

Chapter 10

Constituent order

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1 Introduction

The chapter might strike readers as a bit German-centric. This is probably okay as long as you make it clear at the outset. (And I suppose a discussion of V2 is not just relevant to German or even Germanic.)

This chapter deals with constituent order, with a focus on local order variants. English is the language that is treated most thoroughly in theoretical linguistics but is probably also a rather uninteresting language as far as the possibilities of reordering constituents is concerned: the order of subject, verb, and object is fixed in sentences like (1):

- (1) Kim likes bagels.

Of course, there is the possibility to front the object as in (2) but this is a special, non-local construction that is not the topic of this chapter but is treated in Borsley & Crysmann (2018), Chapter 14 of this volume.

- (2) Bagels, Kim likes.

This chapter deals with scrambling (the local reordering of arguments) and with alternative placements of heads (called *head movement* in some theories). Examples of the former are the subordinate clauses in (3) and an example of the latter is given in (4):

- (3) a. [weil] der Mann der Frau das Buch gibt (German)
because the.NOM man the.DAT woman the.ACC book gives



- b. [weil] der Mann das Buch der Frau gibt
because the.NOM man the.ACC book the.DAT woman gives
 - c. [weil] das Buch der Mann der Frau gibt
because the.ACC book the.NOM man the.DAT woman gives
 - d. [weil] das Buch der Frau der Mann gibt
because the.ACC book the.DAT woman the.NOM man gives
 - e. [weil] der Frau der Mann das Buch gibt
because the.DAT woman the.NOM man the.ACC book gives
 - f. [weil] der Frau das Buch der Mann gibt
because the.DAT woman the.ACC book the.NOM man gives
- (4) Gibt der Mann der Frau das Buch? (German)
gives the.NOM man the.DAT woman the.ACC book
'Does the man give the woman the book?'

(3) shows that in addition to the unmarked order in (3a) (see Höhle (1982) on the notion of unmarked order), five other argument orders are possible in sentences with three-place verbs.

(4) shows that the verb is placed in initial position in questions in German. This contrasts with the verb final order in the subordinate clause in (3a), which has the same order as far as the arguments are concerned. This alternation of verb placement is usually treated as head movement in the transformational literature (Bach 1962; Bierwisch 1963: 34; Reis 1974; Thiersch 1978: Chapter 1). Declarative main clauses in German are V2 clauses and the respective fronting of the preverbal constituent is usually treated as a non-local dependency (see Borsley & Cysmann (2018), Chapter 14 of this volume). Hence, V2 sentences will not be handled here.

The following sections deal with the theoretical options within the HPSG framework for dealing with these phenomena. I first discuss the separation of grammar rules into an immediate dominance part and a linear precedence component in Section 2 and then flat vs. binary branching structures (Section 3). While flat structures allow verbs to be ordered clause-finally or clause-initially, this is not the case for binary branching structures, since only sisters can be ordered. So, for (3a) one would get the bracketing in (5a). If *das Buch* 'the book' and *gibt* 'gives' are ordered in a different order, (5b) results.

- (5) a. [weil] [der Mann [der Frau [das Buch gibt]]]
because the.NOM man the.DAT woman the.ACC book gives

- b. * [weil] [der Mann [der Frau [gibt das Buch]]]
 because the.NOM man the.DAT woman gives the.ACC book

Hence, local reordering is not sufficient to get clause-initial verb order and therefore, proposals with binary branching structures are usually paired with HPSG's analogue of what is head-movement in transformational theories. These are explained in Section 5. Section 6 introduces an extension to standard HPSG developed by Reape (1994): constituent order domains. Such constituent order domains allow for discontinuous constituents and have been used to account for languages like Warlipri (Donohue & Sag 1999). Section 7 shows how such languages can be analyzed without admitting discontinuous constituents.

2 ID/LP format

HPSG was developed out of Generalized Phrase Structure Grammar (GPSG) and Categorical Grammar. The ideas concerning linearization of daughters in a local tree were taken over from GPSG (Gazdar, Klein, Pullum & Sag 1985). In GPSG a separation between immediate dominance and linear precedence is assumed. So, while in classical phrase structure grammar, a phrase structure rule like (6) states that the NP[nom], NP[dat] and NP[acc] have to appear in exactly this order, this is not the case in GPSG and HPSG:

- (6) $S \rightarrow \text{NP}[\text{nom}] \text{NP}[\text{dat}] \text{NP}[\text{acc}] V$

The HPSG schemata corresponding to the phrase structure rule in (6) do not express information about ordering. Instead, there are separate linear precedence (LP) rules. A schema like (6) licenses 24 different orders: the six permutations of the three arguments that were shown in (3) and all possible placements of the verb (to the right of NP[acc], between NP[dat] and NP[acc], between NP[nom] and NP[dat], to the left of NP[nom]). Orders like NP[nom], NP[dat], V, NP[acc] are not attested in German and hence these orderings have to be filtered out. This is done by linearization rules, which can refer to features or to the function of a daughter in a schema. (7) shows some examples of linearization rules:

- (7) a. $X < V$
 b. $X < V[\text{INI}-]$
 c. $X < \text{Head} [\text{INI}-]$

The first rule says that all constituents have to precede a V in the local tree. The second rule says that all constituents have to precede a V that has the INITIAL

value –. One option to analyze German would be the one that was suggested by Uszkoreit (1987) within the framework of GPSG: one could allow for two linearization variants of finite verbs. So in addition to the INI– variant of verbs there could be a INI+ variant and this variant would be linearized initially. The LP rule in (7c) is more general than (7b) in that it does not mention the part of speech but instead refers to the function of the constituent. The rule says that a head that has the INI value – has to be linearized to the right of all other elements in the local tree.

This treatment of constraints on linearization has an advantage that was already pointed out by researchers working in GPSG: it captures the generalizations regarding linearization. For instance the order of verbs and their arguments is the same in embedded sentences in German independent of the finiteness of the verb:

- (8) a. dass er dem Mann das Buch gab
 that he.NOM the.DAT man the.ACC book gave
 ‘that he gave the man the book’
 b. dass er versucht, [dem Mann das Buch zu geben]
 that he.NOM tried the.DAT man the.ACC book to give
 ‘that he tried to give the man the book’

This is also true for the relative order of dative and accusative object in (8). The constraints regarding linearization hold across rules. By factoring these constraints out, the generalizations can be captured.

Furthermore, generalizations about constituent structure can be captured. For example, the two phrase structure rules in (9) would be needed for head-initial and head-final languages, respectively:

- (9) a. $VP \rightarrow V\ NP\ NP$
 b. $VP \rightarrow NP\ NP\ V$

In an ID/LP framework only one rule is needed. The linearization of the head is factored out of the rules. Similarly, HPSG has just one schema for Head-Adjunct structures although languages like English allow adjuncts to precede or follow the head they modify. The schema does not say anything about the order of the daughters. This is taken care of by two LP rules saying that adjuncts marked as pre-modifiers have to precede their head while those that are marked as post-modifiers follow it.

3 Flat and binary branching structures

The previous section discussed LP rules and used flat phrase structure rules for illustration. The corresponding flat structures are also used in HPSG. Schema 1 shows a Head-Complement schema that combines a head with all the complements selected via the COMPS list.¹

Schema 1 (Head-Complement Schema)

head-complement-phrase \Rightarrow

$$\left[\begin{array}{ll} \dots | \text{COMPS} & \langle \rangle \\ \text{HEAD-DTR} & \left[\dots | \text{COMPS } [1] \right] \\ \text{NON-HEAD-DTRS} & \text{synsem2sign}([1]) \end{array} \right]$$

synsem2sign is a relational constraint mapping *synsem* objects as they are contained in the COMPS list onto objects of type *sign* as they are contained in daughters (see Ginzburg & Sag 2000: 34 for a similar proposal).² How this schema can be used to analyze VPs like the one in (10) is shown in Figure 1.

(10) Kim gave Sandy a book.

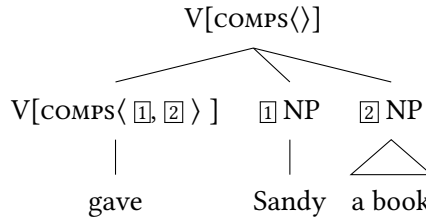


Figure 1: Analysis of the VP *gave Sandy a book* with a flat structure

Researchers working on English usually assume a flat structure (Pollard & Sag 1994)[479]Sag97GSag2000a-u but assuming binary branching structures would

¹Ginzburg & Sag (2000: 4) assume a list called *DTRS* for all daughters including the head daughter. It is useful to be able to refer to specific non-head daughters without having to know a position in a list. For example in head-adjunct structures the adjunct is the selector. So I keep *DTRS* for a list of ordered daughters and *HEAD-DTR* and *NON-HEAD-DTRS* for material that is not necessarily ordered.

²In Sign-Based Construction Grammar the objects in valence lists are of the same type as the daughters. A relational constraint would not be needed in this variant of the HPSG theory. Theories working with a binary branching Head-Complement Schema as Schema 2 on page 186 would not need the relational constraint either since the *synsem* object in the COMPS list can be shared with the *SYNSEM* value of the element in the list of non-head daughters directly.

be possible as well, as is clear from analyses in Categorical Grammar, where binary combinatory rules are assumed (Ajdukiewicz 1935; Steedman 2000). For languages like German it is usually assumed that structures are binary branching (but see Reape 1994: 156 and Bouma & van Noord 1998: 51). The reason for this is that adverbials can be placed anywhere between the arguments as the following example from Uszkoreit (1987: 145) shows:

- (11) *Gestern* hatte *in der Mittagspause* der Vorarbeiter *in der*
 yesterday had during the lunch.break the foreman in the
Werkzeugkammer dem Lehrling *aus Boshaftigkeit langsam zehn*
 tool.shop the apprentice maliciously slowly ten
schmierige Gußeisenscheiben unbemerkt in die Hosentasche gesteckt.
 greasy cast.iron.disks unnoticed in the pocket put
 ‘Yesterday during lunch break, the foreman maliciously and unnoticed,
 put ten greasy cast iron disks slowly into the apprentice’s pocket.’

A straightforward analysis of adjunct placement in German and Dutch is to assume that adjuncts can attach to any verbal projection. For example, Figure 2 shows the analysis of (12):

- (12) *weil* *deshalb* *jemand* *gestern* *der Frau* *schnell* *das Buch* *gab*
 because therefore somebody yesterday the woman quickly the book gave
 ‘because somebody quickly gave the woman the book yesterday’

The adverbials *deshalb* ‘therefore’, *gestern* ‘yesterday’ and *schnell* ‘quickly’ may attach to any verbal projection. For example, *gestern* could also be placed at the other adjunct positions in the clause.

Binary branching structures with attachment of adjuncts to any verbal projection also account for recursion and hence the fact that arbitrarily many adjuncts can attach to a verbal projection. Of course it is possible to formulate analyses with flat structures that involve arbitrarily many adjuncts (Kasper 1994; van Noord & Bouma 1994; Bouma et al. 2001), but these analyses involve relational constraints in schemata or in lexical items. In Kasper’s analysis the relational constraints walk through lists of daughters of unbounded length in order to compute the semantics. In the other two analyses adjuncts are treated as valents, which may be problematic because of scope issues. This cannot be dealt with in detail here but see Levine & Hukari (2006) and Chaves (2009) for discussion.

The following schema licenses binary branching head-complement phrases:

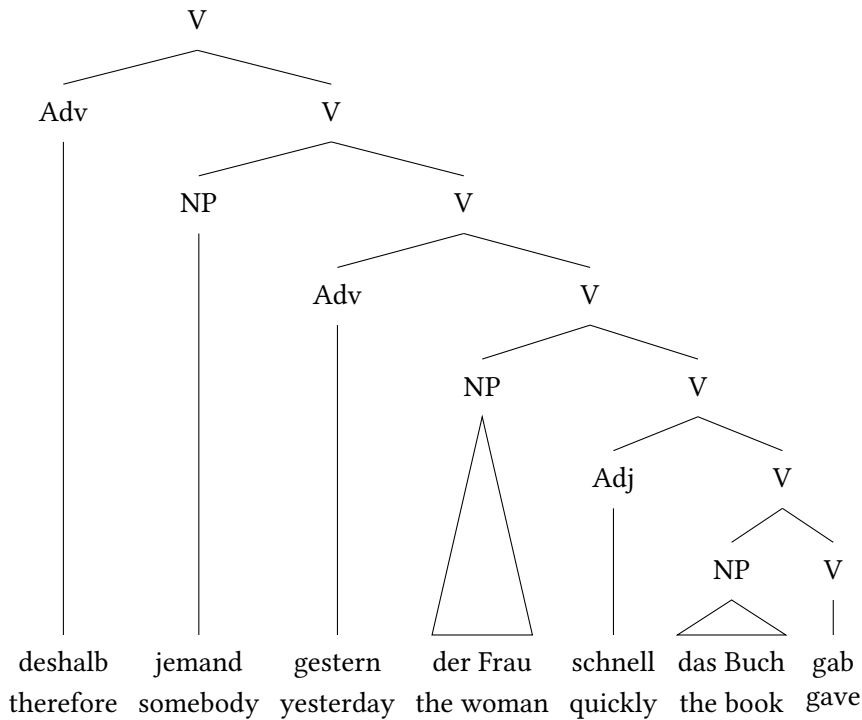


Figure 2: Analysis of [*weil*] *deshalb jemand gestern der Frau schnell das Buch gab* ‘because somebody quickly gave the woman the book yesterday’ with binary branching structures

Schema 2 (Head-Complement Schema (binary branching))

$$\text{head-complement-phrase} \Rightarrow$$

$$\left[\begin{array}{l} \text{COMPS} \\ \text{HEAD-DTR} \\ \text{NON-HEAD-DTRS} \end{array} \quad \begin{array}{l} \boxed{1} \oplus \boxed{2} \\ \left[\text{COMPS } \boxed{1} \oplus \langle \boxed{3} \rangle \oplus \boxed{2} \right] \\ \left\langle \left[\text{SYNSEM } \boxed{3} \right] \right\rangle \end{array} \right]$$

\oplus (append) is a relational constraint that concatenates two lists. The COMPS list of the head daughter is split into three lists: a beginning ($\boxed{1}$), a list containing $\boxed{3}$ and a rest ($\boxed{2}$). $\boxed{3}$ is identified with the SYNSEM value of the non-head daughter. All other elements of the COMPS list of the head daughter are concatenated and the result of this concatenation ($\boxed{1} \oplus \boxed{2}$) is the COMPS list of the mother node. This schema is very general. It works for languages that allow for scrambling since it

allows an arbitrary element to be taken out of the COMPS list of the head daughter and realize it in a local tree. The schema can also be “parametrized” to account for languages with fixed word order. For head final languages with fixed order [2] would be the empty list (= combination with the last element in the list) and for head-initial languages with fixed order (e.g., English) [1] would be the empty list (= combination with the first element in the list). Since the elements in the COMPS list are ordered in the order of Obliqueness (Keenan & Comrie 1977; Pullum 1977) and since this order corresponds to the order in which the complements are serialized in English, the example in (10) can be analyzed as in Figure 3.³ The second tree in the figure is the German counterpart of *gave Sandy a book*:

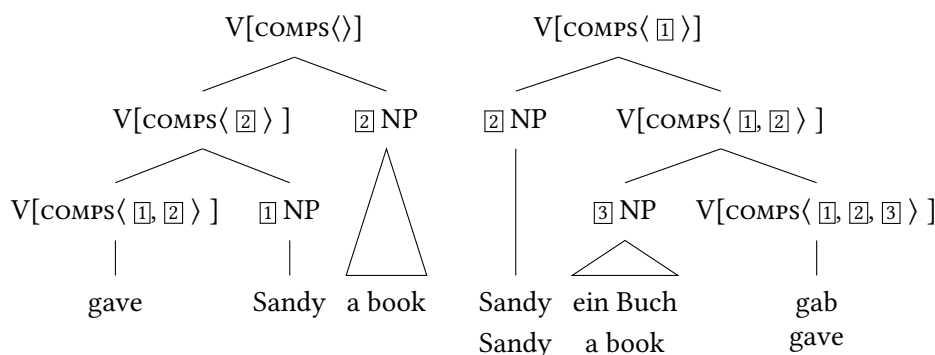


Figure 3: Analysis of the English VP *gave Sandy a book* and the corresponding German verbal projection *Sandy ein Buch gab* with binary branching structures

the finite verb in final position with its two objects in normal order. Section 4 explains why SOV languages like German and Japanese contain their subject in the COMPS list while SVO languages like English and Romance languages do not.

The alternative to using relational constraints as in Schema 2 is to use sets rather than lists for the representation of valence information (Gunji 1986; Hinrichs & Nakazawa 1989; Pollard 1996; Engelkamp, Erbach & Uszkoreit 1992). The Head-Complement Schema would combine the head with one of its complements. Since the elements of a set are not ordered, any complement can be taken

³This structure may seem strange to those working in Mainstream Generative Grammar (MGG, GB/Minimalism). In MGG different branchings are assumed since the form of the tree plays a role in Binding Theory. This is not the case in HPSG: Binding is done on the ARG-ST list. See Branco (2018), Chapter 21 of this volume for a discussion of HPSG's Binding Theory and Borsley & Müller (2018), Chapter 33 of this volume for a comparison between HPSG and Minimalism.

and hence all permutations of complements are accounted for.

The disadvantage of set-based approaches is that sets do not impose an order on their members but an order is needed for various subtheories of HPSG (see Przepiórkowski (2018), Chapter 7 of this volume on case assignment, and Branco (2018), Chapter 21 of this volume on Binding Theory). In the approach proposed above and in Müller (2003b; 2015a,b), the valence lists are ordered but the schema allows for combination with any element of the list. For valence representation and the order of elements in valence lists see Wechsler, Koenig & Davis (2018), Chapter 9 of this volume.

4 SVO vs. SOV

5 Head movement vs. constructional approaches assuming flat structures

The Germanic languages signal the clause type by verb position. All Germanic languages with the exception of English are V2 languages: the finite verb is in second position in declarative main clauses. The same holds for questions with *wh* phrases. Yes/no questions are formed by putting the verb in initial position. English is a so-called *residual V2 language*, that is, there are some constructions that are parallel to what is known from V2 languages. For example, while declarative clauses are in base order (SVO), questions follow the pattern that is known from other Germanic languages.

(13) What_{*i*} did Kim read _{*i*}?

Analyses assuming flat structures (or flat linearization domains, see Section 6) usually treat alternative orders of verbs in Germanic languages as linearization variants (Reape 1994; Kathol 2001; Müller 1995; 2003b; Bjerre 2006), but this is not necessarily so as Bouma and van Noord's analysis of Dutch clauses show (Bouma & van Noord 1998: 62, 71). The alternative to verb placement as linearization is something that is similar to verb movement in Government & Binding: an empty element takes the position of the verb in its canonical position and the verb is realized in initial or – in case something is realized before the finite verb – in second position. The following subsection deals with such approaches in more detail. Subsection 5.2 deals with a constructional approach.

5.1 Head movement approaches

Building on work by Jacobson (1987) in the framework of Categorical Grammar, Borsley (1989) showed that in addition to the analysis of auxiliary inversion in English that was suggested in GPSG (Gazdar et al. 1985) an analysis that is similar to the movement-based analysis in GB is possible in HPSG as well. The technique that is used in the analysis is basically the same that was developed by Gazdar (1981) for the treatment of nonlocal dependencies in GPSG. An empty category is assumed and the information about the missing element is passed up the tree until it is bound off at an appropriate place (that is by the fronted verb). Note that the heading of this section contains the term *head movement* and I talk about traces, but it is not the case that something is actually moved. There is no underlying structure with a verb that is transformed into one with the verb fronted and a remaining trace in the original position of the verb. Instead, the empty element is a normal element in the lexicon and can function as the verb in the respective position. The analysis of (14) is shown in Figure 4.

(14) Did Kim get the job?

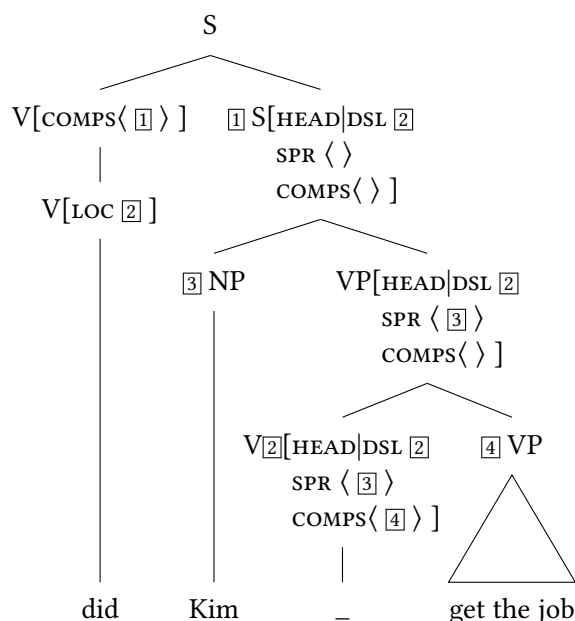


Figure 4: Analysis of English auxiliary constructions as head-movement following (Borsley 1989)

A special variant of the auxiliary selects a full clause in which an auxiliary is missing. The fact that the auxiliary is missing is represented as the value of DSL. The value of DSL is a *local* object, that is something that contains syntactic and semantic information ([2] in Figure 4). DSL is a head feature and hence available everywhere along a projection path (see Borsley & Abeillé (2018), Chapter 1 of this volume for the Head Feature Principle). The empty element for head movement is rather simple:

check reference to Chapter 1.

(15) empty element for head movement:

$$\left[\begin{array}{c} \text{word} \\ \text{PHON} \quad \langle \rangle \\ \text{SYNSEM|LOC} \quad [1] \quad \left[\text{CAT|HEAD|DSL} \quad [1] \right] \end{array} \right]$$

It states that there is an empty element that has the local requirements that correspond to its DSL value. For cases of verb movement it says: I am a verb that is missing itself. The fronted auxiliary is licensed by a lexical rule that maps a non-fronted auxiliary onto one that selects a complete clause from which the input auxiliary is missing.

Such head-movement analyses are assumed by most researchers working on German (Kiss & Wesche 1991: Section 4.7; Oliva 1992; Netter 1992; Kiss 1993; Frank 1994; Kiss 1995; Feldhaus 1997; Meurers 2000; Müller 2005a; 2017) and also by (Bouma & van Noord 1998: 62, 71) in their work on Dutch, by Müller & Ørsnes (2015) in their grammar of Danish and by Müller (2018) for Germanic in general.

5.2 Constructional approaches

The alternative to head-movement-based approaches is a flat analysis with an alternative serialization of the verb. This was already discussed with respect to German, but I want to discuss English auxiliary constructions here, since the figured prominently in linguistic discussions. In the analysis of (16) shown in Figure 5, the auxiliary *did* selects for the subject *Kim* and a VP *get the job*.

(16) Did Kim get the job?

The tree in Figure 5 is licensed by a schema combining a head with its subject ([1]) and its VP complement ([2]) in one go.⁴ As is common in HPSG since 1995 (Sag 1997) phrasal schemata are organized in type hierarchies and the general

⁴An alternative is to assume a separate valence feature for the subject (SUBJ) and assume a schema that combines the head with the element in the SUBJ list and the elements in the COMPS list (Ginzburg & Sag 2000: 36).

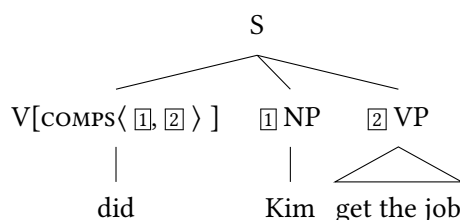


Figure 5: Analysis of English auxiliary constructions according to (Sag et al. 2018)

schema for auxiliary initial constructions has the type *aux-initial-cxt*. Fillmore (1999) and Sag et al. (2018) argue that there are various usages of auxiliary-initial constructions and assign the respective usages to subconstructions of the general auxiliary-initial construction. Technically this amounts to stating subtypes of *aux-initial-cxt*. For example, Sag et al. (2018) posit a subtype *polar-int-cl* for polar interrogatives like (17a) and another subtype *auxinitial-excl-cl* for exclamatives like (17b).

- (17) a. Are they crazy?
 b. Are they crazy!

Chomsky (2010) compared the various clause types used in HPSG with the – according to him – much simpler Merge-based analysis in Minimalism. Minimalism assumes just one very general schema for combination (External Merge is basically equivalent to our Schema 2 above, see Müller (2013)), so this rule for combining linguistic objects is very simple, but this does not help in any way when considering the facts: there are at least five different meanings associated with auxiliary initial clauses (polar interrogative, blessings/curses, negative imperative, exclamatives, conditionals) and these have to be captured somewhere in a grammar. One way is to state them in a type hierarchy as is done in some HPSG analyses and in SBCG, another way is to use implicational constraints that assign meaning with respect to actual configurations (see Section 5.3) and a third way is to do everything lexically. The only option for Minimalism is the lexical one. This means that Minimalism has to either assume as many lexical items for auxiliaries as there are types in HPSG or to assume empty heads that contribute the meaning that is contributed by the phrasal schemata in HPSG (Borsley 2006: Section 5; Borsley & Müller 2018). The latter proposal is generally assumed in Cartographic approaches (Rizzi 1997). Since there is a fixed configuration of functional projections that contribute semantics, one could term these

Rizzi-style analyses *Crypto-Constructional*.

5.3 Mixed approaches

The situation with respect to clause types is similar in German. Verb first sentences can be yes/no questions (18a), imperatives (18b), conditional clauses (18c), and declarative sentences with topic drop (18d).

- (18) a. Kommt Peter? (German)
 comes Peter
 ‘Does Peter come?’
 b. Komm!
 come
 c. Kommt Peter, komme ich nicht.
 comes Peter come I not
 ‘If Peter comes, I won’t come.’
 d. Kommt. (Was ist mit Peter?)
 comes what is with Peter
 ‘What about Peter?’ ‘He comes.’

Verb second sentences can be questions (19a), declarative sentences (19b), or imperatives (19c).

- (19) a. Wer kommt?
 who comes
 b. Peter kommt. (German)
 Peter comes
 c. Jetzt komm!
 now come
 ‘Come now!’

While one could try and capture this situation by assuming surface order-related clause types, such approaches are rarely assumed (but see Kathol (2001) and Wetta (2011). See Section 6.4.2 on why such approaches are doomed to failure). Rather researchers assumed binary branching head-complement structures together with verb movement (I assumed linearization domains (see Section 6) for ten years and then switched to the head-movement approach (Müller 2005a,b; 2017)).

As was explained above, the head movement approaches are based on lexical rules or unary projections. These license new linguistic objects that could contribute the respective semantics. In analogy to what Borsley (2006) has discussed with respect to extraction structures, this would mean that one needs seven versions of fronted verbs to handle the seven cases in (18 and (19), which would correspond to the seven phrasal types that would have to be stipulated in phrasal approaches. But there is a way out of this: one can assume one lexical item with underspecified semantics. HPSG makes it possible to use implicational constraints referring to a structure in which an item occurs. Depending on the context the semantics contributed by a specific item can be further specified. Figure 6 shows the construction-based and the lexical rule-based analysis for comparison. In the construction-based analysis the daughters contribute x and y as

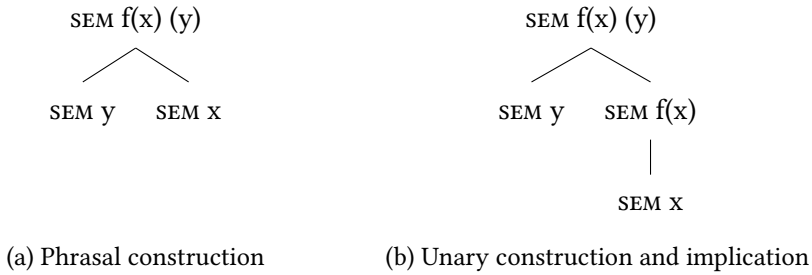


Figure 6: Construction-based, phrasal approach and approach with implicational constraint

semantic values and the whole construction adds the construction meaning f . In the lexical rule- or unary projection-based analysis, the lexical rule/unary projection adds the f and the output of the rule is combined compositionally with the other daughter. Now, implicational constraints can be used to determine the exact contribution of the lexical item (Müller 2016). This is shown with the example of a question in Figure 7. The implication says: when the configuration

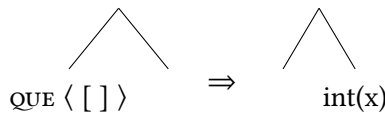


Figure 7: Implication for interrogative sentences

has the form that there is a question pronoun in the left daughter, the output of the lexical rule gets question semantics. Since HPSG represents all linguistic

information in the same AVM, such implicational constraints can refer to intonation as well and hence, implications for establishing the right semantics for V1 questions (18a) vs. V1 conditionals (18c) can be formulated.

Note that in Constructional HPSG as layed out by Sag (1997) implicational constraints can refer to the structure of a complete utterance. Hence items with a complex internal structure can be seen as contributing a certain meaning. This is ruled out by design in Sign-Based Construction Grammar, where linguistic objects of type *phrase* do not have daughters.

Bob: Can't you do everything with constructions in SBCG that you could do with phrases in standard HPSG? I think you need to say more if you want to make this point.

6 Constituent order domains

There is an interesting extension to standard HPSG that opens up possibilities for analyses that are quite different from what is done otherwise in theoretical linguistics:

Bob: Dowty?

Mike Reape (1991; 1992; 1994) working on German suggested formal tools that allow for the modeling of discontinuous constituents. His original motivation was to account for scrambling of arguments in verbal complexes but this analysis was superseded by Hinrichs and Nakazawa's analysis (Hinrichs & Nakazawa 1989; 1994) since purely linearization-based approaches are unable to account for agreement and the so-called remote passive (Kathol 1998: Section 5.1, Section 5.2; Müller 1999: Chapter 21.1). Nevertheless, his work was taken up by others and was used for analyzing German (Kathol & Pollard 1995; Kathol 2000; Müller 1995; 1996; 2004; Wetta 2011; Wetta 2014). As will be discussed below, there were reasons for dropping analyses of German assuming discontinuous constituents (Müller 2005b; 2017) but constituent order domains still play a major role in analyzing ellipsis (Nykiel & Kim 2018, Chapter 20 of this volume) and coordination (Abeillé & Chaves 2018, Chapter 17 of this volume).

6.1 A special representational layer for constituent order

The technique that is used to model discontinuous constituents in frameworks like HPSG goes back to Mike Reape's work on German (1991; 1992; 1994). Reape uses a list called `DOMAIN` to represent the daughters of a sign in the order in which

they appear at the surface of an utterance. (20) shows an example in which the DOM value of a headed-phrase is computed from the DOM value of the head and the list of non-head daughters.

$$(20) \text{ headed-phrase} \Rightarrow \left[\begin{array}{ll} \text{HEAD-DTR|DOM} & \boxed{1} \\ \text{NON-HEAD-DTRS} & \boxed{2} \\ \text{DOM} & \boxed{1} \bigcirc \boxed{2} \end{array} \right]$$

The symbol ‘ \bigcirc ’ stands for the *shuffle* relation. *shuffle* relates three lists A, B and C iff C contains all elements from A and B and the order of the elements in A and the order of the elements of B is preserved in C. (21) shows the combination of two sets with two elements each:

$$(21) \quad \langle a, b \rangle \bigcirc \langle c, d \rangle = \langle a, b, c, d \rangle \vee \\ \langle a, c, b, d \rangle \vee \\ \langle a, c, d, b \rangle \vee \\ \langle c, a, b, d \rangle \vee \\ \langle c, a, d, b \rangle \vee \\ \langle c, d, a, b \rangle$$

The result is a disjunction of six lists. *a* is ordered before *b* and *c* before *d* in all of these lists, since this is also the case in the two lists $\langle a, b \rangle$ and $\langle c, d \rangle$ that have been combined. But apart from this, *b* can be placed before, between or after *c* and *d*.

Every word comes with a domain value that is a list that contains the word itself:

(22) Domain contribution of single words, here *gibt* ‘gives’:

$$\boxed{1} \left[\begin{array}{ll} \text{PHON} & \langle \text{gibt} \rangle \\ \text{SYNSEM} & \dots \\ \text{DOM} & \langle \boxed{1} \rangle \end{array} \right]$$

The description in (22) may seem strange at first glance, since it is cyclic, but it can be understood as a statement saying that *gibt* contributes itself to the items that occur in linearization domains.

The constraint in (23) is responsible for the determination of the PHON values of phrases:

$$(23) \text{ phrase} \Rightarrow \left[\begin{array}{c} \text{PHON } [1] \oplus \dots \oplus [n] \\ \text{DOM } \left\langle \left[\begin{array}{c} \text{sign} \\ \text{PHON } [1] \end{array} \right], \dots, \left[\begin{array}{c} \text{sign} \\ \text{PHON } [n] \end{array} \right] \right\rangle \end{array} \right]$$

It states that the PHON value of a sign is the concatenation of the PHON values of its DOMAIN elements. Since the order of the DOMAIN elements corresponds to their surface order, this is the obvious way to determine the PHON value of the whole linguistic object.

Figure 8 shows how this machinery can be used to license binary branching structures with discontinuous constituents. Words or word sequences that are

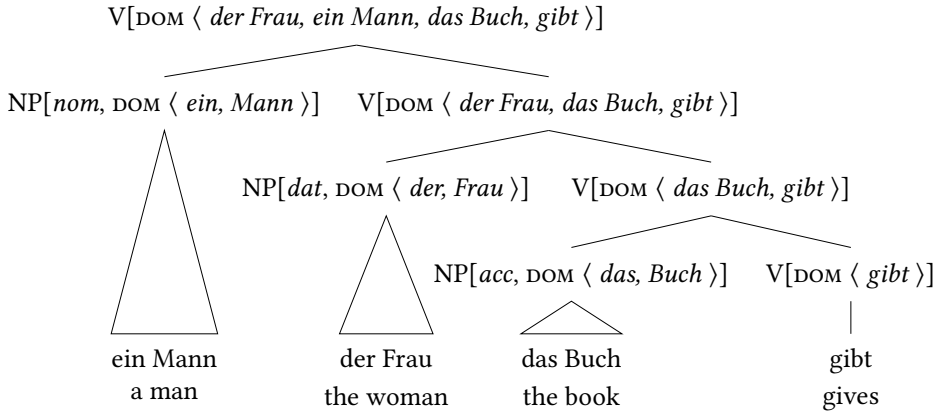


Figure 8: Analysis of *dass der Frau ein Mann das Buch gibt* ‘that a man gives the woman the book’ with binary branching structures and discontinuous constituents

separated by commas stand for separate domain objects, that is, < das, Buch > contains the two objects *das* and *Buch* and < das Buch, gibt > contains the two objects *das Buch* and *gibt*. The important point to note here is that the arguments are combined with the head in the order accusative, dative, nominative, although the elements in the constituent order domain are realized in the order dative, nominative, accusative rather than nominative, dative, accusative, as one would expect. This is possible since the formulation of the computation of the DOM value using the shuffle operator allows for discontinuous constituents. The node for *der Frau das Buch gibt* ‘the woman the book gives’ is discontinuous: *ein Mann* ‘a man’ is inserted into the domain between *der Frau* ‘the woman’ and *das Buch*

‘the book’. This is more obvious in Figure 9, which has a serialization of NPs that corresponds to their order.

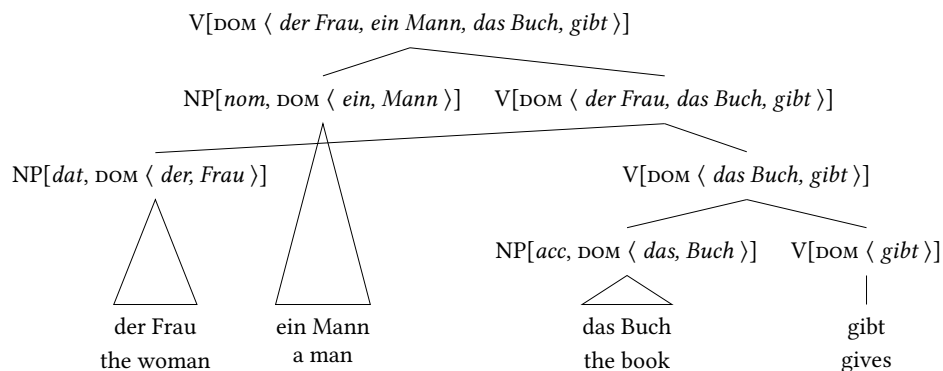


Figure 9: Analysis of *dass der Frau ein Mann das Buch gibt* ‘that a man gives the woman the book’ with binary branching structures and discontinuous constituents showing the discontinuity

6.2 Absolutely free

While German is more exciting than English in terms of constituent order it is still boring in comparison to languages like Warlpiri which have much freer constituent order. In Warlpiri the auxiliary has to be in first or in second position (Donohue & Sag 1999: 8) and apart from this even parts of what are noun phrases in German and English can appear separated from each other. For example, the two parts of the NP *Kurdu-jarra-rlu wita-jarra-rlu* ‘child small’ may appear discontinuously since they are marked with the same case:

- (24) *Kurdu-jarra-rlu ka-pala maliki wajili.pi-nyi wita-jarra-rlu.*
 child-DU-ERG PRES-3DU.SUBJ dog.ABS chase-NPAST small-DU-ERG
 (Warlpiri)

Mistake in
glossing.
Should
pi-nyi be
pi.nyi?

‘Two small children are chasing the dog.’ or
 ‘Two children are chasing the dog and they are small.’

Donohue & Sag (1999) developed an analysis for this that simply liberates domain elements and inserts them into the next higher domain. (25) shows how this is formalized:

(25) *liberating-phras* \Rightarrow

$$\left[\begin{array}{l} \text{DOM} \quad \delta_0 \circ \delta_1 \circ \dots \circ \delta_n \\ \text{HEAD-DTR} \quad \left[\text{DOM} \quad \delta_0 \right] \\ \text{NON-HEAD-DTRS} \quad \left\langle \left[\text{DOM} \quad \delta_1 \right], \dots, \left[\text{DOM} \quad \delta_n \right] \right\rangle \end{array} \right]$$

Rather than inserting the complete daughters into the domain of the mother as in (20), the DOM values of the daughters are shuffled into the domain of the mothers. So instead of having the NPs in the same domain as the verb as in the German example in the previous section one has all the parts of NPs in the next higher domain. Hence, a single nominal element being placed in front of the auxiliary in second position is explained without problems. Figure 10 shows the analysis of Donohue & Sag (1999). *child* and *small* form an NP. They contribute

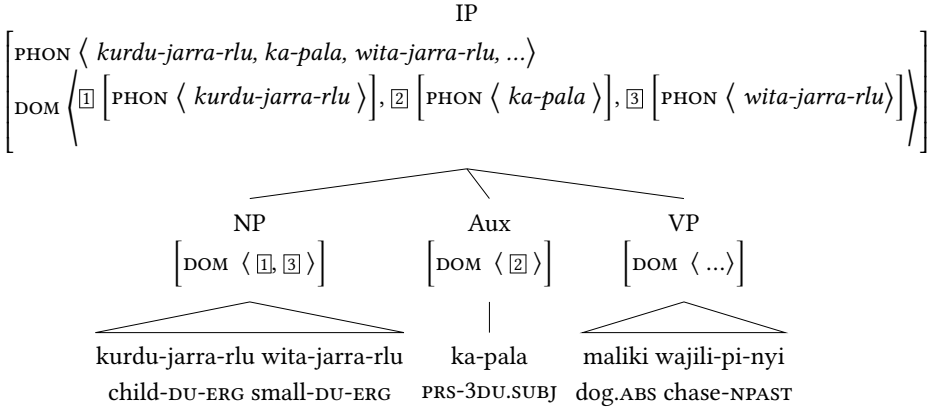


Figure 10: Analysis of free constituent order in Warlpiri according to Donohue & Sag (1999)

two independent domain objects ($\boxed{1}$ and $\boxed{3}$) to the domain of the mother. The second element in this domain has to be the auxiliary ($\boxed{2}$), $\boxed{1}$ is realized initially and $\boxed{3}$ follows the auxiliary.

We have seen so far an analysis that inserts complete objects into the domain of the mother, an analysis that inserts all domain objects of objects into the domain of the mother and in the next subsection I want to look at an intermediate case, so-called *partial compaction*.

Bob: explain compaction. You also don't explain liberation, which is probably necessary.

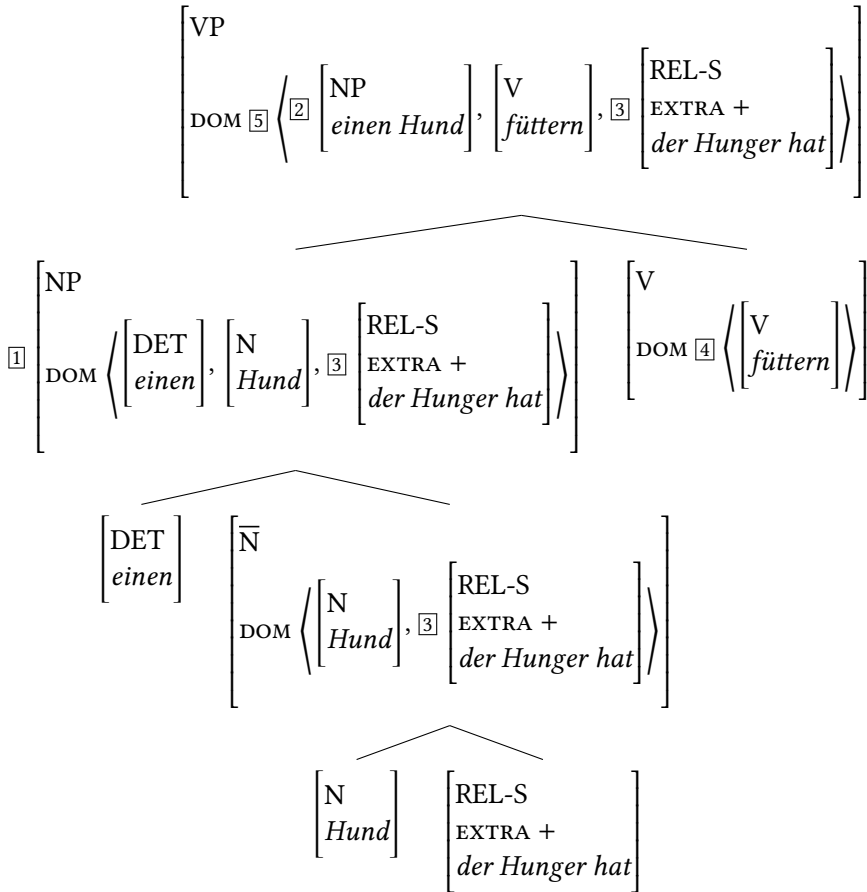
6.3 Partial compaction (extraposition)

Kathol & Pollard (1995) developed an analysis of extraposition that is a mix of the strategies discussed in the two subsections: most of one NP object is inserted into the domain of the mother as a single object, only those parts that are extraposed are liberated and inserted as individual domain objects into the domain of the mother.⁵ Kathol & Pollard's analysis of (26) is given in Figure 11.

- (26) einen Hund füttern, der Hunger hat (German)
 a dog feed that hunger has
 'feed a dog that is hungry'

einen Hund, der Hunger hat 'a dog who is hungry' consists of three domain objects: *einen* 'a', *Hund* 'dog', and *der Hunger hat* 'who hungry is'. The two initial ones are inserted as one object (the NP *ein Hund* 'a dog') into the higher domain and the relative clause is liberated. While the formation of the new domain at the mother node is relatively straight-forward in the cases discussed so far, a complex relational constraint is needed to split the relative clause ([3]) from the other domain objects and construct a new domain object that has the determiner and the noun as constituents ([2]). Kathol and Pollard have a relational constraint called *compaction* that builds new domain objects for insertion into higher domains. *partial compaction* takes an initial part of a domain and forms a new domain object from this returning the remaining domain objects for separate insertion into the higher domain. Due to space limitations, this constraint will not be discussed here but see Müller (1999: 244) for a refined version of Kathol and Pollard's constraint. The effect of partial compaction in Figure 11 is that there is a new object [2] and a list containing the remaining objects, in the example ⟨ [3] ⟩. A list containing the new object ⟨ [2] ⟩, a list containing the remaining objects ⟨ [3] ⟩ are shuffled with the domain list of the head [4]. Since the relative clause is in the same domain as the verb, it can be serialized to the right of the verb.

⁵This analysis of extraposition is not the only option available in HPSG. I explain it here since it shows the flexibility of the domain approach. The more common analysis of extraposition is one that is parallel to the SLASH-based approach to extraction that is explained in Borsley & Cysmann (2018), Chapter 14 of this volume. Since constraints regarding locality differ for fronting to the left and extraposition to the right a different feature is used (EXTRA). See Keller (1995) and Müller (1999) for discussion. More recent approaches assume the projection of semantic indices (Kiss 2005) to be able to solve puzzles like Link's (1984) hydra sentences and even more recent proposals mix index projection and EXTRA projection (Cysmann 2013).



p-compaction($\boxed{1}$, $\boxed{2}$, $\langle \boxed{3} \rangle$)

$$\boxed{5} = \langle \boxed{2} \rangle \circ \langle \boxed{3} \rangle \circ \boxed{4}$$

Figure 11: Analysis of extraposition via partial compaction of domain objects according to Kathol & Pollard (1995)

6.4 Problems with order domains

Constituent order domains may seem rather straight-forward since linearization facts can be handled easily. I assumed constituent order domains and discontinuous constituents for German myself for over a decade (Müller 1995; 2004). However, there are some problems that seem to suggest that a traditional GB-like head-movement approach is the better alternative. In what follows I want to discuss just two problematic aspects of linearization approaches: spurious ambiguities and apparently multiple frontings.

6.4.1 Partial fronting and spurious ambiguities

Kathol (2000) suggests an analysis with binary branching structures in which all arguments are inserted into a linearization domain and can be serialized there in any order provided no LP rule is violated. Normally one would have the elements of the COMPS list in a fixed order, combine the head with one element from the COMPS list after the other, and let the freedom in the DOM list be responsible for the various attested orders. So both sentences in (27) would have analyses in which the verb *erzählt* ‘tells’ is combined with *Geschichten* ‘stories’ first and then *Geschichten erzählt* ‘stories tells’ is combined with *den Wählern* ‘the voters’. Since the verb and all its arguments are in the same linearization domain they can be ordered in any order including the two orders in (27):

- (27) a. weil er den Wählern Geschichten erzählt (German)
 because he the voters stories tells
 ‘because he tells the voters stories’
 b. weil er Geschichten den Wählern erzählt
 because he stories the voters tells

The problem with this approach is that examples like (28) show that grammars have to account for combinations of any of the objects to the exclusion of the other:

- (28) a. Geschichten erzählen sollte man den Wählern nicht. (German)
 stories tell should one the voters not
 ‘One should not tell the voters such stories.’
 b. Den Wählern erzählen sollte man diese Geschichten nicht.
 the voters tell should one these stories not

Kathol (2000: Section 8.9) accounts for examples like (28) by relaxing the order of the objects in the valence list. He uses the shuffle operator in the valence

representation:

$$(29) \quad \langle \text{NP}[\textit{nom}] \rangle \oplus (\langle \text{NP}[\textit{dat}] \rangle \circ \langle \text{NP}[\textit{acc}] \rangle)$$

This solves the problem with examples like (28) but it introduces a new one: sentences like (27) now have two analyses each. One is the analysis we had before and another one is the one in which *den Wählern* ‘the voters’ is combined with *erzählt* ‘tells’ first and the result is then combined with *Geschichten* ‘stories’. Since both objects are inserted into the same linearization domain, both orders can be derived. So we have too much freedom: freedom in linearization and freedom in the order of combination. The proposal that I suggested has just the freedom in the order of combination and hence can account for both (27) and (28) without spurious ambiguities.

6.4.2 Surface order, clause types, fields within fields, and empty elements

Kathol (2001) develops an analysis of German that uses constituent order domains and determines the clause types on the basis of the order of elements in such domains. He suggests the topological fields 1, 2, 3, and 4, which correspond to the traditional topological fields *Vorfeld* ‘prefield’, *linke Satzklammer* ‘left sentence bracket’, *Mittelfeld* ‘middle field’, *rechte Satzklammer* ‘right sentence bracket’. Domain objects may assigned to these fields and they are then ordered by linearization constraints stating that objects assigned to 1 have to precede objects of type 2, type 3, and type 4. Objects of type 2 have to precede type 3, and type 4 and so on. For the *Vorfeld* and the left sentence he stipulates uniqueness constraints saying that at most one constituent may be of this type. This can be stated in a nice way by using the linearization constraints in (30):

$$(30) \quad \begin{array}{ll} \text{a.} & 1 < 1 \\ & \text{b.} \quad 2 < 2 \end{array}$$

This trick was first suggested by Gazdar et al. (1985: 55, Fn. 3) in the framework of GPSG and it works since if there were two objects of type 1 than each one would be required to precede the other one resulting in a violation of the linearization constraint. So in order to avoid such constraint violation there must not be more than one 1.

Kathol (2001) assumes the following definition for V2 clauses:

$$(31) \quad \text{V2-clause} \Rightarrow \left[\begin{array}{c} \text{S}[\textit{fin}] \\ \text{DOM} \left\langle [1], \left[\begin{array}{c} 2 \\ \text{V}[\textit{fin}] \end{array} \right], \dots \right\rangle \end{array} \right]$$

This says that the constituent order domain starts with one element assigned to field 1 followed by another domain object assigned to field 2. While this is in accordance with general wisdom about German, which is a V2 language, there are problems for entirely surface-based theories: German allows for multiple constituents in front of the finite verb. (32) shows some examples:

- (32) a. [Zum zweiten Mal] [die Weltmeisterschaft] errang Clark 1965 ...⁶
 to.the second time the world.championship won Clark 1965
 ‘Clark won the world championship for the second time in 1965.’
 b. [Dem Saft] [eine kräftige Farbe] geben Blutorangen.⁷
 the.DAT juice a.ACC strong color give blood.oranges
 ‘Blood oranges give the juice a strong color.’

Müller (2003a) extensively documents this phenomenon. The categories that can appear before the finite verb are almost unrestricted. Even subjects can be fronted together with other material (Bildhauer & Cook 2010: 72; Bildhauer 2011: 371). The empirical side of these apparent multiple frontings was further examined in the Collective Research Center 632, Project A6 and the claim that only constituents depending on the same verb can be fronted together (Fanselow 1993; Hoberg 1997: 1634) was confirmed (Müller 2017: Chapter 3). A further insight is that the linearization properties of the fronted material (NPs, PPs, adverbs, adjectives) correspond to the linearization properties they would have in the *Mittelfeld*. The example in (33) are even more interesting. It shows that there can be a right sentence bracket (the particle *los*) and an extraposed constituent (something following the particle: *damit*) before the finite verb (*geht* ‘goes’):

- (33) *Los damit geht es schon am 15. April.*⁸
 off there.with goes it PRT on 15. April
 4 5 2 3 3 3
 ‘The whole thing starts on the 15th April.’

In Kathol’s system, *los* would be of type 4 and *damit* would have to be of type 5 (an additional type for extraposed items). Without any modification of the general system, we would get a 4 and a 5 ordered before a 2 (a right sentence

⁶(Beneš 1971: 162)

⁷Bildhauer & Cook (2010) found this example in the *Deutsches Referenzkorpus* (DeReKo), hosted at Institut für Deutsche Sprache, Mannheim: <http://www.ids-mannheim.de/kl/projekte/korpora>, 2018-09-13.

⁸taz, 01.03.2002, p. 8.

bracket and a postfield preceding the left sentence bracket), something that is ruled out by Kathol's linearization constraints.

Müller (2002), still working in a domain-based framework, developed an analysis assuming an empty verbal head to explain the fact that the fronted constituents have to depend on the same verb and that there is a separate topological area that is independent of the remaining clause. So, *los* and *damit* are domain objects within a larger domain object placed in the prefield. Wetta (2011) suggests an analysis in which two or more constituents are compacted into one domain object, so *los* and *damit* would form one object that is inserted into the domain containing the finite verb. However, this begs the question what kind of object it is that is formed. Section 6.3 dealt with partial compaction of NPs. Some of the elements from an NP domain were liberated and other elements were fused into a new object that had the same category as the object containing all material, namely NP. But the situation with examples like (32) and (33) is quite different. We have a particle and a pronominal adverb in (33) and various other combinations of categories in the examples collected by Müller (2003a) and Bildhauer (2011). It would not make sense to claim that the fronted object is a particle or a pronominal adverb. Note that it is neither an option to leave the category of the fronted object unspecified since HPSG comes with the assumption that models of linguistic objects are total, that is, maximally specific (King 1999, see also Richter (2018), Chapter 3 of this volume). Leaving the category and valence properties of the item in the prefield unspecified would make such sentences infinitely many times ambiguous. Of course Wetta could state that the newly created object is a verbal projection but this would just be stating the effect of the empty verbal head within a relational constraint, which I consider less principled than stating the empty element.

However, the empty verbal head that I stated as part of a linearization grammar in 2002 comes as a stipulation since its only purpose in the grammar of German was to account for apparent multiple frontings. Müller (2005b; 2017) drops the linearization approach and assumes head-movement instead. The empty head that is used for accounting for the verb position in German can also be used to account for apparent multiple frontings. The analysis is sketched in (34):

- (34) [_{VP} [_{Zum zweiten Mal}] [_{die Weltmeisterschaft}] _{–V}]_i errang_j Clark
 to.the second time the world.championship won Clark
 1965 _{–i} _{–j}.
 1965

The details cannot be explained here but the analysis treats apparent multiple frontings parallel to partial verb phrase frontings. A lexical rule is used for mul-

multiple frontings which is a special case of the head-movement rule that was discussed in Section 5. So apparent multiple frontings are analyzed with means that are available to the grammar anyway. This analysis allows us to keep the insight that German is a V2 language and it also gets the same-clause constraint and the linearization of elements right. See Müller (2005a,b; 2017) for details.

The paper so far discussed the tools that have been suggested in HPSG to account for constituent order: flat vs. binary branching structures, linearization domains, head-movement via DSL. I showed that analyses of German relying on discontinuous constituents and constituent order domains are not without problems and that head-movement approaches with binary branching and continuous constituents can account for the data. I also demonstrated in Section 6.2 that languages like Warlpiri that allow for much freer constituent order than German can be accounted for in models allowing for discontinuous constituents. The following section discusses a proposal by Bender (2008) showing that even languages like the Australian free constituent order languages can be handled without discontinuous constituents.

7 Free constituent order languages without order domains

Bender (2008) discusses the Australian language Wambaya and shows how phenomena parallel to those treated by Donohue & Sag (1999) can be handled without discontinuous constituents. Bender assumes that all arguments of a head are projected to higher nodes even when they are combined with the head, that is, arguments are not canceled off from valence lists. See also Meurers (1999); Przepiórkowski (1999) and Müller (2008) for earlier non-cancellation approaches.⁹ The example (24) from Section 6.2 can be recast with continuous constituents as is shown in Figure 12. The figure shows that arguments are not removed from the valence representation after combination with the head. Rather they are marked as satisfied. Since they are still in the representation, schemata may refer to them. Bender suggests a schema that identifies the MOD value of an element that could function as an adjunct in a normal head-adjunct structure with an element in the valence representation. In Figure 12 the MOD value of the second ergative nominal *wita-jarra-rlu* ‘small’ is identified with an argument of the auxiliary verb (11). The adjunct hence has access to the referential index of the argument and it is therefore guaranteed that both parts of the noun phrase refer to the same discourse referent. The NP for *kurdu-jarra-rlu* is combined with the projection of

⁹Higginbotham (1985) and Winkler (1997) make similar suggestions with regard to the representation of theta roles.

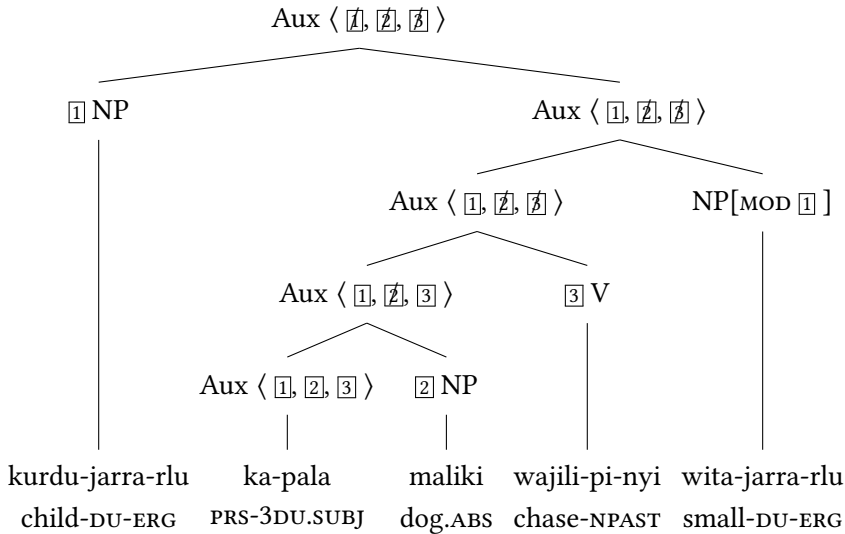


Figure 12: Analysis of free constituent order in Warlpiri using non-cancellation

the auxiliary to yield a complete sentence. Since ① not just contains the semantic index and hence information about number (the dual) but also case information, it is ensured that distributed noun phrases have to bear the same case. Since information about all arguments are projected along the head path, ② would also be available for an adjunct referring to it. So in the place of *wita-jarra-rlu* ‘small-DU-ERG’ we could also have another adjunct referring to *maliki* ‘dog.ABS’. This shows that even languages with constituent order as free as the Australian languages can be handled within HPSG without assuming discontinuous constituents.

8 Summary

This paper discussed general approaches to constituent order in HPSG. On the one hand there are approaches assuming flat constituent structure allowing permutation of daughters as long as no LP constraints are violated and on the other hand, there are approaches assuming binary branching structures. Approaches that assume flat structures can serialize the head to the left or to the right or somewhere between other daughters in the structure. Approaches assuming binary branching have to use other means. One such means is “head movement”, which is analyzed as a series of local dependencies by passing information about

the missing head up along the head path. The alternative to head movement is linearization of elements in special linearization domains, allowing for discontinuous constituents. I showed that there are reasons for assuming head-movement for German and how even languages with extremely free constituent order can be analyzed without assuming discontinuous constituents.

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