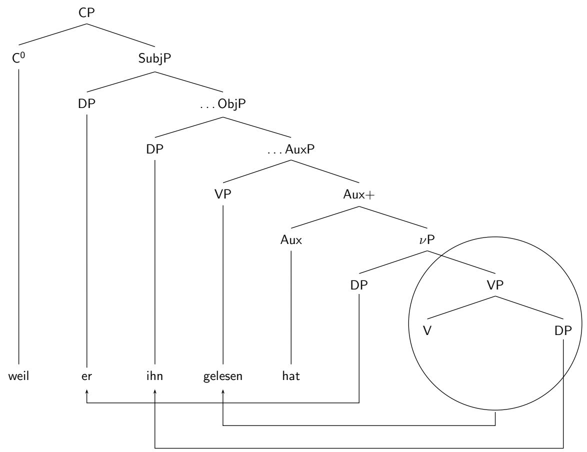
HPSG vs. Transformational Grammar

- General differences:
  - lack of precision since the 80ies
    (intentionally: Chomsky, 1981, p. 2–3; Chomsky, 1990, p. 146)
  - for discussion of this point see
    Gazdar, Klein, Pullum and Sag, 1985, p. 6;
    Pullum, 1985, 1989; Kornai and Pullum, 1990, Pullum, 1991, p. 48
  - As a consequence: No large-scale consistent (implemented) fragments.
- HPSG is a Model Theoretic approach,
  while GB/Minimalism are generative-enumerative approaches.
  On differences see Pullum and Scholz, 2001.
  Note: There are Model Theoretic variants of GB. See for instance Rogers, 1998.

Evidence from a single language and UG

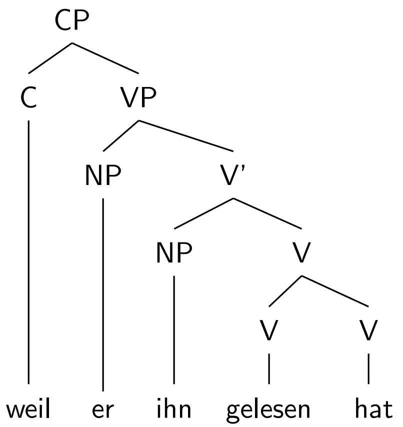
- What does it mean for other languages that a rule/morpheme is present in one particular language?
- Possible answer: If we have a certain structure in language X, it must be present in all languages.
- Example:
  - Basque: Tree positions for object agreement (AgrO, AgrIO)
  - Japanese: Tree position for topic marker
- German and Dutch neither have object agreement nor topic morphemes.
- Conclusion: If such inferences regarding properties of particular languages, one has to assume (very specific!) innate linguistic knowledge.

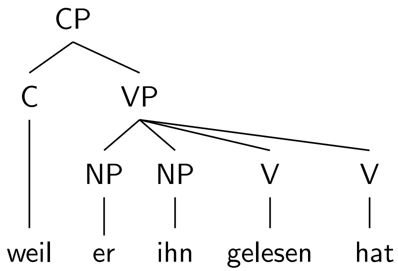
German is English/Romance (SVO, Laenzlinger following Kayne)



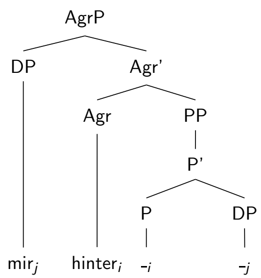
- All languages are SVO underlyingly.
- The object is moved out of the VP.
- The subject is fronted.
- The empty VP is fronted.
- There are further empty heads (Cinque, 1999).
- Innateness has to be assumed.

German is German (GB Variants, CG, LFG, HPSG, ...)



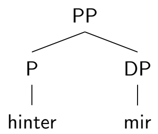


English, German, ... are Hungarian



- Hornstein, Nunes and Grohmann (2005, p. 124): agreement head for the checking of case features
- Preposition is moved there.
- DP is put into the specifier position of this head.
- Evidence for this: Agreement in Hungarian postpositional phrases
- English is like Hungarian, but the movement is invisible.

German is German, . . . Hungarian is Hungarian



- A PP is a P together with an NP (or DP).
- No movement instead of two movements.
- Structure has five nodes less.
- Truly minimal!
- Question: What constitutes an explanation?
  Where and how is complexity of language represented?

Sociological Differences

- The way arguments work differs dramatically.
- Avoid empty elements!
  This should be a strategy for every linguistic theory (Occam's Razor)!

HPSG vs. OT

- OT is not a (complete) linguistic theory.
- You need a linguistic theory and on top of it you can do OT.
- Often OT papers do not give their assumptions about the underlying grammar.
- Factorial typology is attractive,
  but requires the assumption of domain specific innate knowledge about language.
- OT is often misunderstood to provide a way to deal with gradedness.
  Gradedness can be and has been introduced into HPSG implementations (as in OT-LFG).

HPSG vs. LFG

- HPSG uses typed feature structures, LFG does not.
- Generalizations can be expressed in type hierarchies.
  LFG uses macro hierarchies for this (Dalrymple, Kaplan and King, 2004).
- There are subtle differences between types and macros
  (for instance type inference).

Two Levels of Description: c-structure and f-structure

- LFG has two levels of description: c-structure and f-structure.
  They have different status.
  c-structure rules are phrase structure rules with atomic node labels.
  Possibly extended by features.
- In HPSG phrases are of the same kind as lexical items and lexical rules.
  This makes it possible to capture generalizations regarding such objects.
  Examples:
  - Complementizer (word) and initial verb (LR).
  - Adjective (word) and relative clause (phrase)
- Crosslinguistically oriented work in LFG usually focuses on f-structures,
  c-structures are often not made explicit.
  In implementations they vary widely.

LFG's f-structure and HPSG's projected Argument Structure

- Wambaya: The traditional NP can be realized discontinuously.
  Adjectives and nouns agree in case.
- Nordlinger (1998) suggested LFG analysis in which constituents refer to the f-structure for the enforcement of agreement.
- Bender (2008): This can be modeled in HPSG if a non-cancellation approach to valence is assumed.
- Non-cancellation was first suggested in GB: Higginbotham (1985, p. 560).
- Introduced and motivated for HPSG:
  Meurers, 1999, Przepiórkowski, 1999, Müller, 2008, Chapter 17.4

The Biggest Problem with LFG (not so serious slide)

- The biggest problem with LFG is:
  They sold the theory to Microsoft. (http://powerset.com/)
- Since Transformational Grammar belongs to the German Telekom:
  http://www.wipo.int/pctdb/en/wo.jsp?
  WO=2004003888&IA=WO2004003888&DISPLAY=DESC
- So HPSG is the only free linguistic theory.

HPSG vs. CG

- Many insights are taken over from CG.
  - Binary branching functor argument structures.
    (some HPSG grammars use flat structures)
  - Argument composition for predicate complexes (Geach, 1970).
- CG has problems with relative clauses and pied piping (Pollard, 1988).
- Additional rules are needed in CG,
  some are already there (topicalization).
- It does not make sense for all structures to assume a head (functor).
  See for instance Constructionist work by Jackendoff (2008) and Jacobs (2008).

HPSG vs. CxG: Constructionist Aspects

HPSG and CxG are close friends:

- Many of the insights of CxG regarding idiosyncrasies and similar points are taken over into other frameworks.
  HPSG: Sag, 1997
  LFG: Asudeh, Dalrymple and Toivonen, 2008
  Simpler Syntax: Culicover and Jackendoff, 2005
- So all of these frameworks can be regarded as constructional approaches to language (Goldberg).

Formalization and Argument Structure Constructions

However:

- Most work in CxG lacks precision.
- Attempts to formalize the analyses (Kay, 2002) failed (Müller, 2006).
- Formal variants are either directly encoded in Lisp (Fluid CxG) or use the formal apparatus of HPSG (Bergen and Chang, 2005; Sag, 2007).

- Phrasal analyses of argument structure constructions have problems: Müller, 2006, In Preparationa
- Language acquisition facts are not a proof that we need phrasal analyses: Müller, In Preparationa

Empty Elements

- CxG dogma: No empty elements
  Michaelis and Ruppenhofer, 2001, p. 49–50; Goldberg, 2003, p. 219; Goldberg, 2006, p. 10; Culicover and Jackendoff, 2005
  Approaches with empty elements can be translated into ones without empty elements.
  The ban of empty elements makes capturing of generalizations impossible:
  Müller, To appeara, Bender, 2002, Sag, Wasow and Bender, 2003, p. 464

- Sociological remark:
  Most Construction Grammar papers are not about grammar.

Conclusion

- All we have is:
  - features and values
  - complex and atomic values
    - atomic values are types
    - complex values are a certain bundling of features (which makes predictions)
  - identity of values
- Linguistic objects are of a certain type.
  Therefore they have to satisfy constraints associated with the respective type in order to be licensed by the grammar.
- HPSG can model constructionist aspects of language (CxG insights).
- HPSG is model theoretic/constraint based.
- Since HPSG is precisely formulated, computer implementations are possible, but don't worry . . .
  Even if you hate computers, you can work in this framework.
- It is the right way to go!

Constituent Order: Binary vs. Flat Structures

- We used binary branching structures in Class 1.
  head-argument-phrase →

$$\begin{bmatrix} \textsc{cat}|\textsc{subcat}\ \boxed{A} \\ \textsc{head-dtr}|\textsc{cat}|\textsc{subcat}\ \boxed{A} \oplus \langle\ \boxed{1}\ \rangle \\ \textsc{non-head-dtrs}\ \langle\ \boxed{1}\ \rangle \end{bmatrix}$$

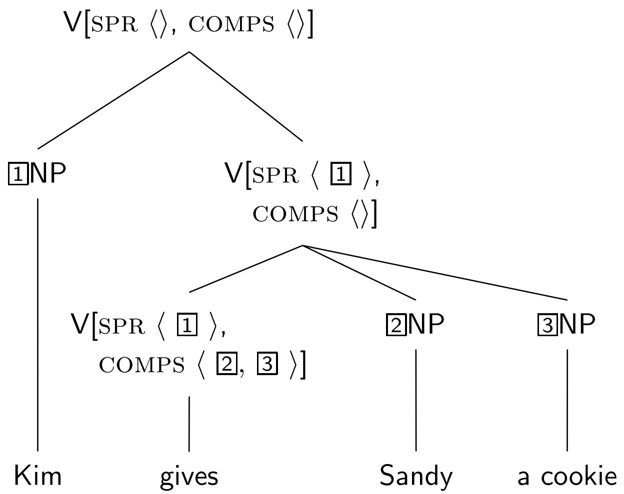
  We will argue for binary branching structures for German shortly.
- However, binary branching is not the only option.
  For languages like English a flat VP is assumed.
- The subject is represented separately
  (as the value of the feature SPECIFIER).
  The other arguments are represented under COMPS.
- Elements in COMPS are combined with their head in one go.

Constituent Order: Binary vs. Flat Structures

- The following head argument schema licenses VPs, that is, projections of a head that include the head and all its arguments except the specifier.
  head-complement-phrase →

$$\begin{bmatrix} \textsc{cat}|\textsc{comps}\ \langle\rangle \\ \textsc{head-dtr}|\textsc{cat}|\textsc{comps}\ \boxed{A} \\ \textsc{non-head-dtrs}\ \boxed{A} \end{bmatrix}$$

The English Clause



Argument-Structure/Valency Mappings: English

- A list valued feature ARGUMENT-STRUCTURE is used for the representation of arguments independent of their function as subject or complement.
- English: The subject is VP-external, both for finite and nonfinite verbs.
- All arguments but the subject are mapped from ARG-ST to COMPS:
  gives:

$$\begin{bmatrix} \textsc{spr} & \langle\ \boxed{1}\ \rangle \\ \textsc{comps} & \boxed{A} \\ \textsc{arg-st} & \left\langle \boxed{1}\text{NP}[\textit{nom}] \right\rangle \oplus \boxed{A} \left\langle \text{NP}[\textit{acc}],\ \text{NP}[\textit{acc}] \right\rangle \end{bmatrix}$$

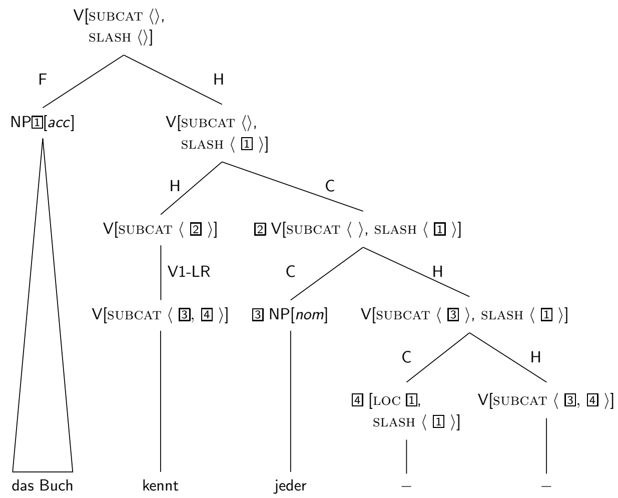
  Linking is done with reference to ARG-ST.

Argument-Structure/Valency Mappings: German

- German: no distinction between subject and other arguments for finite verbs.
  (In GB terms: The subject is VP-internal.
  Much discussed topic: Haider, 1982; Grewendorf, 1983; Kratzer, 1984; Webelhuth, 1985; Sternefeld, 1985; Scherpenisse, 1986; Fanselow, 1987; Grewendorf, 1988; Dürscheid, 1989; Webelhuth, 1990; Oppenrieder, 1991; Wilder, 1991; Haider, 1993; Grewendorf, 1993; Frey, 1993; Lenerz, 1994; Meinunger, 2000)
- All arguments are mapped from ARG-ST to COMPS:
  gibt (*gives*, finite Form):

$$\begin{bmatrix} \text{SPR} & \langle\rangle \\ \text{COMPS} & \boxed{A} \\ \text{ARG-ST} & \boxed{A}\left\langle \text{NP}[\textit{nom}],\ \text{NP}[\textit{acc}],\ \text{NP}[\textit{dat}] \right\rangle \end{bmatrix}$$

Extraction and Verb Movement



Ackerman, Farrell and Webelhuth, Gert. 1998. *A Theory of Predicates*. CSLI Lecture Notes, No. 76, Stanford, CA: CSLI Publications.

Asudeh, Ash, Dalrymple, Mary and Toivonen, Ida. 2008. Constructions with Lexical Integrity: Templates as the Lexicon-Syntax Interface. In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of the LFG 2008 Conference*, Stanford, CA: CSLI Publications. http://cslipublications.stanford.edu/LFG/13/lfg08.html, 23.01.2009.

Barwise, Jon and Perry, John. 1983. *Situations and Attitudes*. Cambridge: Massachusetts, London: England: The MIT Press.

Barwise, Jon and Perry, John. 1987. *Situationen und Einstellungen – Grundlagen der Situationssemantik*. Berlin, New York: de Gruyter.

Bender, Emily M. 2002. *Syntactic Variation and Linguistic Competence: The Case of AAVE Copula Absence*. Ph. D.thesis, Stanford University. http://faculty.washington.edu/ebender/dissertation/, 21.05.2004.

Bender, Emily M. 2008. Radical Non-Configurationality without Shuffle Operators: An Analysis of Wambaya. In Stefan Müller (ed.), *Proceedings of the 15th International Conference on Head-Driven Phrase Structure Grammar, NICT, Keihanna, Japan*, pages 6–24, Stanford, CA: CSLI Publications. http://cslipublications.stanford.edu/HPSG/9/, 31.10.2008.

Bergen, Benjamin K. and Chang, Nancy. 2005. Embodied Construction Grammar in Simulation-Based Language Understanding. In Jan-Ola Östman and Miriam Fried (eds.), *Construction Grammars: Cognitive Grounding and Theoretical Extensions*, Amsterdam, Philadelphia: John Benjamins Publishing Co.

Bildhauer, Felix. 2008. *Representing Information Structure in an HPSG Grammar of Spanish*. Ph. D.thesis, Universität Bremen.

Borsley, Robert D. 1999. *Syntactic Theory: A Unified Approach*. London: Edward Arnold, second edition.

Bouma, Gosse, Malouf, Robert and Sag, Ivan A. 2001. Satisfying Constraints on Extraction and Adjunction. *Natural Language and Linguistic Theory* 19(1), 1–65. ftp://csli-ftp.stanford.edu/linguistics/sag/bms-nllt.ps, 18.08.2002.

Bouma, Gosse and van Noord, Gertjan. 1998. Word Order Constraints on Verb Clusters German and Dutch. In Erhard W. Hinrichs, Andreas Kathol and Tsuneko Nakazawa (eds.), *Complex Predicates in Nonderivational Syntax*, volume 30 of *Syntax and Semantics*, pages 43–72, San Diego: Academic Press. http://www.let.rug.nl/~vannord/papers/, 20.12.2007.

Bresnan, Joan. 1982. The Passive in Lexical Theory. In Joan Bresnan (ed.), *The Mental Representation of Grammatical Relations*, MIT Press Series on Cognitive Theory and Mental Representation, pages 3–86, Cambridge: Massachusetts, London: England: The MIT Press.

Bresnan, Joan and Mchombo, Sam A. 1995. The Lexical

Integrity Principle: Evidence from Bantu. *Natural Language and Linguistic Theory* 13, 181–254.

Chomsky, Noam. 1968. *Language and Mind*. New York: Harcourt, Brace and World.

Chomsky, Noam. 1981. *Lectures on Government and Binding*. Dordrecht: Foris Publications.

Chomsky, Noam. 1990. On formalization and formal linguistics. *Natural Language and Linguistic Theory* 8, 143–147.

Chomsky, Noam. 1993. A Minimalist Program for Linguistic Theory. In Kenneth Hale and Samuel Jay Keyser (eds.), *The View from Building 20: Essays in Linguistics in Honor of Sylvain Bromberger*, Current Studies in Linguistics, No. 24, pages 1–52, Cambridge, Massachusetts/London: The MIT Press.

Cinque, Guglielmo. 1999. *Adverbs and Functional Heads. A Cross-Linguistic Perspective*. New York, Oxford: Oxford University Press.

Cooper, Robin, Mukai, Kuniaki and Perry, John (eds.). 1990. *Situation Theory And Its Applications, Volume 1*. CSLI Lecture Notes, No. 22, Stanford, CA: CSLI Publications.

Copestake, Ann and Briscoe, Ted. 1992. Lexical Rules in a Unification Based Framework. In James Pustejovsky and Sabine Bergler (eds.), *Lexical Semantics and Knowledge Representation*, Lecture Notes in Artificial Intelligence, No. 627, pages 101–119, Berlin: Springer-Verlag. http://www.cl.cam.ac.uk/Research/NL/acquilex/papers.html, 18.08.2002.

Copestake, Ann, Flickinger, Daniel P., Pollard, Carl J. and Sag, Ivan A. 2005. Minimal Recursion Semantics: an Introduction. *Research on Language and Computation* 4(3), 281–332. http://lingo.stanford.edu/sag/papers/copestake.pdf, 11.10.2006.

Crysmann, Berthold. 2002. *Constraint-Based Coanalysis: Portuguese Cliticisation and Morphology-Syntax Interaction in HPSG*. Saarbrücken Dissertations in Computational Linguistics and Language Technology, No. 15, Saarbrücken: Deutsches Forschungszentrum für Künstliche Intelligenz und Universität des Saarlandes.

Culicover, Peter W. and Jackendoff, Ray. 2005. *Simpler Syntax*. Oxford University Press.

Dalrymple, Mary, Kaplan, Ronald M. and King, Tracy Holloway. 2004. Linguistic Generalizations over Descriptions. In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of the LFG 2004 Conference*, pages 199–208, Stanford, CA: CSLI Publications. http://cslipublications.stanford.edu/LFG/9/lfg04.html, 29.03.2006.

Devlin, Keith. 1992. *Logic and Information*. Cambridge: Cambridge University Press.

Dowty, David R. 1979. *Word Meaning and Montague Grammar*. Synthese Language Library, No. 7, Dordrecht, Boston, London: D. Reidel Publishing Company.

Dürscheid, Christa. 1989. *Zur Vorfeldbesetzung in deutschen Verbzweit-Strukturen*. FOKUS, No. 1, Trier: Wissenschaftlicher Verlag.

Engelkamp, Judith, Erbach, Gregor and Uszkoreit, Hans. 1992. Handling Linear Precedence Constraints by Unification. In Henry S. Thomson (ed.), *30th Annual Meeting of the Association for Computational Linguistics. Proceedings of the Conference*, pages 201–208, Newark, Delaware: Association for Computational Linguistics, auch als CLAUS-Report, Nr. 19, Universität des Saarlandes erschienen.

Erdmann, Oskar. 1886. *Grundzüge der deutschen Syntax nach ihrer geschichtlichen Entwicklung*, volume 1. Stuttgart: Verlag der J. G. Cotta'schen Buchhandlung, Reprint: Hildesheim: Georg Olms Verlag, 1985.

Fanselow, Gisbert. 1987. *Konfigurationalität*. Studien zur deutschen Grammatik, No. 29, Tübingen: originally Gunter Narr Verlag now Stauffenburg Verlag.

Fanselow, Gisbert. 1993. Die Rückkehr der Basisgenerierer. *Groninger Arbeiten zur Germanistischen Linguistik* 36, 1–74.

Fanselow, Gisbert. 2001. Features, θ-Roles, and Free Constituent Order. *Linguistic Inquiry* 32(3), 405–437.

Fanselow, Gisbert. 2002. Against Remnant VP-Movement. In Artemis Alexiadou, Elena Anagnostopoulou, Sjef Barbiers and Hans-Martin Gärtner (eds.), *Dimensions of Movement. From Features to Remnants*, Linguistik Aktuell/Linguistics Today, No. 48, pages 91–127, Amsterdam, Philadelphia: John Benjamins Publishing Co.

Flickinger, Daniel P. 1987. *Lexical Rules in the Hierarchical Lexicon*. Ph. D.thesis, Stanford University.

Flickinger, Daniel P., Pollard, Carl J. and Wasow, Thomas. 1985. Structure-Sharing in Lexical Representation. In William C. Mann (ed.), *Proceedings of the Twenty-Third Annual Meeting of the Association for Computational Linguistics*, pages 262–267, Association for Computational Linguistics, Chicago, IL.

Fodor, Jerry A., Bever, Thomas G. and Garrett, Merrill F. 1974. *The Psychology of Language. An Introduction to Psycholinguistics and Generative Grammar*. New York: McGraw-Hill Book Co.

Frey, Werner. 1993. *Syntaktische Bedingungen für die semantische Interpretation. Über Bindung, implizite Argumente und Skopus*. studia grammatica XXXV, Berlin: Akademie Verlag.

Gazdar, Gerald, Klein, Ewan, Pullum, Geoffrey K. and Sag, Ivan A. 1985. *Generalized Phrase Structure Grammar*. Cambridge, Massachusetts: Harvard University Press.

Gazdar, Gerald, Pullum, Geoffrey K. Sag, Ivan A. and Wasow, Thomas. 1982. Coordination and Transformational Grammar. *Linguistic Inquiry* 13(4), 663–677.

Geach, Peter Thomas. 1970. A Program for Syntax. *Synthese* 22, 3–17.

Ginzburg, Jonathan and Sag, Ivan A. 2000. *Interrogative Investigations: the Form, Meaning, and Use of English Interrogatives*. CSLI Lecture Notes, No. 123, Stanford, CA: CSLI Publications.

Goldberg, Adele E. 2003. Constructions: a New Theoretical

Approach to Language. *Trends in Cognitive Sciences* 7(5), 219–224.

Goldberg, Adele E. 2006. *Constructions at Work. The Nature of Generalization in Language*. Oxford Linguistics, Oxford, New York: Oxford University Press.

Grewendorf, Günther. 1983. Reflexivierungen in deutschen A.c.I.-Konstruktionen – kein transformationsgrammatisches Dilemma mehr. *Groninger Arbeiten zur Germanistischen Linguistik* 23, 120–196.

Grewendorf, Günther. 1988. *Aspekte der deutschen Syntax. Eine Rektions-Bindungs-Analyse*. Studien zur deutschen Grammatik, No. 33, Tübingen: originally Gunter Narr Verlag now Stauffenburg Verlag.

Grewendorf, Günther. 1993. German. A Grammatical Sketch. In Joachim Jacobs, Arnim von Stechow, Wolfgang Sterenfeld and Theo Vennemann (eds.), *Syntax – Ein internationales Handbuch zeitgenössischer Forschung*, volume 9.2 of *Handbücher zur Sprach- und Kommunikationswissenschaft*, pages 1288–1319, Berlin: Walter de Gruyter Verlag.

Grewendorf, Günther. 2002. *Minimalistische Syntax*. UTB für Wissenschaft: Uni-Taschenbücher, No. 2313, Tübingen, Basel: A. Francke Verlag GmbH.

Gunji, Takao. 1986. Subcategorization and Word Order. In William J. Poser (ed.), *Papers from the Second International Workshop on Japanese Syntax*, pages 1–21, Stanford, CA: CSLI Publications.

Haider, Hubert. 1982. Dependenzen und Konfigurationen: Zur deutschen V-Projektion. *Groninger Arbeiten zur Germanistischen Linguistik* 21, 1–60.

Haider, Hubert. 1986. Fehlende Argumente: vom Passiv zu kohärenten Infinitiven. *Linguistische Berichte* 101, 3–33.

Haider, Hubert. 1993. *Deutsche Syntax – generativ. Vorstudien zur Theorie einer projektiven Grammatik*. Tübinger Beiträge zur Linguistik, No. 325, Tübingen: Gunter Narr Verlag.

Haider, Hubert. 2000. OV is More Basic than VO. In Peter Svenonius (ed.), *The Derivation of VO and OV*, pages 45–67, Amsterdam: John Benjamins Publishing Co.

Higginbotham, James. 1985. On Semantics. *Linguistic Inquiry* 16(4), 547–593.

Hinrichs, Erhard W. and Nakazawa, Tsuneko. 1989. Subcategorization and VP Structure in German. In *Aspects of German VP Structure*, SfS-Report-01-93, Eberhard-Karls-Universität Tübingen.

Höhle, Tilman N. 1982. Explikation für „normale Betonung" und „normale Wortstellung". In Werner Abraham (ed.), *Satzglieder im Deutschen – Vorschläge zur syntaktischen, semantischen und pragmatischen Fundierung*, Studien zur deutschen Grammatik, No. 15, pages 75–153, Tübingen: originally Gunter Narr Verlag now Stauffenburg Verlag.

Hornstein, Norbert, Nunes, Jairo and Grohmann, Kleantes K. 2005. *Understanding Minimalism*. Cambridge Textbooks in Linguistics, Cambridge, UK: Cambridge University Press.

Jackendoff, Ray S. 1975. Morphological and Semantic Regularities in the Lexikon. *Language* 51(3), 639–671.

Jackendoff, Ray S. 2008. Construction after Construction and Its Theoretical Challenges. *Language* 84(1), 8–28.

Jacobs, Joachim. 2008. Wozu Konstruktionen? *Linguistische Berichte* 213, 3–44.

Kay, Paul. 2002. An Informal Sketch of a Formal Architecture for Construction Grammar. *Grammars* 5(1), 1–19. http://www.icsi.berkeley.edu/~kay/cg.arch.pdf, 06.10.2004.

Kayne, Richard S. 1994. *The Antisymmetry of Syntax*. Cambridge, Massachusetts: The MIT Press.

Kiss, Tibor. 1992. Variable Subkategorisierung. Eine Theorie unpersönlicher Einbettungen im Deutschen. *Linguistische Berichte* 140, 256–293.

Kiss, Tibor. 1995. *Merkmale und Repräsentationen*. Opladen/Wiesbaden: Westdeutscher Verlag.

Koenig, Jean-Pierre. 1999. *Lexical Relations*. Stanford Monographs in Linguistics, Stanford, CA: CSLI Publications.

Kornai, András and Pullum, Geoffrey K. 1990. The X-bar Theory of Phrase Structure. *Language* 66(1), 24–50.

Kratzer, Angelika. 1984. On Deriving Syntactic Differences between German and English, TU Berlin, ms.

Krieger, Hans-Ulrich. 1994. Derivation Without Lexical Rules. In C.J. Rupp, Michael A. Rosner and Rod L. Johnson (eds.), *Constraints, Language and Computation*, Computation in Cognitive Science, pages 277–313, London/San Diego/New York: Academic Press.

Krieger, Hans-Ulrich and Nerbonne, John. 1993. Feature-Based Inheritance Networks for Computational Lexicons. In Briscoe, Copestake and de Paiva (eds.), *Inheritance, Defaults, and the Lexicon*, pages 90–136, Cambridge University Press.

Laenzlinger, Christoph. 2004. A feature-based theory of adverb syntax. In J. R. Austin, St. Engelberg and G. Rauh (eds.), *Adverbials: The Interplay Between Meaning, Context, and Syntactic Structure*, pages 205–252, Amsterdam: Benjamins.

Lebeth, Kai. 1994. Morphosyntaktischer Strukturaufbau – Die Generierung komplexer Verben im HPSG-Lexikon eines Sprachproduktionssystems. Hamburger Arbeitspapiere zur Sprachproduktion – IV Arbeitspapier No. 16, Universität Hamburg, Fachbereich Informatik.

Lenerz, Jürgen. 1994. Pronomenprobleme. In Brigitta Haftka (ed.), *Was determiniert Wortstellungsvariation? Studien zu einem Interaktionsfeld von Grammatik, Pragmatik und Sprachtypologie*, pages 161–174, Opladen: Westdeutscher Verlag.

Lipenkova, Janna and Müller, Stefan. To appear. Serial Verb Constructions in Mandarin Chinese. In Müller (To appearb).

Meinunger, André. 2000. *Syntactic Aspects of Topic and Comment*. Linguistik Aktuell/Linguistics Today, No. 38, Amsterdam, Philadelphia: John Benjamins Publishing Co.

Meurers, Walt Detmar. 1999. Raising Spirits (and Assigning Them Case). *Groninger Arbeiten zur Germanistischen Linguistik (GAGL)* 43, 173–226. http://www.sfs.uni-tuebingen.de/~dm/papers/gagl99.html, 18.04.2000.

Meurers, Walt Detmar. 2000. Lexical Generalizations in the Syntax of German Non-Finite Constructions. Arbeitspapiere des SFB 340 No. 145, Eberhard-Karls-Universität, Tübingen. http://www.ling.ohio-state.edu/~dm/papers/diss.html, 19.08.2002.

Michaelis, Laura A. and Ruppenhofer, Josef. 2001. *Beyond Alternations: A Constructional Model of the German Applicative Pattern*. Stanford Monographs in Linguistics, Stanford, CA: CSLI Publications.

Mineur, Anne-Marie. 1995. Interview with Bob Carpenter. *Ta!, the Dutch Students' Magazine for Computational Linguistics* 3(1).

Müller, Stefan. 2002. *Complex Predicates: Verbal Complexes, Resultative Constructions, and Particle Verbs in German*. Studies in Constraint-Based Lexicalism, No. 13, Stanford, CA: CSLI Publications. http://hpsg.fu-berlin.de/~stefan/Pub/complex.html, 23.09.2009.

Müller, Stefan. 2006. Phrasal or Lexical Constructions? *Language* 82(4), 850–883. http://hpsg.fu-berlin.de/~stefan/Pub/phrasal.html, 23.09.2009.

Müller, Stefan. 2007. Phrasal or Lexical Constructions: Some Comments on Underspecification of Constituent Order, Compositionality, and Control. In Stefan Müller (ed.), *Proceedings of the 14th International Conference on Head-Driven Phrase Structure Grammar, Stanford Department of Linguistics and CSLI's LinGO Lab*, pages 373–393, Stanford, CA: CSLI Publications. http://hpsg.fu-berlin.de/~stefan/Pub/phrasal-2.html, 29.07.2007.

Müller, Stefan. 2008. *Head-Driven Phrase Structure Grammar: Eine Einführung*. Stauffenburg Einführungen, No. 17, Tübingen: Stauffenburg Verlag, second edition. http://hpsg.fu-berlin.de/~stefan/Pub/hpsg-lehrbuch.html, 23.09.2009.

Müller, Stefan. 2009. Towards an HPSG Analysis of Maltese. In Bernard Comrie, Ray Fabri, Beth Hume, Manwel Mifsud, Thomas Stolz and Martine Vanhove (eds.), *Introducing Maltese linguistics. Papers from the 1st International Conference on Maltese Linguistics (Bremen/Germany, 18–20 October, 2007)*, volume 113 of *Studies in Language Companion Series*, pages 83–112, Amsterdam, Philadelphia: John Benjamins Publishing Co. http://hpsg.fu-berlin.de/~stefan/Pub/maltese-sketch.html, 23.09.2009.

Müller, Stefan. In Preparationa. Formal Grammar, Constructions, and Language Acquisition. In Hans C. Boas and Ivan A. Sag (eds.), *Sign-based Construction Grammar*, Stanford, CA: CSLI Publications.

Müller, Stefan. In Preparationb. *Grammatiktheorie: Von der Transformationsgrammatik zur beschränkungsbasierten Grammatik*. Stauffenburg Einführungen, Tübingen: Stauffenburg Verlag. http://hpsg.fu-berlin.de/~stefan/Pub/grammatiktheorie.html, 23.09.2009.

Müller, Stefan. In Preparationc. Head-Driven Phrase Structure Grammar. In Artemis Alexiadou and Tibor Kiss (eds.), *Syntax – Ein internationales Handbuch zeitgenössischer Forschung*, Handbücher zur Sprach- und Kommunikationswissenschaft, Berlin: Walter de Gruyter Verlag, second edition.

Müller, Stefan. To appeara. Elliptical Constructions, Multiple Frontings, and Surface-Based Syntax. In Gerhard Jäger, Paola Monachesi, Gerald Penn and Shuly Wintner (eds.), *Proceedings of Formal Grammar 2004, Nancy*, Stanford, CA: CSLI Publications. http://hpsg.fu-berlin.de/~stefan/Pub/surface.html, 23.09.2009.

Müller, Stefan (ed.). To appearb. *Proceedings of the 16th International Conference on Head-Driven Phrase Structure Grammar, University of Göttingen, Germany*, Stanford, CA, CSLI Publications.

Müller, Stefan. To appear 2010. Persian Complex Predicates and the Limits of Inheritance-Based Analyses. *Journal of Linguistics* 46(2). http://hpsg.fu-berlin.de/~stefan/Pub/persian-cp.html, 23.09.2009.

Newmeyer, Frederick J. 2005. *Possible and Probable Languages: A Generative Perspective on Linguistic Typology*. Oxford: Oxford University Press.

Nordlinger, Rachel. 1998. *Constructive Case: Evidence from Australia*. Stanford, CA: CSLI Publications.

Oppenrieder, Wilhelm. 1991. *Von Subjekten, Sätzen und Subjektsätzen*. Linguisitische Arbeiten, No. 241, Tübingen: Max Niemeyer Verlag.

Orgun, Cemil Orhan. 1996. *Sign-Based Morphology and Phonology*. Ph. D.thesis, University of Califonia, Berkeley.

Ørsnes, Bjarne. To appear. Preposed Sentential Negation in Danish. In Müller (To appearb).

Paul, Hermann. 1919. *Deutsche Grammatik. Teil IV: Syntax*, volume 3. Halle an der Saale: Max Niemeyer Verlag, 2nd unchanged edition 1968, Tübingen: Max Niemeyer Verlag.

Pollard, Carl J. 1988. Categorial Grammar and Phrase Structure Grammar: An Excursion on the Syntax-Semantics Frontier. In Richard Oehrle, Emmon Bach and Deirdre Wheeler (eds.), *Categorial Grammars and Natural Language Structures*, pages 391–415, Dordrecht, Boston, London: D. Reidel Publishing Company.

Pollard, Carl J. 1996. On Head Non-Movement. In Harry Bunt and Arthur van Horck (eds.), *Discontinuous Constituency*, Natural Language Processing, No. 6, pages 279–305, Berlin, New York: Mouton de Gruyter, veröffentlichte Version eines Ms. von 1990.

Pollard, Carl J. and Sag, Ivan A. 1987. *Information-Based Syntax and Semantics*. CSLI Lecture Notes, No. 13, Stanford, CA: CSLI Publications.

Pollard, Carl J. and Sag, Ivan A. 1994. *Head-Driven Phrase Structure Grammar*. Studies in Contemporary Linguistics, Chicago, London: University of Chicago Press.

Przepiórkowski, Adam. 1999. On Case Assignment and "Adjuncts as Complements". In Gert Webelhuth,

Jean-Pierre Koenig and Andreas Kathol (eds.), *Lexical and Constructional Aspects of Linguistic Explanation*, Studies in Constraint-Based Lexicalism, No. 1, pages 231–245, Stanford, CA: CSLI Publications.

Pullum, Geoffrey. 1991. *The Great Eskimo Vocabulary Hoax and Other Irreverent Essays on the Study of Language*. Chicago, IL: University of Chicago Press.

Pullum, Geoffrey K. 1985. Assuming Some Version of X-bar Theory. In *Papers from the 21nd Annual Meeting of the Chicago Linguistic Society*, pages 323–353.

Pullum, Geoffrey K. 1989. Formal Linguistics Meets the Boojum. *Natural Language and Linguistic Theory* 7(1), 137–143. http://dx.doi.org/10.1007/BF00141350, 31.01.2009.

Pullum, Geoffrey K. and Scholz, Barbara C. 2001. On the Distinction between Generative-Enumerative and Model-Theoretic Syntactic Frameworks. In Philippe de Groote, Glyn Morrill and Christian Retor (eds.), *Logical Aspects of Computational Linguistics: 4th International Conference*, Lecture Notes in Computer Science, No. 2099, pages 17–43, Berlin: Springer Verlag.

Riehemann, Susanne Z. 1998. Type-Based Derivational Morphology. *Journal of Comparative Germanic Linguistics* 2, 49–77. http://doors.stanford.edu/~sr/morphology.ps, 05.04.2009.

Rogers, James. 1998. *A Descriptive Approach to Language-Theoretic Complexity*. Stanford, CA: CSLI Publications.

Ross, John Robert. 1967. *Constraints on Variables in Syntax*. Ph. D.thesis, MIT, reproduced by the Indiana University Linguistics Club.

Sag, Ivan A. 1997. English Relative Clause Constructions. *Journal of Linguistics* 33(2), 431–484. http://lingo.stanford.edu/sag/papers/rel-pap.pdf, 30.05.2004.

Sag, Ivan A. 2007. Sign-Based Construction Grammar: An Informal Synopsis. Unpublished ms, Stanford University. http://lingo.stanford.edu/sag/papers/theo-syno.pdf, 23.10.2007.

Sag, Ivan A., Wasow, Thomas and Bender, Emily M. 2003. *Syntactic Theory: A Formal Introduction*. CSLI Lecture Notes, No. 152, Stanford, CA: CSLI Publications, second edition.

Saussure, Ferdinand de. 1916. *Grundfragen der allgemeinen Sprachwissenschaft*. Berlin: Walter de Gruyter & Co, 2nd edition 1967.

Scherpenisse, Wim. 1986. *The Connection Between Base Structure and Linearization Restrictions in German and Dutch*, volume 47 of *Europäische Hochschulschriften, Reihe XXI, Linguistik*. Frankfurt/M.: Peter Lang.

Shieber, Stuart M., Uszkoreit, Hans, Pereira, Fernando, Robinson, Jane and Tyson, Mabry. 1983. The Formalism and Implementation of PATR-II. In *Research on Interactive Acquisition and Use of Knowledge*, pages 39–79, Menlo Park, CA: Artificial Intelligence Center, SRI International.

Sternefeld, Wolfgang. 1985. On Case and Binding Theory. In

Jindřich Toman (ed.), *Studies in German Grammar*, Studies in Generative Grammar, No. 21, pages 231–285, Dordrecht: Holland, Cinnaminson: U.S.A.: Foris Publications.

van Eynde, Frank. 1994. *Auxiliaries and Verbal Affixes—A Monostratal Cross-linguistic Analysis*. Katholieke Universiteit Leuven, Faculteit Letteren, Departement Linguïstiek, proefschrift.

von Stechow, Arnim. 1996. The Different Readings of *wieder* "again": A Structural Account. *Journal of Semantics* 13, 87–138.

Webelhuth, Gert. 1985. German is Configurational. *The Linguistic Review* 4(3), 203–246.

Webelhuth, Gert. 1990. Diagnostics for Structure. In Günther Grewendorf and Wolfgang Sternefeld (eds.), *Scrambling and Barriers*, Linguistik Aktuell / Linguistics Today, No. 5, pages 41–75, Amsterdam, Philadelphia: John Benjamins Publishing Co.

Wilder, Chris. 1991. Small Clauses and Related Objects. *Groninger Arbeiten zur Germanistischen Linguistik* 34, 215–236.

Williams, Edwin. 1981. Argument Structure and Morphology. *The Linguistic Review* 1(1), 81–114.