Morphology in LFG and HPSG

Rachel Nordlinger and Louisa Sadler

1 Background

Lexical Functional Grammar (LFG) (Bresnan, 1982a, 2001a; Dalrymple, 2001; Bresnan et al., 2016) and Head-Driven Phrase Structure Grammar (HPSG) (Pollard and Sag, 1994; Sag et al., 2003; Kathol et al., 2011; Müller, 2015a) are both lexicalist, non-transformational, constraint-based grammatical frameworks.[1] While they differ in many respects – some of which are detailed in this chapter – they share a number of fundamental principles relevant to morphological theory and analysis, which guide the overall architecture of the grammar. The two frameworks also share a common commitment to being fully explicit and implementable, with strong links to computational implementations. (For HPSG see Bender et al. (2010), Flickinger (2000) and Müller (2015b), inter alia. For LFG, see especially Halvorsen and Kaplan (1988), Dalrymple et al. (1995), Butt et al. (1999), Cahill et al. (2005), Crouch et al. (2008), among many others.)

Firstly, they are both frameworks which incorporate a strong lexicalist perspective assuming the separation of syntax and morphology, such that the internal structure of words is opaque to the mechanisms of syntax (Pollard and Sag, 1994; Müller, 2015a; Bresnan, 2001a). Syntax and morphology are distinct components

[1]We would like to thank the editors for inviting us to contribute this chapter and for their guidance on how to reduce two complex theoretical frameworks into a limited amount of space. For helpful comments and suggestions which led to significant improvements in the final version we are grateful to Olivier Bonami, Berthold Crysmann, Stefan Müller and an anonymous reviewer.

of the grammar, with only the *output* of the morphology/lexicon relevant to the syntactic component. From this it follows that both frameworks eschew the syntacticisation of inflectional (or derivational) morphological processes. Inflectional morphs, therefore, are not syntactically independent (as they are in some other frameworks). Rather, they combine into fully inflected words exclusively in the morphological component and their role in the syntax is limited to the information they contribute.

These two frameworks also share the property of being constraint-based – meaning that descriptions of linguistic structures essentially constrain the models of linguistic objects – and non-derivational, in the sense that the different dimensions of linguistic structure are co-present and do not stand in a derivational relationship to each other. This takes a different form in the two theories, because the overall architecture of levels looks very different, and will be made clear in more detail in the introductory sections for each framework below.

LFG and HPSG are essentially syntactic frameworks and as such have not traditionally assumed any particular theory of morphology. In fact, given the separation of the morphological and syntactic components, both frameworks are essentially compatible with any (strong lexicalist) theoretical view of the morphological component. However, researchers within the respective frameworks have become interested in morphological questions, primarily those that relate to the morphology-syntax interface, and so we will survey some of this work in this chapter. Given the constraints of space, we have focussed on a few of the key themes that arise in morphologically-related research in these two theories, but

have made no attempt to be comprehensive. Different themes emerge in our discussion of each theoretical framework, often reflecting the different foci of the relevant researchers.[2]

1.1 Overview of LFG

Lexical-Functional Grammar (LFG) (Bresnan, 1982a; Kaplan and Bresnan, 1982; Dalrymple et al., 1995; Bresnan, 2001a; Falk, 2001; Dalrymple, 2001; Bresnan et al., 2016) is a non-derivational, lexicalist, constraint-based theory with co-present parallel structures, linked by principles of correspondence. Each of the structures of LFG has a distinct formal character and models a different aspect of the structure of language. The primary syntactic structures are c-structure (constituent structure) and f-structure (functional structure). The former models precedence and phrasal dominance relations in the familiar terms of a phrase structure tree and the latter models syntactic predicate-argument relations in terms of grammatical functions. As discussed above, LFG is primarily a syntactic framework and can therefore interface with any theory of morphology that assumes the principle of lexical integrity (stated in LFG terms in (1)). Thus, the c-structure of LFG takes fully inflected words as its terminal nodes, but does not impose any particular constraints on how these words have been composed in the morphological component. This flexibility has allowed different researchers interested in the morphology-syntax interface to respond to trends and developments in the

[2]Bonami and Crysmann (In Press) also provides an overview of approaches to morphology within these two theoretical frameworks, and nicely complements this chapter by taking a slightly different focus (and therefore dealing with some different phenomena).

morphological literature and adapt their preferred morphological perspective to the LFG architecture. In this chapter we will present some of the morphological questions that have been addressed by researchers working within the broader LFG framework, but it is important to remember that none of these morphological perspectives is dictated by the framework itself. Furthermore, the bulk of such work relates to the interface between the morphology and the syntax (see for example, Sadler and Spencer (2004); Andrews (2005); Dalrymple (2015); Kaplan and Butt (2002)), rather than morphological theory proper.

(1) **Lexical integrity** (Bresnan 2001a: 92):

Morphologically complete words are leaves of the c-structure tree and each leaf corresponds to one and only one c-structure node.

Information is mapped to the f-structure from the nodes of the c-structure, including the individual words which form the terminal nodes. Formally, f-structures are finite functions from attributes to values, which may themselves be complex (i.e. f-structures), and they are conventionally represented as attribute-value matrices. Equations (known as functional (f-) descriptions) associated with lexical items and with nodes of the c-structure specify properties of f-structures: the mapping function or projection ϕ has nodes of the c-structure as its domain and f-structures as its range (the inverse ϕ^{-1} maps f-structures to c-structures and is not a function). The notation $\uparrow$ refers to the f-structure associated with the mother of the current node (i.e. it denotes the mother's f-structure) while $\downarrow$ refers to the f-structure of the node to which it is annotated. Feature assertions are satisfied by

f-structures which contain attribute-value pairs corresponding to these assertions. Of particular importance is the *smallest* f-structure which satisfies a collection of constraints or feature assertions, known as the *minimal model*. The f-structure of an utterance is the minimal model or solution satisfying the constraints introduced by the words and phrases in the utterance.

The formal correspondence between c-structure and f-structure is many-to-one: to each c-structure node there is assigned a unique (but not necessarily distinct) (minimal) f-structure. Nevertheless, individual c-structure elements, including words, may specify complex f-structures. For example, *sees* in (2), which will associate with a single node V in c-structure, defines the f-structure shown in (3).

(2) *sees, V* $(\uparrow \text{PRED}) = \text{`SEE} < \text{SUBJ, OBJ} >\text{'}$
$(\uparrow \text{TENSE}) = \text{PRES}$
$(\uparrow \text{SUBJ}) = \downarrow$
$(\downarrow \text{PERS}) = 3$
$(\downarrow \text{NUM}) = \text{SG}$

(3)
$$\begin{bmatrix} \text{PRED} & \text{`SEE <SUBJ, OBJ>'} \\ \text{TENSE} & \text{PRES} \\ \text{SUBJ} & \begin{bmatrix} \text{PERS} & 3 \\ \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix}$$

An important facet of LFG is its commitment to lexicalism. The Lexical Integrity Principle (1) (see also Simpson (1991); Bresnan and Mchombo (1995); Mohanan (1995) and references therein) distinguishes the morphological (lexical) and syntactic components as being subject to different principles of composition.

Words are constructed in the morphology, while c-structure and f-structure form the core of the syntactic component. This means that the input to these syntactic levels—e.g. the terminal elements of c-structure trees—are fully inflected words, and that syntactic processes cannot manipulate the internal morphological structure of these items. Crucially however, this does not rule out the possibility that both morphological and syntactic constituents may contribute information to the f-structure (e.g. Simpson (1983, 1991); Bresnan and Mchombo (1987, 1995); Bresnan (2001a)). In the example above, we see that morphological information associated with the verb – in this case the PERS and NUM features – is unified directly with the f-structure associated with the SUBJ(ect), as is the relevant information provided by the rest of the c-structure (i.e. via the subject NP). In this way, the information contributed by the morphology is integrated with the syntactic component while maintaining Lexical Integrity, since the nodes of the c-structure contain only morphologically complete words (e.g. *sees*).

Given the flexibility of the LFG architecture, it is not necessary to postulate otherwise unmotivated c-structure nodes in morphologically rich languages where the morphology directly encodes much f-structure or relational information, and indeed the Principle of Economy of Expression states that all syntactic nodes are optional unless otherwise required for the satisfaction of semantic expressivity or other independent principles (Bresnan, 2001a). These assumptions, combined with the separation of c-structure from f-structure, makes it possible to represent the fact that different languages may express the same grammatical properties in very different ways. Thus, we might find two languages in which grammati-

cal relations, for example, are encoded syntactically in one language (e.g. via the syntactic configuration of overt NP/DPs), and morphologically in another (e.g. via pronominal agreement morphology on the verb). In LFG this difference between the two languages would be captured at c-structure, while the similarity in function is captured at f-structure (see, for example, Bresnan (2001a) and Nordlinger and Bresnan (2011) for detailed discussion, and the Chicheŵa example in (7)).

Work on the relative contributions of the morphology and the syntax to the f-structure has highlighted the interplay and competition between morphological and syntactic expression. Andrews (1990) (also Andrews (1982)) is an example of early work on this issue. In this work, Andrews proposes a notion of 'morphological blocking', whereby the existence of a more highly specified form in the lexicon precludes the use of a less highly specified form. For example, if the verbal paradigm includes an inflected form encoding 1st person singular subject, then this form will 'block' the use of an unmarked verb form combined with a 1st person singular subject pronoun, even though the semantic content of the two constructions is apparently the same. Thus, this principle accounts for the Ulster Irish examples provided in (4) (from Andrews 1990: 512):

(4) a. Chuirfinn isteach ar an phost sinn.
put.COND.1SGSUBJ in on the job that

b. *Chuirfeadh mé isteach ar an phost sinn.
put.COND 1SG.SUBJ in on the job that
'I would apply for that job.'

The ungrammaticality of the analytic form in (4b) follows from the presence of

a synthetic form specifying the same information. The Principle of Morphological Blocking (see Andrews (1990: 519) for precise wording) states that a lexical entry whose associated f-structure subsumes that of another lexical entry is blocked (presuming, of course, that both are compatible with the sentence more broadly). Thus the more general verb form *chuirfeadh* (5) is blocked in the (b) example above, given that the paradigm also includes the more specific *chuirfinn* (6).

(5)
$$\begin{bmatrix} \text{PRED} & \text{`CUIR} < \ldots > \text{'} \\ \text{TENSE} & \text{COND} \end{bmatrix}$$

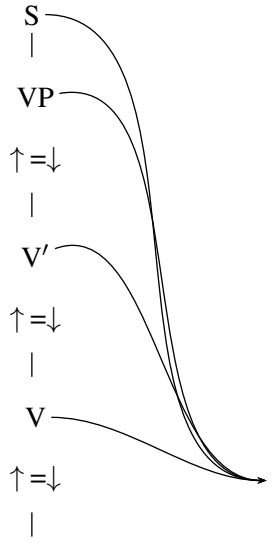
(6)
$$\begin{bmatrix} \text{PRED} & \text{`CUIR} < \ldots > \text{'} \\ \text{TENSE} & \text{COND} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`PRO'} \\ \text{PERS} & 1 \\ \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix}$$

The general theme that 'morphology competes with syntax' runs through much LFG work in the 1990s and early 2000s, especially that of Joan Bresnan (e.g. Bresnan (1998, 2000, 2001a,b)). It underlies one of the strengths of LFG, which allows it to easily deal with a wide range of morphosyntactic variation, from non-configurational languages, to head-marking languages, to highly syntacticized languages like English (see Nordlinger and Bresnan (2011) for an overview). For example, at its simplest level, the differentiation of the c-structure from the f-structure in LFG allows for the fact that the following two sentences have completely different surface expression and completely different c-structures, but essentially identical f-structures. Both examples mean *If I see him*; in Chicheŵa (7) this is expressed with a single verb, whereas in English (8) it is expressed with a

whole phrase. Crucially, however, the relations encoded in the f-structure are the same.

(7) ndi-ka-mú-ona

SUBJ-COND-OBJ-see
'if I see him.'



$$\begin{bmatrix} \text{MODE} & \text{COND} \\ \text{PRED} & \text{'SEE}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'PRO'} \\ \text{PERS} & 1 \\ \text{NUM} & \text{SG} \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{'PRO'} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \\ \text{NOUNCLASS} & 1\text{A} \end{bmatrix} \end{bmatrix}$$

ndi-ka-mú-ona

SUBJ-COND-OBJ-see

(↑ PRED) = 'SEE⟨SUBJ,OBJ⟩'

(↑ MODE) = COND

((↑ SUBJ PRED) = 'PRO')

(↑ SUBJ PERS) = 1

(↑ SUBJ NUM) = SG

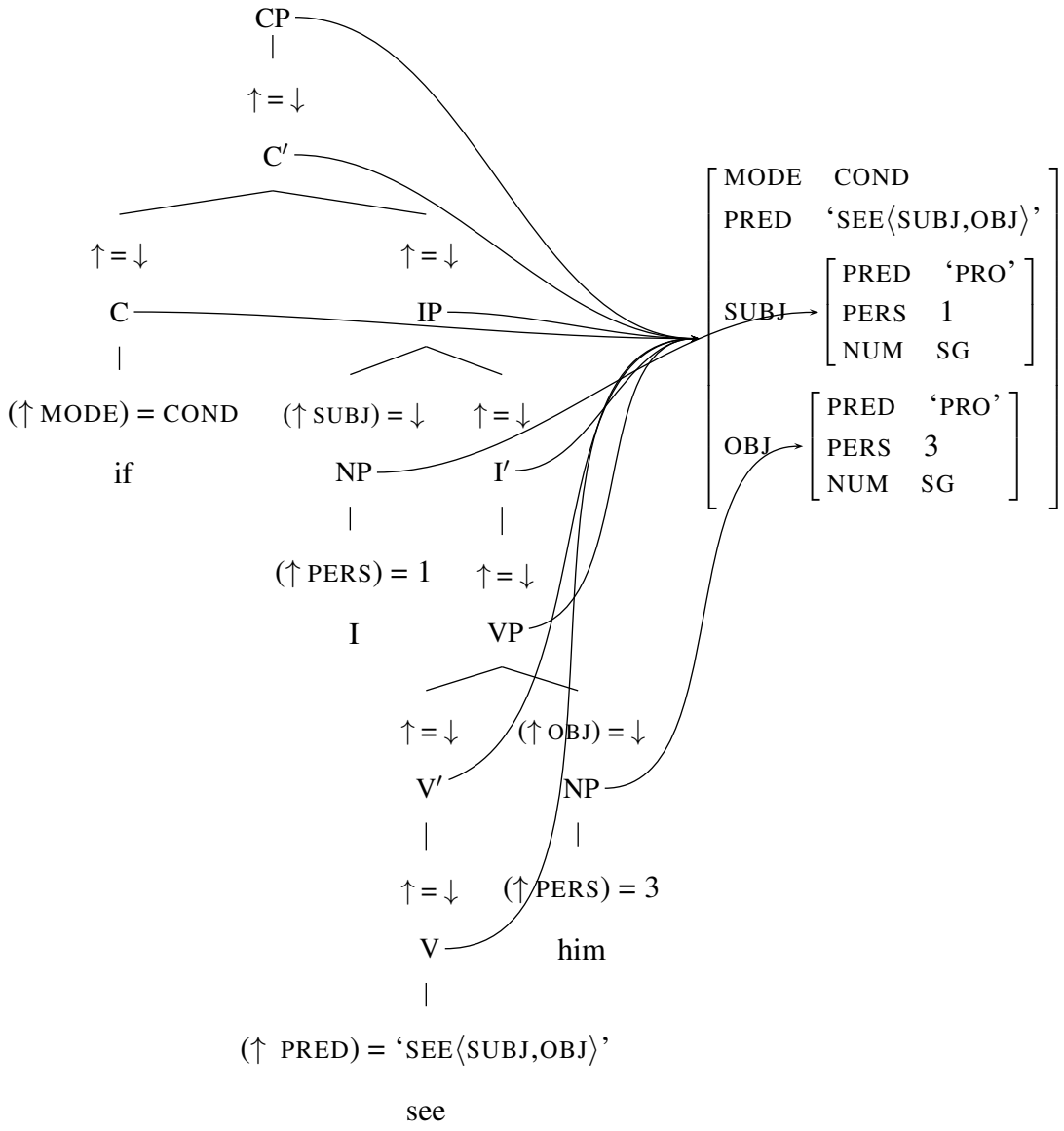
(↑ OBJ PRED) = 'PRO'

(↑ OBJ PERS) = 3

(↑ OBJ NUM) = SG

(↑ OBJ NOUNCLASS) = 1A

(8) ‘if I see him’



The flexibility afforded by the LFG architecture in this respect underlies much of the work we discuss below, including the treatments of multiple exponence,

auxiliary selection and case stacking in Australian languages.

1.2 Overview of HPSG

The foundational publications in HPSG are Pollard and Sag (1987, 1994). HPSG has clear origins in both GPSG (Gazdar et al., 1985) and Categorial Grammar. There are a number of quite significant architectural differences between the 1987 (Pollard and Sag, 1987) and the 1994 (Pollard and Sag, 1994) versions of HPSG.[3] Since Pollard and Sag (1994) there have been two further major developments.

The first of these is that some work in HPSG separates constituent structure from the representation of the surface order of forms, taking a non-concatenative approach to linear order. This radical separation of constituent and linear structure originates (within HPSG) with Reape (1993, 1994, 1996), and similar early proposals are found in Kathol (1995, 2000) (for implementations of this approach see also Müller (1996, 2002)). The essence of such domain-based or linearization approaches is that daughters within a constituent can be "liberated" for linearization among the daughters of dominating constituents. These ideas have also found a place in the treatment of morphological phenomena, to which we return briefly below (and see Kathol (1995); Crysmann (2003)).

The second is an increasing convergence with the ideas of Berkeley Construction Grammar.[4] The hallmark of such approaches is essentially the generaliza-

[3] Although the later book generally supercedes the earlier, Pollard and Sag (1987) contains an extensive discussion of lexical generalizations and hierarchies, which is of interest from a morphological and morphosyntactic point of view.

[4] By Berkeley Construction Grammar we refer to the Construction Grammar approach asso-

tion of multiple inheritance type hierarchies from the lexicon to syntax, where constructions, or multi-dimensional collections of linguistic information, are expressed directly in the type system. There are in fact two major current variants of construction-based HPSG, constructional HPSG (Sag, 1997; Ginzburg and Sag, 2000) and Sign-Based Construction Grammar (Sag, 2012) (SBCG). Both of these descend very clearly from the earlier HPSG of Pollard and Sag (1987, 1994) and share many features including the fundamental modelling assumptions (feature structures model linguistic objects, attribute value matrices are descriptions of model objects), and both reflect a degree of contact and convergence with Construction Grammar.

In HPSG (including SBCG) feature structures model linguistic objects. Attribute value matrices (AVMs) are used to describe feature structures. Unlike LFG, HPSG analyses are expressed in a *typed* feature structure formalism: feature structures are grouped into classes instantiating linguistic types. Types are organised into a multiple inheritance hierarchy specified in the signature of the grammar: the most general type of words or phrases is the *sign*. Such inheritance hierarchies are used in HPSG (including SBCG) to capture syntactic and (some) lexical generalizations. Feature structures must instantiate a maximal type (that is, be fully specified), although of course *descriptions* will typically make significant use of underspecification. The use of typing in HPSG grounds many well-formedness constraints directly in the ontology in a way that does not occur in LFG.

---

ciated most notably with Paul Kay and Chuck Fillmore and the Berkeley group (Fillmore et al., 1988; Kay, 2002).

In (all versions of) HPSG (again, in contrast to LFG), one single data structure is used to model all dimensions of a linguistic object, leading to a highly structured representation. The details of the precise geometry has changed considerably over the years, but the following very schematic representations of *word* and *phrase* (based on Müller (2015a)) give the flavour, showing the parallel representation of phonological, syntactic and semantic information. In the HPSG structures in this chapter, the italicised annotations at the top of the left brackets indicate the *type* of the feature structure.

(9)
$$\begin{bmatrix} \textit{word} \\ \text{PHON} \quad < \textit{wordform} > \\ \text{SYNSEM} \quad \begin{bmatrix} \textit{synsem} \\ \text{LOCAL} \quad \begin{bmatrix} \text{CAT} \quad \ldots \\ \text{CONTENT} \quad \ldots. \end{bmatrix} \\ \text{NONLOCAL} \quad \ldots \end{bmatrix} \end{bmatrix}$$

(10)
$$\begin{bmatrix} \textit{phrase} \\ \text{PHON} \quad < \textit{the man} > \\ \text{HEAD-DTR} \quad \begin{bmatrix} \textit{sign} \\ \text{PHON} \quad < \textit{man} > \\ \text{SYNSEM} \quad \begin{bmatrix} \textit{synsem} \\ \text{LOCAL} \quad \begin{bmatrix} \text{CAT} \quad \ldots \\ \text{CONTENT} \quad \ldots. \end{bmatrix} \\ \text{NONLOCAL} \quad \ldots \end{bmatrix} \end{bmatrix} \\ \text{NON-HD-DTRS} \quad \left\langle \begin{bmatrix} \textit{sign} \\ \text{PHON} \quad < \textit{the} > \\ \text{SYNSEM} \quad \ldots. \end{bmatrix} \right\rangle \end{bmatrix}$$

The syntactic (CAT) feature is itself highly structured. The NONLOCAL fea-

ture is used in the description of various types of non-local dependency. The features HEAD-DTR ('head daughter') and NON-HD-DTRS ('non-head-daughters') (in (10)) model the constituent structure of linguistic objects, and are often omitted from illustrative AVMs in favour of the use (for illustrative purposes) of tree-based representations.[5] Good sources for detailed overviews of HPSG include Müller (2015a), Sag (2012), chapters 1 and 2 of Ginzburg and Sag (2000), and Kathol et al. (2011).

The lexicon plays a most important role in HPSG as the treatment of many syntactic phenomena is lexicalized. The lexicon as a whole and descriptions of individual words (roots and stems) are highly structured. Vertical generalizations holding over the set of elements which are members of a specific word class or subclass are captured in the lexical inheritance hierarchy (a type system and associated constraints). Horizontal generalizations can be captured by lexical rules which are intended to capture relationships between lexical elements. The issue of how lexical rules should be conceptualised and formalized was the focus of considerable interest in HPSG from the early 1990s, the central question being whether lexical rules should be viewed as meta-level or description-level statements. In the former case, they are seen as stating relations between lexical entries (that is, between descriptions of objects) (Calcagno, 1995), and hence lie 'outside'

[5]The version of HPSG outlined in Ginzburg and Sag (2000) uses HD-DTR and DTRS, where the latter also includes a sign token-identical to the value of HD-DTR. Nothing crucial follows from these small differences. The feature geometry of SBCG differs principally in that information about daughters is not represented internally to the *sign* but in *constructs*, feature structures with MTR ('mother') and DTRS ('daughters') features, where DTRS is a nonempty list of signs. Since these differences are not directly relevant to our concerns here, we will not discuss them further.

the lexicon itself. In the latter case, they are seen as stating relations between the objects themselves (Meurers, 1995, 2001). A simple formalization of the latter (description-level) view is to express them within the typed feature structures in such a way that the 'input' is the DTR of the 'output' of the lexical rule (Krieger and Nerbonne, 1993; Riehemann, 1998; Meurers, 1995, 2001). In this way, a lexical rule can be thought of as a unary rule. (11) shows in very schematic form (following Müller (2015a)) a possible lexical rule format, in which the 'output' phonology is some function of the 'input' phonology. In (11) (and similarly in subsequent feature structures) $\boxed{1}$ indicates token-identity.

(11)
$$\begin{bmatrix} \textit{lexical-rule} & \\ \text{PHON} & f(\boxed{1}) \\ \text{SYNSEM} & [\cdots\quad] \\ \text{LEX-DTR} & \begin{bmatrix} \text{PHON} & \boxed{1} \\ \text{SYNSEM} & \ldots\ldots \\ \textit{stem} & \end{bmatrix} \end{bmatrix}$$

2 Basic Issues

2.1 The representation of morphological processes

2.1.1 In LFG

In a lot of LFG research, there has been a tendency to provide lexical entries for morphemes, primarily as place-holders to reflect the fact that f-structure information is contributed by the morphology. Bresnan (2001a: 82), for example, pro-

vides the lexical entry in (12) for the English third singular present tense verbal inflection:

(12) *-s:* (↑ TENSE) = PRES
(↑ SUBJ) = ↓
(↓ PERS) = 3
(↓ NUM) = SG

Sub-lexical rules then constrain the ways in which lexical items of all types combine to form fully inflected words (cf. Selkirk (1982)). Simpson (1991, 238), for example, provides the following morphological rule for the Australian language Warlpiri that adds a case suffix (Aff) to a nominal stem (N^{-1}) to produce a nominal word (N) which can then be inserted into the c-structure:[6]

(13) N ⟶ N^{-1} Aff
↑ = ↓ ↑ = ↓

In more recent years some authors have explored what the morphological component might look like, including an integration of realizational morphology with LFG (e.g. Nordlinger and Sadler (2006); Spencer (2003); Butt and Sadler (2003); Ackerman and Stump (2004); Andrews (2005); Dalrymple (2015)). In the computational implementation of LFG (XLE), a finite-state morphological component is used to manage inflectional morphology, which can accommodate various theories of morphology (e.g. Karttunen et al. (1992); Kaplan and Kay (1994); Beesley and

[6]Simpson's rule is slightly more complicated than shown here, but the details are not relevant to the point at hand.

Karttunen (2003); Karttunen (2003); Seiss (2011)), and is therefore compatible with realizational, constructional or morpheme-based theories of morphology. As discussed above, from the perspective of the syntactic component, the morphology is a "black box": the c-structure of LFG takes fully inflected words as its terminal nodes, but does not impose any particular constraints on how these words have been composed in the morphological component. Thus, the framework of LFG is not committed to a particular theory of the morphology, and different researchers have taken different approaches.

A number of authors have put forward proposals aimed at separating out certain properties into *m(orphological)-structure*, a morphosyntactic structure which models morphological wellformedness conditions. By assuming m-structure as the locus of language specific constraints on *form*, it is possible to maximise the extent to which f-structures are cross-linguistically similar. The m-structure proposals arose primarily out of work on compound tenses and the auxiliary system, in languages such as English with complex auxiliary selection facts.

Early analyses in LFG analysed auxiliaries as raising verbs, assigning them a PRED value, and introducing the main verb in a complement clause (XCOMP) (e.g.Falk (1984)). Later analyses assume a flatter c-structure, with auxiliaries as non-subcategorising elements which contribute functional information (e.g. tense, aspect) but without PRED features. On these analyses, the main verb is the functional head of the clause, with the auxiliary providing grammatical information only (e.g. Butt et al. (1996); King (1995); Bresnan (2001a)). Among many arguments in favour of the flat analysis is the fact that it allows for a consistent analysis

of constructions with similar functions cross-linguistically: the f-structure will be essentially the same irrespective of whether a language expresses its past perfective with a synthetic verb form, or with an analytic structure consisting of an auxiliary followed by an infinitive verb, for example. The positing of a separate m-structure allows for the idiosyncratic morphological facts associated with the past perfective construction in each language to be captured while maintaining the cross-linguistic similarity at f-structure. Thus, it is at m-structure that information about combinatory possibilities is encoded (e.g. the fact that in English the *have* auxiliary requires the following verb to be in the *-en* form – *had eaten* – while the *be* auxiliary requires the *-ing* form, as in *had been eating*).

The early proposal by Butt et al. (1996) introduces a mapping μ from nodes of the c-structure to elements of the m-structure, in addition to the function ϕ mapping c-structure nodes to f-structure. The form requirements within the verbal complex are stated not in f-structure, but at this level of morphosyntactic structure. This allows a clear separation of aspects of surface exponence from more crosslinguistically invariant aspects of temporal and aspectual specification.

(14) Kim has been running

(15)
$$f: \begin{bmatrix} \text{PRED} & \text{`RUN}< \text{SUBJ}>\text{'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`KIM'} \end{bmatrix} \\ \text{ASPECT} & \begin{bmatrix} \text{PROG} & + \\ \text{PERF} & + \end{bmatrix} \\ \text{TENSE} & \text{PRES} \end{bmatrix} \quad m: \begin{bmatrix} \text{VFORM} & \text{FIN} \\ \text{DEP} & \begin{bmatrix} \text{VFORM} & \text{PASTPART} \\ \text{DEP} & \begin{bmatrix} \text{VFORM} & \text{PRESPART} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

The relationship between the verbs in the c-structure and the corresponding m-

structure is captured by the following phrase structure rule in which μ is the mapping from nodes of the c-structure to elements of the m-structure, ($\hat{*}$) denotes the immediately dominating c-structure node, and (*) denotes the current c-structure node. Thus, (16) states that the m-structure associated with the V′ (is equated with the m-structure associated with the V, whereas the m-structure associated with the VP complement is associated with that of the DEP in the m-structure. See Dalrymple (2001, 178-182) for further discussion.

(16) $V' \longrightarrow$ V (↑ = ↓, $\mu(\hat{*}) = \mu(*)$) VP (↑ = ↓, $\mu(\hat{*}\ \text{DEP}) = \mu(*)$)

Frank and Zaenen (2002) make different assumptions about where the m-structure fits in the overall architecture. Working on the assumption that case and agreement features should also be represented at m-structure, they point out some issues with the architecture assumed by Butt et al. (1996). Their main focus is past participle agreement in object relative clauses in French: the participle shows agreement with its OBJ just in case it is preceded by it, a situation which arises in relative clauses. In this case, the participle must in fact have access to the agreement features of the relative pronoun, which agrees with the head noun and may be unboundedly distant - an example is (17b) (from Frank and Zaenen (2002)):

(17) a. Les enfants adorent les histoires qu'on leur a déjà racontées mille fois.
Children are fond of the stories that one has told them already a thousand

times.

b. Les enfants adorent les histoires qu'on sait bien qu'on leur a déjà racontées mille fois.
   Children are fond of the stories that one knows perfectly well (that) one has told them already a thousand times.

Frank and Zaenen (2002) argue that in the architecture of Butt et al. (1996) long-distance functional uncertainty statements over the m-structures (which essentially recapitulate the hierarchy of the f-structure) are required to capture such long-distance agreement dependencies. Instead they propose a different architecture in which μ is projected from the f-structure, so that morphological constraints can be stated locally: the m-structure is not connected, but simply encodes morphosyntactic aspects of that piece of f-structure. A simple example of subject-verb agreement on this view is illustrated with the lexical entry for the French verb *tournera* in (18), which shows the distribution of information to the f-structure (encoded with $\uparrow$) and the m-structure (encoded with $\uparrow_{\mu}$).[7]

[7] Another related proposal is that of Falk (2006) who argues for a level of grammatical marking structure projected from f-structure.

(18) *tournera: V* $(\uparrow \text{PRED}) = \text{`TOURNER}\langle(\uparrow \text{SUBJ})(\uparrow \text{OBJ})\rangle\text{'}$

$(\uparrow_{\mu} \text{AUX}) = -$

$(\uparrow_{\mu} \text{FIN}) = +$

$(\uparrow \text{TENSE}) = \text{FUT}$

$(\uparrow \text{SUBJ}_{\mu} \text{NUM}) = \text{SG}$

$(\uparrow \text{SUBJ}_{\mu} \text{PERS}) = 3$

Sadler and Spencer (2001) expand on the m-structure analyses to propose a distinction between morphological features (*m-features*) and syntactic features (*s-features*), where the latter are the more familiar f-structure attributes while the former are those features which regulate morphological form in the m-structure. While the mapping between the two will be straightforward in many cases (such as when a verb form realizing the m-feature [Tense: Past] also contributes the f-structure information TENSE PAST), the distinction between the two types of features allows for an account of mismatch cases, where a verb marked with present tense morphologically is involved in a construction which means simple past, for example (Sadler and Spencer, 2001). In a recent paper Dalrymple (2015) provides an explicit proposal for integrating the morphological component in the LFG architecture, incorporating much of this previous work.

2.1.2 In HPSG

A cornerstone of lexicalist theories such as HPSG (and LFG) is the clear separation of syntax from morphology: in particular, syntactic machinery is not extended into

inflectional morphology, and the principles which govern syntax are not assumed to extend to inflectional or derivational processes.[8]

The overwhelming majority of work in HPSG inflectional morphology espouses a realizational approach (such as that of Paradigm Function Morphology (PFM) (Stump, 2001)) in which affixes are not themselves signs and affixation is carried out by morphological functions. However alternative approaches are also found (for example, the morpheme-based work of Van Eynde (1994) and the constructional approach of Riehemann (1998, 2001)). Providing an appropriate marriage of realizational morphology (such as PFM) with HPSG poses many non-trivial issues, leading to a rich vein of work on this topic, including Bonami and Boyé (2002, 2006), Crysmann and Bonami (2012), Bonami and Crysmann (2013) and Crysmann and Bonami (In Press).

Among the issues relevant to a treatment of morphology which have been addressed to a significant extent in the HPSG literature are the following: (i) the nature and status of lexical rules; (ii) the role and status of the basic ontology, with respect to issues of morphological productivity, and the possible role of on-line type creation; (iii) the delimitation of syntax from morphology and the treatment of interface phenomena (e.g. status of 'clitics'); (iv) the role and nature of defaults; and (v) the development of a sign-based approach to morphophonology. We discuss some of these in the relevant sections below.

[8]For example, Sag (2012, 78) observes: "I assume that a largely autonomous set of constraints characterize the relation betwen the phonological and morphological aspects of sign".

3 The subparts of morphology

3.1 Word Formation

3.1.1 In LFG

Word formation and compounding in LFG are primarily lexical processes and are therefore dealt with in the morphological/lexical component, rather than the syntax. Since Bresnan's early work on the passive construction (Bresnan, 1982b), the standard LFG approach has been to assume lexical redundancy rules that introduce lexical alternations in predicate-function mappings. The resulting syntactic differences then result from the interaction of these alternative predicate-function mappings with regular syntactic principles (such as completeness, coherence, and function-argument bi-uniqueness) (see Bresnan 2001a: Chapter 3 for detailed discussion). This approach follows from the standard assumption in morphology (e.g. Aronoff (1976, 1994)) that processes such as derivation and compounding are morpholexical and that, therefore, the inputs to these processes must also be morpholexical. From this it follows that relation changing processes such as passivization, causativization, applicativization and so forth, that can be shown to be inputs to lexical processes of derivational morphology in some languages (such as nominalization, for example), must also be formed in the lexical component (Bresnan 2001a: 30).[9]

[9] In fact, argument structure and LFG's lexical mapping theory have been the subject of a large amount of research and debate in recent years, and there is not space in this chapter to do it justice. For further discussion see, among others, Asudeh et al. (2014), Müller and Wechsler (2014) and the enormous array of references provided in Bresnan et al. (2016, 345-348).

Bresnan and Moshi (1990) show how the formation of passives, applicatives and reciprocal verbs in Bantu languages such as Kigaya and Chicheŵa can be captured in terms of morpholexical operations on argument structure which suppress, add or bind roles. These operations can be considered to be associated with the corresponding derivational morphology so that they are unified with the verbal argument structure on affixation (see also Bresnan and Kanerva (1989)). The passive operation, for example, suppresses the highest argument in the verb's argument structure, which prevents it being linked to the SUBJ grammatical function and results instead in the linking of the patient argument to SUBJ (via regular argument linking principles) (see Dalrymple (2001, Chapter 8) for detailed discussion of this aspect of the theory).

A similar approach to verb derivation is found in the analysis of Chicheŵa applicatives by Alsina and Mchombo (1993), and in the approach to applicatives in complex predicates in Murrinhpatha (Australia) taken by Seiss and Nordlinger (2010). Baker et al. (2010) also use a lexical alternation rule in their account of the external possession incorporation construction in Wubuy (Australia) and its interaction with noun incorporation.

3.1.2 In HPSG

A major theme in HPSG work concerns the nature and role of the lexicon and the mechanisms by which lexical generalizations (and hence also derivational relations) between lexemes may be most adequately modelled. In early HPSG and

related work, lexical rules were essentially external operations or functions applying to feature structures (Pollard and Sag, 1987; Flickinger, 1987). An important strand of work over the last twenty or so years has addressed in various ways the issue of bringing lexical generalizations 'inside' the basic architecture (Meurers, 1995, 2001).

In early work Krieger and Nerbonne (1993) (also Krieger and Nerbonne (1991)) outline an approach to both inflection and derivation using complex feature descriptions. The basic proposal is to interpret a lexical rule as an information-bearing object "indistinguishable in its form and meaning from other entries of the lexicon". The leading idea is that derivation is within the lexicon, not an external process which then populates the lexicon. They propose an approach in which complex morphs (i.e. derived words) have HEAD-MORPH and a COMP-MORPH features to encode morphological structure, regulated by constraints over the morphological structure (e.g. constraints over the order of HEAD and COMP, feature inheritance principles, subcategorisation and so forth).

In related work, Krieger (1993) proposes a morphemic, word-structure approach to the derivation of *-bar* Adjectives and *vor-* prefixation in German, in which the morphotactics are handled by attributes representing internal structure (AFFIX and WORD) within a DTRS attribute, and realization is handled by a realization function which applies to the attribute MORPH|FORM. The basic geometry for word formation is shown in (19). A slightly simplified version of the feature description for *-bar* on this approach (which revises Krieger and Nerbonne (1993)) is given in (20), showing the inheritance of the valence information from

the verbal stem to the derived adjectival form.

(19)
$$\begin{bmatrix} \textit{complex-word} \\ \text{MORPH} \quad \textit{word-morphology} \\ \text{SYN} \quad \textit{word-syntax} \\ \text{SEM} \quad \textit{word-semantics} \\ \text{DTRS} \quad \begin{bmatrix} \textit{affix-word-structure} \\ \text{AFFIX} \quad \textit{affix} \\ \text{WORD} \quad \textit{part-of-speech} \end{bmatrix} \end{bmatrix}$$

(20)
$$\begin{bmatrix} \textit{bar-suffix} \\ \text{MORPH} \quad \begin{bmatrix} \textit{affix-morphology} \\ \text{FORM} \quad \textit{-bar} \\ \text{SUBCAT} \quad \begin{bmatrix} \textit{bar-verb} \\ \text{SYN}|\text{LOC}|\text{SUBCAT} \quad \begin{bmatrix} \text{OBJ} \quad \boxed{1} \\ \text{COMPS} \quad \boxed{2} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \text{SYN}|\text{LOC} \quad \begin{bmatrix} \text{HEAD}|\,\text{MAJ} \quad \text{A} \\ \text{SUBCAT} \quad \begin{bmatrix} \text{SUBJ} \quad \boxed{1} \\ \text{COMPS} \quad \boxed{2} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

The account of derivational morphology in Krieger (1993) depends on having feature structures for affixes. An alternative aimed at avoiding the phrase structure (word syntactic) aspect of Krieger and Nerbonne (1993) and Krieger (1993) is Riehemann (1998), which develops an approach in which the formative *-bar* is not a suffix with its own lexical entry, or simply phonological material, but is represented essentially as a schema in a type-based approach to derivational

morphology. Important considerations underlying this work are to capture both the very productive fully regular derivational process and the subregularities (for example, *-bar* adjectives from verbs with dative objects such as *unausweichbar* 'inescapable'). Her approach uses only monotonic multiple inheritance (i.e. it does not have recourse to defaults). She posits a productive maximal subtype of *trans-bar-adjective* to model the productive regular case and a number of lexicalised maximal types for other *-bar* adjectives. The idea is that any appropriate stem (of type *trans-verb*) can be used with the productive *reg-bar-adj* type, shown in (21) (Riehemann's original contains also constraints over the CONTENT feature, representing the semantic argument structure, but we abstract away from these details here for simplicity and greater readability).[10] On this approach, derivational affixes do not have lexical entries. In (21) and elsewhere $\oplus$ indicates the relational constraint *append*, used to concatenate two lists.

(21)
$$\left[\begin{array}{l} \textit{reg-bar-adj} \\ \textsc{phonology} \quad \boxed{1} + \textit{bar} \\ \textsc{morph-b} \quad \left\langle \left[\begin{array}{l} \textit{trans-verb} \\ \textsc{phon} \quad \boxed{1} \\ \textsc{synsem}|\textsc{loc} \quad \left[\textsc{cat}|\textsc{val}|\textsc{comps} \quad <\text{NP}_{[acc]}:\boxed{2}> \oplus \boxed{3}\right] \end{array}\right] \right\rangle \\ \textsc{synsem}|\textsc{loc}\left[\textsc{cat} \quad \left[\begin{array}{ll} \textsc{head} & \textit{adj} \\ \textsc{valence} & \left[\begin{array}{ll} \textsc{subj} & <\text{NP}:\boxed{2}> \\ \textsc{comps} & \boxed{3} \end{array}\right] \end{array}\right]\right] \end{array}\right]$$

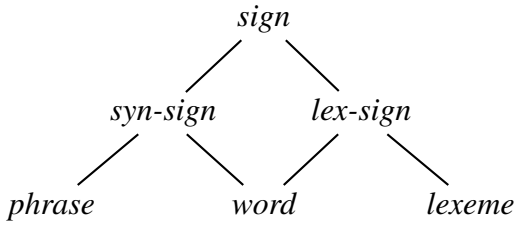
The issue of how morphological productivity can be captured is discussed in

[10] Riehemann's MORPH-B attribute stands for morphological bases.

Koenig and Jurafsky (1995) who observe that Pollard and Sag (1987, 1994) use a compiled-out type hierarchy to capture the common properties of words and lexical rules for productivity, and propose instead to underspecify the type system to deal with lexical productivity. They store a type for each root and for each productive morphological template and propose an algorithm for building types for surface forms, called *online type construction* (OLTC). Koenig (1999) provides extensive further discussion of this issue within an HPSG context. The fundamental idea is that the (lexical) type hierarchy is organised into essentially orthogonal, conjunctive *dimensions*: maximal (leaf) types are inferable (by OLTC) by inheritance from one maximal (leaf) type in *each* dimension. This cross-classificatory approach using intersection of leaf types captures horizonal generalizations across the lexicon.

The relatively small literature on derivation and compounding in HPSG includes Desmets and Villoing (2009), which offers a morphological approach to French VN compounds such as *tournevis* 'screwdriver' and *grille-pain* 'toaster'. They use the type hierarchy in (see (22)) (Bonami and Boyé, 2006) where objects of type *lex- sign* (words and lexemes) have an attribute MORPHOLOGICAL-DAUGHTERS with values of type *lexeme*, and *lexeme* has the attribute STEMS with a value of type *stem-space*.

(22)



Desmets and Villoing (2009) extend this type hierarchy to allow for lexemes with 'complex morphology' by introducing an additional dimension of classification for *lexemes* called FORMATION. Lexemes which are morphologically complex (of type *morph-complex-lex*) are subclassified into compound, derived and converted subtypes. The essence of the approach to the representation of compounds can be ascertained from the following constraint on the type *vn-lexeme*, which specifies that a Verb-Noun compound (in French) is syntactically a Noun formed by combining a verbal and a nominal stem in the morphology.

(23) *vn-lexeme* $\rightarrow$

$$\left[\begin{array}{ll}
\textsc{stems} & \left[\textsc{slot}1 \quad \boxed{3} \oplus \boxed{4}\right] \\
\textsc{synsem} & \left[\begin{array}{ll}\textsc{cat} & \textit{noun} \\ \textsc{cont} & \ldots\end{array}\right] \\
\textsc{m-dtrs} & \left\langle \begin{array}{l} \textit{v-lex}\left[\begin{array}{ll}\textsc{stems} & \left[\textsc{slot}1 \quad \boxed{3}\right] \\ \textsc{synsem} & \ldots\end{array}\right] \\ \textit{n-lex}\left[\begin{array}{ll}\textsc{stems} & \left[\textsc{slot}1 \quad \boxed{4}\right] \\ \textsc{synsem} & \ldots\end{array}\right] \end{array} \right\rangle
\end{array}\right]$$

3.2 Inflection

3.2.1 In LFG

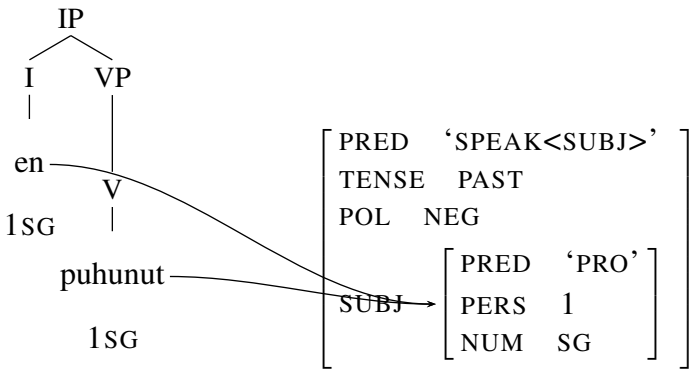
As discussed above, the framework of LFG is not committed to a particular treatment of inflection, and thus there has been little LFG work on a general theory of inflectional morphology. However, the flexibility of the LFG architecture has enabled interesting accounts of certain inflectional phenomena that have been less straightforwardly handled in other frameworks. In this section we focus particularly on multiple exponence and constructive morphology.

Multiple exponence

Cases of multiple exponence, especially those where the same inflectional category is marked across multiple words in the clause, can be problematic for approaches which hold that inflectional morphology is related to abstract functional nodes in the syntax (see Niño (1997) for a more detailed discussion of such approaches and the difficulties). The unification-based nature of LFG, and the fact that all morphosyntactic information unifies into the same clausal f-structure, means that the number of times that compatible information can be contributed (and unified) is limitless, and will always result in the same f-structure. Thus, cases of multiple exponence are not only straightforwardly captured in this framework, but require no additional mechanisms or assumptions; the multiple instances of the same inflectional feature are simply unified in the f-structure, as shown in the Finnish example below (from Niño (1997)).

(24) e-**n** puhu-**nut**
NEG-1SG speak-PAST.SG
'I did not speak.'

(25)



In the Finnish example in (24), we see that both the negative polarity item and the verb carry inflection encoding singular number for the subject. In the LFG analysis of this sentence, a simplified form of which is shown in (25), this information is unified with the same f-structure associated with the subject in both cases. Thus, the appearance of the singular subject inflectional feature on multiple parts of the clause does not change the f-structure of the sentence, but is an issue of relevance for the morphological component only. If the morphology generates words of different word classes which mark the same inflectional feature, this situation will be accommodated by the syntactic component. In contrast, syntactic models of inflectional morphology treat each inflectional feature as being associated with a functional head, and thus multiple instantiations of a single feature can only be accounted for through other processes such as feature percolation or copying (e.g. Mitchell (1991)).

Nordlinger and Bresnan (1996) show that this general approach can also be extended to account for situations in which distinct, yet compatible information is contributed by different parts of the clause, and unified at the f-structure. They discuss the case of distributed tense/aspect/mood (TAM) marking in the Australian language Wambaya. In Wambaya, TAM is marked on both a second position auxiliary, and on the verb. These two elements need not be contiguous in the clause, since Wambaya clauses have grammatically free word order (apart from the second-position auxiliary). Crucially, however, the TAM information contributed by each element is not identical; rather the two interact to mutually determine the TAM for the clause. According to the Nordlinger and Bresnan (1996) analysis, this is accounted for by treating the categories of tense and mood in Wambaya as composites of three primitive binary features, as follows:

(26) a. PAST: $\begin{bmatrix} \text{PAST} & + \\ \text{FUTURE} & - \\ \text{UNCERTAIN} & - \end{bmatrix}$

b. PRESENT: $\begin{bmatrix} \text{PAST} & - \\ \text{FUTURE} & - \\ \text{UNCERTAIN} & - \end{bmatrix}$

c. FUTURE: $\begin{bmatrix} \text{PAST} & - \\ \text{FUTURE} & + \\ \text{UNCERTAIN} & + \end{bmatrix}$

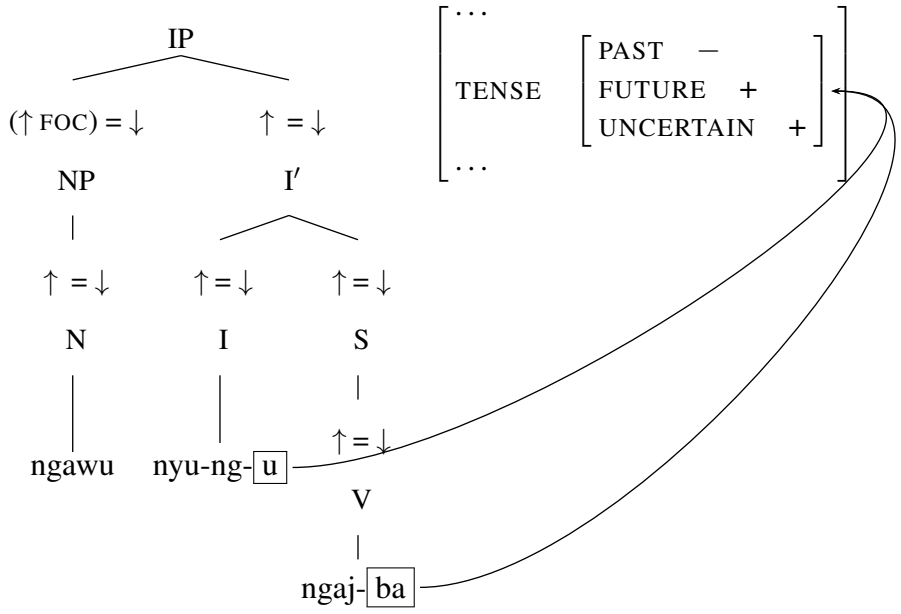
d. IMPERATIVE: $\begin{bmatrix} \text{PAST} & - \\ \text{FUTURE} & - \\ \text{UNCERTAIN} & + \end{bmatrix}$

The TAM inflections on the auxiliary and verb each encode (partial) combinations of these features which then combine in the clausal f-structure to fully spec-

ify the TAM value for the clause as a whole. An example (taken from Nordlinger and Bresnan (2011)) is provided in (27); for a more complete discussion of the analysis see Nordlinger and Bresnan (1996).

(27) a. Ngawu nyu-ng-u ngaj-ba.
1SG 2SG.A-1.O-[PAST−,FUTURE+] see-[UNCERTAIN+]
'You will see me.' **Future tense**

b.



Crucial to this analysis is the LFG notion of co-heads (Bresnan 2001a), and in particular the fact that complements of functional categories are f-structure co-heads. It is this principle which determines that both I and V (via S) in (27) are f-structure heads (indicated with the annotation ↑ = ↓), and therefore their f-structures are identified with the f-structure of the clause as a whole. This allows for them to each provide partial information about the clause-level property of

TAM, which information is then unified into the clausal f-structure.[11]

Constructive morphology

The 'constructive morphology' approach grew out of Nordlinger's (1998) analysis of case stacking in the Indigenous languages of Australia. In this approach, Nordlinger argues that the case morphology in these largely non-configurational languages encodes information directly about the larger syntactic context in which the nominal appears. Inflecting a nominal with ergative case, for example, doesn't just mark the nominal as having ergative case, but also encodes the fact that the nominal is functioning as transitive subject in the larger clause. Thus, on this view, case markers do not just reflect grammatical relations, but actually play a central role in constructing them. Nordlinger (1998) shows how this approach can provide a natural and straightforward account for a range of complex morphological phenomena in these languages that are challenging for other theoretical frameworks, such as multiple case marking (case stacking) and the use of case morphology to encode clausal tense/aspect/mood (on this, see also Nordlinger and Sadler (2004)).

As a simple illustration of the model, consider the Wambaya ergative nominal *galalarrinyi-ni* 'dog-ERG'. A traditional approach to case might assume that the ergative case marker here contributes the case information CASE = ERG, and that elsewhere in the grammar this information will interact with the argument struc-

[11] See Sells (2004) for discussion of multiple exponence in Swedish and its analysis within OT-LFG, a combination of Optimality Theory with the framework of LFG (Bresnan, 2001b).

ture of the verb to ensure that the nominal is only licensed as a transitive subject. On the constructive case approach, however, the ergative case marker constructs the larger f-structure in which this nominal belongs, specifying that the nominal must hold the grammatical relation of SUBJ in a transitive clause. The information associated with the ergative case marker is shown in (28), and the f-structure constructed by the whole nominal *galalarrinyi-ni* is shown in (29).[12]

(28) ERG: ((SUBJ ↑) OBJ)

(↑ CASE) = ERG

(29)
$$\begin{bmatrix} \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`DOG'} \\ \text{CASE} & \text{ERG} \end{bmatrix} \\ \text{OBJ} & [\,] \end{bmatrix}$$

The idea that pieces of case morphology can contribute information to the larger f-structures within which they are contained (enabled by LFG's inside-out function application (e.g. Halvorsen and Kaplan (1988); Dalrymple (2001)) allows Nordlinger (1998) to account for the phenomenon of case stacking (see also Andrews (1996)) and opens up possibilities for such morphology to encode information about other aspects of this broader syntactic context, such as clausal tense/aspect/mood (Nordlinger, 1998; Nordlinger and Sadler, 2004) or interclausal relations (Nordlinger, 2000). This idea has also been extended to other morphological contexts as well, such as pronominal clitics and phrasal affixes (O'Connor, 2002) and word order freezing (Mahowald, 2011).[13]

[12]Note that Nordlinger's original analysis assumes a morphemic morphological approach, but Nordlinger and Sadler (2006) show how it can also be cast within a realizational morphology.

[13]In contrast, Malouf (2001) argues that HPSG is able to account for the Australian case stack-

3.2.2 In HPSG

From the outset there has been a fairly general consensus in favour of adopting broadly inferential-realizational approaches to inflectional morphology in HPSG, although of course the framework itself does not preclude the development of other theoretical approaches (see, for example, the remarks in Krieger and Nerbonne (1991) on the advantages of adopting a 'lexemic' view over a 'morphemic' view, and similar views in Miller and Sag (1997)).

Paradigms

Krieger and Nerbonne (1993) presents an early attempt to define the central notion of paradigm in feature structures directly associated with syntactic information. Their approach makes use of defaults in the lexicon. They express paradigms directly in feature structures by defining them as disjunctions and using distributive disjunction to link the alternation on morphosyntactic features to that in formal expression. In (30) for the present tense weak paradigm of German, *p1* is the name of the distributive disjunction which associates pairwise elements from the ENDING and AGR attributes.

---

ing data without the use of inside-out function application by assuming a concord constraint that recursively propagates the case feature of a head onto all of its dependents (which must necessarily include adjuncts as well).

(30)
$$\left[\begin{array}{ll} \textsc{morph} & \left[\begin{array}{ll} \textsc{stem} & \boxed{2} \\ \textsc{ending} & \boxed{3}\ \{_{p1}\text{“e”,“st”,“t”,“n”, “t”,“n” }\} \\ \textsc{form} & \boxed{2} \wedge \boxed{3} \end{array}\right] \\ \textsc{syn|local|head|agr} & \left\{ {}_{p1}\left[\begin{array}{ll} \textsc{per} & 1\textsc{st} \\ \textsc{num} & \textsc{sg} \end{array}\right] \left[\begin{array}{ll} \textsc{per} & 2\textsc{nd} \\ \textsc{num} & \textsc{sg} \end{array}\right] .... \left[\begin{array}{ll} \textsc{per} & 3\textsc{rd} \\ \textsc{num} & \textsc{pl} \end{array}\right] \right\} \end{array}\right]$$

Stem Space

The issue of expressing PFM-inspired analyses in HPSG is the focus of a number of recent papers. Bonami and Boyé (2002, 2006) address the issue of inflectional irregularity and in particular how the representation of multiple (morphomic) stems (for a lexeme) should be accommodated in the HPSG architecture. A brief outline of Bonami and Boyé (2006) gives the flavour of this strand of work. They propose that the feature STEMS is appropriate for members of the type *lexeme* (the relevant portion of the type hierarchy is given in (22) above). Classes of lexemes default to showing a regular stem pattern, while irregular lexemes are lexically specified with the appropriate STEM phonologies, as shown in (33) for the (French) verb *valoir*. The constraint in (31) specifies that elements of the type *lexeme* have a STEMS attribute (with a value of type *stem-space* while (32) states that the value of STEMS defaults to the type *regular* (the default value is preceded by “/”), in which all the stem forms are in fact identical. Note that attributes under STEMS are purely phonological forms, and hence the treatment is entirely morphomic. (34) illustrates the approach, showing the first person present indicative inflectional rule, which is realized by appending õ to the phonological form which is

the value of SLOT1 in the STEMS feature structure.

(31) *lexeme* → $\left[\text{STEMS} \quad \textit{stem-space}\right]$

(32) *verb-lexeme* → $\left[\text{STEMS} \quad \textit{/regular}\right]$

(33) *valoir*: $\left[\text{STEMS} \quad \begin{bmatrix}\text{SLOT2} & \text{val}\\ \text{SLOT3} & \text{vo}\end{bmatrix}\right]$

(34) *prst-indic-1pl* → $\left[\begin{array}{ll}\textit{word} & \\ \text{PHON} & \boxed{1} \oplus \tilde{\text{o}} \\ \text{SYNSEM} & \left[\begin{array}{ll}\text{HEAD} & \left[\begin{array}{ll}\textit{verb} & \\ \text{TENSE} & \textit{prst} \\ \text{MOOD} & \textit{indicative}\end{array}\right] \\ \text{SUBJ} & \langle \text{NP[1PL]} \rangle\end{array}\right] \\ \text{M-DTRS} & \left\langle \left[\begin{array}{ll}\textit{v-lexeme} & \\ \text{STEMS|SLOT1} & \boxed{1}\end{array}\right] \right\rangle\end{array}\right]$

The use of default values as in (32) is not simply an abbreviatory device permitting compact statements of generalizations: as Bonami and Boyé (2006) point out, it is intended to constrain the members of an open lexicon, so that new or unknown verbs will be inflected as *regular* items.

Variable Morph Ordering

Crysmann and Bonami (In Press) addresses the issue of encoding an inferential, realizational treatment of variable morphotactics in HPSG (and see also earlier, related papers on this topic Crysmann and Bonami (2012); Bonami and Crysmann

(2013)). The approach is templatic, differing crucially from the inferential, realizational approach of PFM in that it characterises the placement of morphs without reference to the stem, and hence eschews the organisation of realization rules into successively applied rule blocks. Generalizations over classes of rules are expressed by organising realization rules into inheritance type hierarchies.[14] The templatic approach allows a simple treatment a range of departures from canonical (stem-centric) placement, including *misplaced alignment* where elements which are in opposition occur in different linear positions, *conditional placement* where the placement of a morph is dependent on the presence of other morphosyntactic features which it does not express, *free ordering*, *partial ordering* and cases where shared forms are *positionally disambiguated* (such as the Swahili subject and object markers which are largely identical but appear in different positional slots).

The fundamental units of description are *morphs* or segmentable formatives, associated with position class and phonological information. Realization rules are expressed as typed feature structures. A rule typically encodes what features it realises and specifies its form: the attribute MUD stands for morphology under discussion and MPH encodes the phonological form (PH) and the position class (PC) information of the morph. A crucial component of the approach is the distinction between conditioning and expression, so that rules can also impose constraints on

[14]In fact, to deal with cases of horizontal redundancy such as the systematic relationship exhibited by the Swahili subject and object marker paradigms, which are mainly identical but in different position classes, Crysmann and Bonami (In Press) additionally use online type construction (Koenig and Jurafsky, 1995) which involves a closure operation on a type underspecified hierarchical lexicon partitioned with conjunctively interpreted dimensions.

features which they do not realise, by means of the MS feature which captures any such (co-ocurrence) constraints on the morph. For example, in the context of negation, past tense in the Swahili verb in realised by a morph *ku* in position class 3 while it is realised by *li* in other contexts. (35) shows the negative (context) allomorph, where ∪ denotes set union.

(35)
$$\begin{bmatrix} \text{MUD} & \{past\} \\ \text{MS} & \{neg\} \cup set \\ \text{MPH} & \left\{ \begin{bmatrix} \text{PH} & \text{<ku>} \\ \text{PC} & 3 \end{bmatrix} \right\} \end{bmatrix}$$

Portmanteau forms are captured by associating a set of features (as value of MUD) with a single exponent and null exponence by assuming a non-realization default for a morphosyntactic property. Discontinuous exponence is exemplified by (36) for regular negation in Chintang, which involves the circumfix *ma-...-yokt*.

(36)
$$\begin{bmatrix} \text{MUD} & \{neg\} \\ \text{MPH} & \left\{ \begin{bmatrix} \text{PH} & \text{<ma>} \\ \text{PC} & 1 \vee 2 \vee 3 \end{bmatrix} \begin{bmatrix} \text{PH} & \text{<yokt>} \\ \text{PC} & 5 \end{bmatrix} \right\} \end{bmatrix}$$

In this approach, rules pair morphosyntactic properties and sets of exponents (building on Crysmann (2003)) in a flat structure of segmentable morphs, rather than incrementally adding exponents to a stem. Stem introduction rules introduce the stem, associated with a particular templatic position. For example, (37) (for the Swahili verb) places the stem shape associated with (the lexical identity of) a lexeme in position class 6.

(37)
$$\begin{bmatrix} \text{MUD} & \left\{ \begin{bmatrix} \textit{lid} \\ \text{STEM} & \boxed{1} \end{bmatrix} \right\} \\ \text{MPH} & \left\{ \begin{bmatrix} \text{PH} & \boxed{1} \\ \text{PC} & 6 \end{bmatrix} \right\} \end{bmatrix}$$

Two principles of well-formedness constrain the type *word*. Inflectional morphology is represented as the value of the attribute MORPH which encodes the relation between the MS set, the set of realization rules (RR) and the set of morphs (MP) indexed for position. *Morphotactic* well-formedness is ensured by a constraint on the type *word* shown in (38). The MS value of the word is the union of the MUD values of the morphs, ensuring that every morphosyntactic property is realised, that is, it ensures that the morphosyntactic features expressed by the rules must match up to produce the property set of the word.[15]

(38)
$$\textit{word} \rightarrow \begin{bmatrix} \text{MPH} & \boxed{\text{e}_1} \cup \ldots \cup \boxed{\text{e}_n} \\ \text{MS} & \boxed{0} \left(\boxed{\text{m}_1} \uplus \ldots \uplus \boxed{\text{m}_n} \right) \\ \text{RR} & \left\{ \begin{bmatrix} \text{MPH} & \boxed{\text{e}_1} \\ \text{MUD} & \boxed{\text{m}_1} \\ \text{MS} & \boxed{0} \end{bmatrix}, \ldots, \begin{bmatrix} \text{MPH} & \boxed{\text{e}_n} \\ \text{MUD} & \boxed{\text{m}_n} \\ \text{MS} & \boxed{0} \end{bmatrix} \right\} \end{bmatrix}$$

In terms of *exponence*, morphs are required to occur in the order given by their position class indices (which are a property of morphs rather than of rule blocks in this approach): this is captures by two further constraints, constituting the Morph Ordering Principle (MOP). (39a) requires the phonology of the word to

[15] $\uplus$ is non-trivial set union and ensures that each property is contributed only once.

be the concatenation of the phonologies of the set of morphs while (39b) requires position class order to be respected.

(39) a.
$$word \rightarrow \begin{bmatrix} \text{PH} & \boxed{1} \oplus ... \oplus \boxed{n} \\ \text{MPH} & \left\{ \begin{bmatrix} \text{PH} & \boxed{1} \end{bmatrix}, ... \begin{bmatrix} \text{PH} & \boxed{n} \end{bmatrix} \right\} \end{bmatrix}$$

b.
$$word \rightarrow \neg \left(\begin{bmatrix} \text{PH} & list \oplus \boxed{1} \oplus \boxed{r} \oplus list \\ \text{MPH} & \left\{ \begin{bmatrix} \text{PH} & \boxed{1} \\ \text{PC} & \boxed{m} \end{bmatrix}, \begin{bmatrix} \text{PH} & \boxed{r} \\ \text{PC} & \boxed{n} \end{bmatrix}, ... \right\} \end{bmatrix} \wedge \boxed{m} \geq \boxed{n} \right)$$

Floating Affixes and HPSG Domains

Some work in morphology in HPSG makes use of the additional flexibility in the relationship between the surface string and the surface constituent structure afforded by making use of a non-concatenative approach to linear order known as domain or linearization theory in HPSG (e.g. Reape (1993); Kathol (1995, 2000)) (and see in this connection the distinction between phenogrammar and tectogrammar discussed in Dowty (1995)). Analyses adopting this (powerful) flexibility add a list-valued feature to *sign* representing its word order domain, and allow elements to 'escape' from the domain of their local constituent subtree, so that linear order does not (necessarily) reflect the yield of the constituent structure. This provides, for example, an approach to discontinuous constituency and to free word order phenomena.[16] To illustrate the application of domain theory to morphology we briefly discuss Crysmann (2006)'s analysis of Polish floating affixes

[16]Reape (1993)'s original order domains contain *signs*. Other proposals have sought to restrict order domains to smaller structures (see Kathol and Pollard (1995); Kathol (1995)).

in linearization HPSG.[17] (40)-(41) illustrate the basic phenomenon. The past tense agreement marker shows evidence of affixal status in the case of the agreeing form of the participle in (40), but word-internal morphophonological effects (effect on lexical stress, raising of *o* to *ó* ([u]) in word final syllables before voiced consonants, and *yer* vocalisation (Booij and Rubach, 1987)) are absent when the agreement marker is preverbal, as in (41). These absence of these word-internal effects is unexpected if the past tense agreement marker is an affix.

(40) (ty) widział-eś tę kiażkę
you see-2SG this book
You saw this book.

(41) Daleko-m poszła
far-1SG went
I went a long way.

The fundamental proposal of Crysmann (2006) is that the rules of morphological exponence treat the realization of agreement uniformly but the mapping of phonology to domain object permits the "affix" to linearise separately. Polish past tense verbs can contribute more than one domain object to linear domain structure. Effectively, past tense agreement is treated as a morphsyntactic hybrid in that the agreement marker is syntactically visible 'floating' phonology.[18] The supertype of the stems with this type of mobile morphology, such as the past (participle) *ł*

[17]For other work on Polish affixes, see also Borsley (1999), Kupść (2000) and Kupść and Tseng (2005).

[18]The past tense markers *-m*, *-ś*, *-śmy*, *ście* are treated as exponents of agreement (and not as tense markers).

stem does not fix the order of the stem and affix, as shown by the use of shuffle ($\bigcirc$) in (42), where *pst-agr* is the most general type corresponding to the inventory of person/number markers – for example, it is a supertype of the 1st sing marker [PH $<$ m$>$].

(42) $\left[\text{M} \quad \left\langle \begin{bmatrix} \textit{stem} \\ \text{HEAD} \quad \textit{verb} \end{bmatrix} \right\rangle \bigcirc \textit{list(pst-agr)} \right]$

Linearization in HPSG is extended in this analysis to permit words to project more than one single domain object (see Kathol (1995) and Crysmann (2003) for this idea). Lexical integrity is preserved since it is only the phonological contribution (of the morph) which may 'float' beyond the word. Where morphologically attached agreement markers are inseparable from the stem, a constraint expresses this restriction by requiring the lexical DOM (domain) list to be of length 1.

4 Interface with Syntax

As we have made clear above, in both LFG and HPSG morphology and syntax are separate and autonomous subsystems in these frameworks, with the interface between them regulated by lexical integrity. Many of the issues discussed above relate to the morphology-syntax interface. In this section we touch (briefly) on work in both frameworks concerning clitics and edge inflection.

4.1 In LFG

Sadler (1998) shows how the framework of LFG can be used to capture Spencer's (1991) insight that *non-syllabic* reduced auxiliaries in English are more appropriately treated as affixes, while the *syllabic* reduced auxiliaries are clitics. Examples using the auxiliary *will* are given below; analogous facts are also found with *would*, and tensed forms of *be* and *have*:

(43) Mary's flu'll (*/l/, /əl/) be gone by tomorrow.
John and Sue'll (*/l/, /əl/) be singing all day long.
The boy who's laughing'll (*/l/, /əl/) go to the party.

(44) You'll (/l/) be able to go home at two o'clock.
I'll (/l/) be leaving tomorrow.

The syllabic reduced forms in (43) behave like clitics: they attach phonologically to the final element of the preceding constituent, without showing any (lexical) selection as to their host. In LFG such clitics are treated as syntactic terminals in the c-structure (just like the corresponding full auxiliary), with their particular phonological properties a matter for the interface between syntax and prosodic structure.[19] The non-syllabic forms in (44) however, are quite different, and can be shown to behave like inflectional affixes (bound morphs) rather than clitics. The evidence is laid out in detail in Spencer (1991) but, in brief, amounts to the

[19] See Butt and King (1998) and Bögel et al. (2009), among others, for a discussion of prosodic structure in LFG and the treatment of clitics.

following: (i) the non-syllabic forms can attach *only* to non-coordinate pronominal subjects (as in (44)) and are therefore highly selective as to their 'host' in a way that is expected of affixes, but not clitics; (ii) word internal phonological processes apply within the 'pronoun + non-syllabic reduced auxiliary' unit suggesting that it is a single morphological unit; (iii) the stem to which the non-syllabic auxiliary attaches shows stem allomorphy that is not predictable on phonological grounds (e.g. *we'll* /wi:l/ becomes [wɪl]), again suggesting word internal structure as opposed to a post-lexical clitic; and (iv) the fact that the non-syllabic auxiliary cannot scope over a coordinated subject, whereas the syllabic (clitic) auxiliary can, is behaviour that we would expect of an affix that is combined within the morphological component rather than the syntax.

Sadler (1998) shows how these tense-inflected pronominals can be given a straightforward account within LFG using inside-out function application (as we saw in the discussion of constructive case above). The inflected pronoun *you'll* (as in *You'll like it*), has the lexical entry shown in (45), corresponding to the f-structure information shown in (46). As shown in this f-structure, the inflected pronoun contributes both information about the subject of the clause, and tense information to the clause itself, thus allowing for the clausal contribution of the non-syllabic auxiliary to be contributed to the f-structure without violating Lexical Integrity.

(45) *you'll* (↑ PRED) = 'PRO'

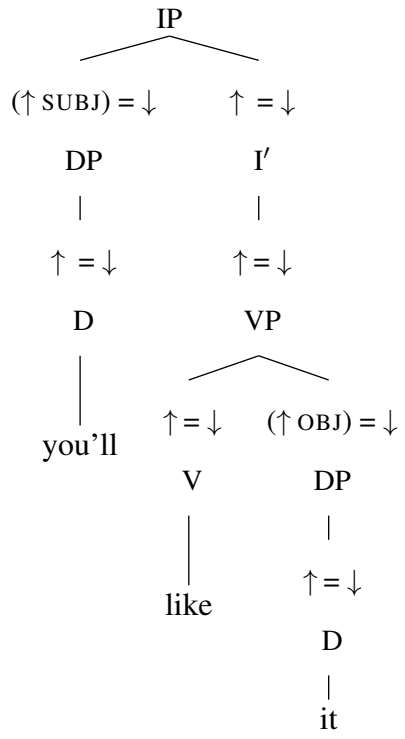
(↑ PERS) = 2

((SUBJ ↑) TENSE) = FUT

(46)
$$\begin{bmatrix} \text{TENSE} & \text{FUT} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'PRO'} \\ \text{PERS} & 2 \end{bmatrix} \end{bmatrix}$$

The basic c-structure (47) and f-structure (48) for the full sentence *You'll like it* are given below.

(47)



(48)
$$\begin{bmatrix} \text{PRED} & \text{`LIKE} < \text{SUBJ, OBJ} > \text{'} \\ \text{TENSE} & \text{FUT} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`PRO'} \\ \text{PERS} & 2 \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{`PRO'} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix}$$

An alternative approach to the affixal nature of non-syllabic reduced auxiliaries in English is provided by Wescoat (2002), who develops a model of 'lexical sharing' within the LFG framework which allows a single word to coinstantiate more than one adjacent terminal node in the c-structure. Wescoat applies this approach to a number of different morphosyntactic phenomena. Broadwell (2008) also uses it to account for suspended affixation phenomena in Turkish. There are clear conceptual similarities between lexical sharing and approaches to co-analysis in other models, such as Sadock (1991); Lapointe (1991), or, within HPSG, Crysmann (2003).

Clitics and related phenomena have been the subject of a large amount of work in LFG, and space limitations preclude us from discussing it all here. See, for example, Grimshaw (1982); Sadler (1997); Sharma (1999); O'Connor (2002, 2004); Luis and Sadler (2003); Luís (2004); Luís and Otoguro (2004, 2005); Luis and Otoguro (2011); Bögel (2010); Spencer and Luís (2012); Lowe (2016) and the references therein.

4.2 In HPSG

In this section we very briefly discuss two issues (i) the affixal treatment of what are pretheoretically described as object clitics, and (ii) the treatment of EDGE phenomena.

A substantial body of work in HPSG argues for affixal (word-internal) treatments of various pronominal 'clitics', following the early influential analysis of French pronominal clitics as affixes developed in Miller and Sag (1997), building especially on the work of Miller (1992). Miller and Sag (1997) draw a distinction between *plain-word*s and *cliticized-word*s, the latter being inflected words which also realize (at least) one argument affixally, with concomitant changes in the word's valency requirements, shown in (49).

(49)
$$\left[\begin{array}{ll} \text{MORPH} & \left[\begin{array}{ll} \text{FORM} & F_{praf}(\boxed{0},....) \\ \text{I-FORM} & \boxed{0} \end{array}\right] \\ \text{SSM}|\text{LOC}|\text{CAT} & \left[\begin{array}{ll} \text{HEAD} & \textit{verb} \\ \text{VAL} & \left[\begin{array}{ll} \text{SUBJ} & \boxed{2} \\ \text{COMPS} & \boxed{3}\ \textit{list(non-aff)} \end{array}\right] \\ \text{ARG-ST} & (\boxed{2} \oplus \boxed{3}) \bigcirc \textit{nelist(aff)} \end{array}\right] \end{array}\right]$$

The function PRAF spells out the form of the inflected word on the basis of the I-FORM value (provided by the word's inflectional type), the HEAD value and the ARG-ST value. The approach is modelled on PFM although the morphological details are not fully specified. Similar accounts have been developed for other Romance clitics (see Monachesi (1998) and Bildhauer (2008), amongst others).

Tseng (2003) argues that the sandhi phenomenon of consonant liaison in French is subject to a range of lexical, syntactic and stylistic considerations rather than being a purely phonological process.[20] The target (adjectival) forms are treated allomorphically in a paradigm-based approach (Bonami and Boyé, 2002, 2003), such that the forms are distinguished in terms of a RIGHT|LIAIS +/- feature in the morphosyntactic feature set. Trigger (versus non-trigger) words are distinguished in terms of a liaison-trigger feature - words are marked as LEFT|LIAIS + if their left edge can trigger liaison. Because contexts are syntactically conditioned, propagation of these features in the syntax (as edge features) is required: for example, the + liaison allomorphy of the MSG adjective *grand* 'large' is required in a liaison context (e.g. before *appartement* 'flat'), even if the adjective is embedded in an AP such as *très grand* 'very large'. The essence of the account is the following. Values of the EDGE feature are propagated in the syntax by virtue of the Edge Feature Principle in (50), which makes reference to the surface order (via DOMAIN). A constraint which applies to all phrases then ensures the realization of liaison, specifying that an element with the feature RIGHT|LIAIS: + must be immediately followed by an element with the feature LEFT|LIAISON: +.[21]

(50) *phrase* ⇒
$$\left[\begin{array}{l} \textsc{edge} \quad \left[\begin{array}{l} \textsc{left} \quad \boxed{1} \\ \textsc{right} \quad \boxed{2} \end{array}\right] \\ \textsc{domain} \quad \left\langle \left[\textsc{edge|left} \quad \boxed{1}\right], \ldots, \left[\textsc{edge|right} \quad \boxed{2}\right] \right\rangle \end{array}\right]$$

Samvelian and Tseng (2010) is concerned with mobile object 'clitics' in Per-

[20] An alternative, purely phonological account in HPSG is developed in Asudeh and Klein (2003).
[21] See also Miller's 1992 treatment of the definite article as a phrasal affix.

sian, and builds on both Miller and Sag (1997)'s approach to pronominal affixes and Tseng (2003)'s use of EDGE features. The object 'clitic' in Persian is relatively mobile, permitting realization on a range of hosts to the left of the verb. They argue that it is a suffix permitting a degree of promiscuous attachment to a range of different hosts. The basic generalization which they put forward concerning the distribution of the preverbal 'clitic' is that it is hosted by the least oblique complement of the verb (when not hosted by the verb itself). An example, with the pronominal object realized on the PP dependent, is shown in (51b).

(51) a. [$_{PP}$ ru-ye miz] gozâšt-im-aš
on-EZ table put-1PL-3SG
We put it on the table.

b. [$_{PP}$ ru-ye miz]-aš gozâšt-im
on-EZ table-3SG put-1PL
We put it on the table.

In such cases, the affix does not bear any syntactic argument relation to the host on which it is realized. A fully lexical treatment of these cases of phrasal affixation is afforded by separating the morphological effect (of suffixation) from the syntactic and semantic contribution, at the phrasal level. The mechanism by which this is achieved involves postulating an additional parameter to the function *PRAF*, namely an EDGE|RIGHT feature which permits the information about the presence of the pronominal affix to be recorded and passed to the head which syntactically selects it.

5 Further Reading and References

In this chapter we've attempted to provide an overview of the general approach to morphology and morphological theory taken by researchers working within the frameworks of HPSG and LFG. We have seen that the two frameworks share the property of lexicalism and the clear separation of morphology from syntax. This means that there is flexibility within the two frameworks as to the theoretical treatment of the morphological component, although a number of researchers have addressed morphological questions of various types. In this chapter we have surveyed some of the key research in this area in each framework, but for reasons of space have not been able to do due justice to all relevant work in this general domain.

For further interesting work on the relationship between morphology and syntax in LFG, see for example, Cho and Sells' (1995) work on case markers and verbal inflectional suffixes in Korean, Sells' (2004) discussion of multiple exponence in Swedish, and Otoguro's (2012) analysis of the interaction between inflectional and periphrastic tense/aspect/mood marking in Japanese. The morphosyntactic treatment of periphrasis is also taken up in a number of works by Ackerman (e.g. Ackerman (2000); Ackerman and Stump (2004); Ackerman et al. (2011)).

For other work on embedding morphological realizational functions in HPSG see also Kathol (1999). See Bonami and Samvelian (2015) on a PFM-based approach to Persian inflectional periphrasis in HPSG. Sag (2012) gives a brief exemplification of compounding and derivation in SBCG. For work on Sorani morphol-

ogy, see Bonami and Samvelian (2008),Walther (2012) and Bonami and Crysmann (2013). Different HPSG analyses of the Polish data discussed in 3.1.2 are given in Borsley (1999) and Kupść and Tseng (2005). In an unpublished paper Müller (2007) addresses the issue of using default inheritance to capture derivational morphology, arguing that the cost of such a move (which avoids the need for lexical rules, however encoded) is too high. In particular this paper gives a very clear statement of the 'closure problem' which arises in attempting to encode productive morphological processes directly in the type system. Bonami and Crysmann (In Press) provides an up-to-date overview of morphology in HPSG.

Both LFG and HPSG have active research communities and annual conferences. We have no doubt that researchers working within these frameworks will continue to explore the nature of morphology and its representation, and we would encourage interested readers to keep an eye on their online proceedings for future developments: `http://cslipublications.stanford.edu/LFG`, and `http://cslipublications.stanford.edu/HPSG`. Comprehensive bibliographies of work within each framework are available at `https://www.essex.ac.uk/linguistics/external/LFG/FAQ/Bibliography.html` (for LFG) and `http://hpsg.fu-berlin.de/HPSG-Bib` (for HPSG).

References

Ackerman, Farrell. 2000. Lexical constructions: Paradigms and periphrastic expression. Paper presented at the LFG00 Conference, University of California,

Berkeley.

Ackerman, Farrell and Gregory T. Stump. 2004. Paradigms and periphrastic expression: A study in realization-based lexicalism. In A. Spencer and L. Sadler, eds., *Projecting Morphology*, pages 111–157. Stanford, CA: CSLI Publications.

Ackerman, Farrell, Gregory T. Stump, and Gert Webelhuth. 2011. Lexicalism, periphrasis and implicative morphology. In R. D. Borsley and K. Börjars, eds., *Non-Transformational Syntax: Formal and explicit models of grammar*, pages 325–358. Oxford: Wiley-Blackwell.

Alsina, Alex and Sam A. Mchombo. 1993. Object asymmetries and the Chichewa applicative construction. In S. A. Mchombo, ed., *Theoretical Aspects of Bantu Grammar*, pages 17–45. Stanford, CA: CSLI Publications.

Andrews, Avery. 1982. The representation of case in Modern Icelandic. In J. Bresnan, ed., *The Mental Representation of Grammatical Relations*, pages 427–503. Cambridge, MA: MIT Press.

Andrews, Avery. 1990. Unification and morphological blocking. *Natural Language and Linguistic Theory* 8(4):507–558.

Andrews, Avery. 1996. Semantic case-stacking and inside-out unification. *Australian Journal of Linguistics* 16(1):1–55.

Andrews, Avery. 2005. F-structural spellout in LFG morphology. MS, ANU.

Aronoff, Mark. 1976. *Word formation in generative grammar*. Cambridge, MA: MIT Press.

Aronoff, Mark. 1994. *Morphology by itself: stems and inflectional classes*. Cambridge, MA: MIT Press.

Asudeh, Ash, Gianluca Giorgolo, and Ida Toivonen. 2014. Meaning and valency. In M. Butt and T. H. King, eds., *Proceedings of the LFG14 Conference*, pages 68–88. Stanford, CA: CSLI Publications.

Asudeh, Ash and Ewan Klein. 2003. Shape conditions and phonological context. In F. Van Eynde, L. Hellan, and D. Beermann, eds., *Proceedings of the 8th International HPSG Conference*, pages 20–30. Stanford, CA: CSLI Publications.

Baker, Brett, Kate Horrack, Rachel Nordlinger, and Louisa Sadler. 2010. Putting it all together: Agreement, incorporation, coordination and external possession in Wubuy (Australia). In M. Butt and T. H. King, eds., *Proceedings of LFG10*, pages 64–84. Stanford, CA: CSLI Publications.

Beesley, Kenneth R. and Lauri Karttunen. 2003. *Finite-State Morphology*. Stanford, CA: CSLI Publications.

Bender, Emily, Scott Drellishak, Antske Fokkens, Laurie Poulson, and Safiyyah Saleem. 2010. Grammar customization. *Research on Language and Computation* 8(1):23–72.

Bildhauer, Felix. 2008. Clitic left dislocation and focus projection in Spanish. In S. Müller, ed., *Proceedings of the 15th International Conference on Head-*

Driven Phrase Structure Grammar, pages 346–357. Stanford, CA: CSLI Publications.

Bögel, Tina. 2010. Pashto (endo)clitics in a parallel architecture. In M. Butt and T. H. King, eds., *Proceedings of LFG 2010*, pages 85–105. Stanford, CA: CSLI Publications.

Bögel, Tina, Miriam Butt, Ronald M. Kaplan, Tracy Holloway King, and John Maxwell III. 2009. Prosodic phonology in LFG: A new proposal. In M. Butt and T. H. King, eds., *Proceedings of LFG 2009*, pages 146–166. Stanford, CA: CSLI Publications.

Bonami, Olivier and Gilles Boyé. 2002. Suppletion and dependency in inflectional morphology. In F. van Eynde, L. Hellan, and D. Beermann, eds., *Proceedings of the 8th International HPSG Conference*, pages 51–70. Stanford, CA: CSLI Publications.

Bonami, Olivier and Gilles Boyé. 2003. La nature morphologique des allomorphies conditionées. In B. Fradin, ed., *Actes du Troisième Forum de Morphologie*, pages 39–48. UMR SILEX, Université Lille 3, Lille.

Bonami, Olivier and Gilles Boyé. 2006. Deriving inflectional irregularity. In S. Müller, ed., *Proceedings of the 13th International Conference on Head-Driven Phrase Structure Grammar, Varna*, pages 361–380. Stanford, CA: CSLI Publications.

Bonami, Olivier and Berthold Crysmann. 2013. Morphotactics in an information-based model of realisational morphology. In S. Müller, ed., *Proceedings of the 20th International Conference on Head-Driven Phrase Structure Grammar, Freie Universität Berlin*, pages 27–47. Stanford, CA: CSLI Publications.

Bonami, Olivier and Berthold Crysmann. In Press. The role of morphology in constraint-based lexicalist grammars. In A. Hippisley and G. T. Stump, eds., *Cambridge Handbook of Morphology*. Cambridge: Cambridge University Press.

Bonami, Olivier and Pollet Samvelian. 2008. Sorani Kurdish person markers and the typology of agreement. Paper presented at 13th Vienna Morphology Meeting, 2008.

Bonami, Olivier and Pollet Samvelian. 2015. The diversity of inflectional periphrasis in Persian. *Journal of Linguistics* 51(2):327–382.

Booij, Geert and Jerzy Rubach. 1987. Postcyclic versus postlexical rules in Lexical Phonology. *Linguistic Inquiry* 18:1–44.

Borsley, Robert. 1999. Weak auxiliaries, complex verbs and inflected complementizers in Polish. In R. D. Borsley and A. Przepiórkowski, eds., *Slavic in Head-Driven Phrase Structure Grammar*, pages 29–59. Stanford, CA: CSLI Publications.

Bresnan, Joan, ed. 1982a. *The Mental Representation of Grammatical Relations*. Cambridge, MA: MIT Press.

Bresnan, Joan. 1982b. The passive in lexical theory. In J. Bresnan, ed., *The Mental Representation of Grammatical Relations*, pages 3–86. Cambridge, MA: MIT Press.

Bresnan, Joan. 1998. Morphology competes with syntax: Explaining typological variation in weak crossover effects. In P. Barbosa, D. Fox, P. Hagstrom, M. McGinnis, and D. Pesetsky, eds., *Is the Best Good Enough? Proceedings from the Workshop on Optimality in Syntax*, pages 59–92. Cambridge, MA: MIT Press.

Bresnan, Joan. 2000. Explaining morphosyntactic competition. In M. Baltin and C. Collins, eds., *Handbook of Contemporary Syntactic Theory*, pages 11–44. Oxford: Blackwell Publishers.

Bresnan, Joan. 2001a. *Lexical Functional Syntax*. Oxford: Blackwell.

Bresnan, Joan. 2001b. Optimal syntax. In J. Dekkers, F. van der Leeuw, and J. van de Weijer, eds., *Optimality Theory: Phonology, Syntax and Acquisition*, pages 334–385. Oxford: Oxford University Press.

Bresnan, Joan, Ash Asudeh, Ida Toivonen, and Stephen Wechsler. 2016. *Lexical Functional Syntax*. Oxford: Wiley-Blackwell, 2nd edn.

Bresnan, Joan and Jonni M. Kanerva. 1989. Locative Inversion in Chichewa: A case study of factorization in grammar. *Linguistic Inquiry* 20:1–50.

Bresnan, Joan and Sam Mchombo. 1987. Topic, pronoun and agreement in Chichewa. *Language* 63(4):741–82.

Bresnan, Joan and Sam A. Mchombo. 1995. The Lexical Integrity Principle: Evidence from Bantu. *Natural Language and Linguistic Theory* 13(2):181–254.

Bresnan, Joan and Lioba Moshi. 1990. Object asymmetries in comparative Bantu syntax. *Linguistic Inquiry* 21(2):147–185.

Broadwell, George Aaron. 2008. Turkish suspended affixation is lexical sharing. In M. Butt and T. H. King, eds., *The Proceedings of the LFG08 conference*, pages 198–213. Stanford, CA: CSLI Publications.

Butt, Miriam and Tracy Holloway King. 1998. Interfacing phonology with LFG. In M. Butt and T. H. King, eds., *Proceedings of the LFG98 Conference*. Stanford, CA: CSLI Publications.

Butt, Miriam, Tracy Holloway King, María-Eugenia Niño, and Frédérique Segond. 1999. *A Grammar Writer's Cookbook*. Stanford, CA: CSLI Publications.

Butt, Miriam, María-Eugenia Niño, and Frédérique Segond. 1996. Multilingual processing of auxiliaries in LFG. In D. Gibbon, ed., *Natural Language Processing and Speech Technology*, pages 111–122. Berlin: Mouton de Gruyter.

Butt, Miriam and Louisa Sadler. 2003. Verbal morphology and agreement in Urdu. In U. Junghanns and L. Szucsich, eds., *Syntactic Structures and Morphological Information*, pages 57–100. Berlin: Mouton de Gruyter.

Cahill, Aoife, Michael Burke, Martin Forst, Ruth O'Donovan, Christian Rohrer, Josef van Genabith, and Andy Way. 2005. Treebank-based acquisition of multilingual unification grammar resources. *Research on Language and Computation* 3(2):247–279.

Calcagno, Mike. 1995. Interpreting lexical rules. In *Proceedings of the First Conference on Formal Grammar*, pages 33–45. Barcelona.

Cho, Young-Mee Yu and Peter Sells. 1995. A lexical account of inflectional suffixes in Korean. *Journal of East Asian Linguistics* 4(2):119–174.

Crouch, Richard, Mary Dalrymple, Ron Kaplan, Tracy King, John Maxwell, and Paula Newman. 2008. *XLE Documentation*. Palo Alto, CA: Palo Alto Research Centre.

Crysmann, Berthold. 2003. *Constraint-based Coanalysis:Portuguese Cliticisation and Morphology-Syntax Interaction in HPSG*. Saarbrücken: Saarbrücken Dissertations in Computational Linguistics and Language Technology, Universität des Saarlandes and DFKI.

Crysmann, Berthold. 2006. Floating affixes in Polish. In S. Müller, ed., *Proceedings of the 13th International Conference on Head-Driven Phrase Structure Grammar, Varna*, pages 123–139. Stanford, CA: CSLI Publications.

Crysmann, Berthold and Olivier Bonami. 2012. Establishing order in type-based realisational morphology. In S. Müller, ed., *Proceedings of the 19th Interna-*

tional Conference on Head-Driven Phrase Structure Grammar, pages 123–143. Stanford, CA: CSLI Publications.

Crysmann, Berthold and Olivier Bonami. In Press. Variable morphotactics in Information-Based Morphology. *Journal of Linguistics* 52.

Dalrymple, Mary. 2001. *Lexical Functional Grammar*. San Diego, CA: Academic Press.

Dalrymple, Mary. 2015. Morphology in the LFG architecture. In M. Butt and T. H. King, eds., *Proceedings of the LFG15 Conference*, pages 64–83. Stanford, CA: CSLI Publications.

Dalrymple, Mary, Ronald Kaplan, John Maxwell III, and Annie Zaenen, eds. 1995. *Formal issues in Lexical Functional Grammar*. Stanford, CA: CSLI Publications.

Desmets, Marianne and Florence Villoing. 2009. French VN lexemes: morphological compounding in HPSG. In S. Müller, ed., *Proceedings of the 16th International Conference on Head-Driven Phrase Structure Grammar, Georg-August-Universität Göttingen, Germany*, pages 89–109. Stanford, CA: CSLI Publications.

Dowty, David R. 1995. Toward a minimalist theory of syntactic structure. In P. Jacobson and G. Pullum, eds., *Syntactic Discontinuity*, pages 11–62. Dordrecht: Reidel.

Falk, Yehuda. 2001. *Lexical-Functional Grammar: An Introduction to Parallel Constraint-Based Syntax*. Stanford, CA: CSLI Publications.

Falk, Yehuda. 2006. On the representation of case and agreement. In M. Butt and T. H. King, eds., *Proceedings of the LFG06 Conference*. Stanford, CA: CSLI Publications.

Falk, Yehuda N. 1984. The English auxiliary system: A Lexical-Functional analysis. *Language* 60(3):483–509.

Fillmore, Charles J., Paul Kay, and Mary Catherine O'Connor. 1988. Regularity and idiomaticity in grammatical constructions: The case of 'let alone'. *Language* 64(3):501–538.

Flickinger, Dan. 2000. On building a more efficient grammar by exploiting types. *Natural Language Engineering* 6(1):15–28.

Flickinger, Daniel P. 1987. *Lexical rules in the hierarchical lexicon*. Ph.D. thesis, Stanford University.

Frank, Anette and Annie Zaenen. 2002. Tense in LFG: Syntax and morphology. In H. Kamp and U. Reyle, eds., *How we say WHEN it happens*, pages 17–53. Tübingen: Max Niemeyer Verlag.

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

Ginzburg, Jonathan and Ivan Sag. 2000. *Interrogative Investigations*. Stanford, CA: CSLI Publications.

Grimshaw, Jane. 1982. On the lexical representation of Romance reflexive clitics. In J. Bresnan, ed., *The Mental Representation of Grammatical Relations*, pages 87–148. Cambridge, MA: The MIT Press.

Halvorsen, Per-Kristian and Ronald M. Kaplan. 1988. Projections and semantic description in Lexical-Functional Grammar. In *Proceedings of the International Conference on Fifth Generation Computer Systems (FGCS-88)*, pages 1116–1122. Tokyo. Reprinted in Dalrymple et al. (1995, pp. 279–292).

Kaplan, Ron and Miriam Butt. 2002. The morphology-syntax interface in LFG. Paper presented at the LFG02 Conference, Athens, Greece.

Kaplan, Ronald M. and Joan Bresnan. 1982. Lexical Functional Grammar: A formal system for grammatical representation. In J. Bresnan, ed., *The Mental Representation of Grammatical Relations*, pages 173–282. Cambridge, MA: MIT Press.

Kaplan, Ronald M. and Martin Kay. 1994. Regular models of phonological rule systems. *Computational Linguistics* 20(3):331–378.

Karttunen, Lauri. 2003. Computing with Realizational Morphology. In A. Gelbukh, ed., *Computational Linguistics and intelligent text processes: Proceedings of the 4th International Conference CICLing 2003*, pages 203–214. Berlin: Springer-Verlag.

Karttunen, Lauri, Ronald M Kaplan, and Annie Zaenen. 1992. Two-level morphology with composition. In *Proceedings of the 14th conference on Computational Linguistics, Volume 1*, pages 141–148. Association for Computational Linguistics.

Kathol, Andreas. 1995. *Linearization-Based German Syntax*. Ph.D. thesis, Ohio State University.

Kathol, Andreas. 1999. Agreement and the syntax-morphology interface in HPSG. In R. Levine and G. Green, eds., *Studies in Current Phrase Structure Grammar*, pages 223–274. Cambridge: Cambridge University Press.

Kathol, Andreas. 2000. *Linear Syntax*. Oxford: Oxford University Press.

Kathol, Andreas and Carl J. Pollard. 1995. Extraposition via Complex Domain Formation. In *Proceedings of the 33rd Annual Meeting of the ACL*, pages 174–180. Association for Computational Linguistics.

Kathol, Andreas, Adam Przepiórkowski, and Jesse Tseng. 2011. Advanced topics in Head-Driven Phrase Structure Grammar. In R. D. Borsley and K. Börjars, eds., *Non-Transformational Syntax: Formal and Explicit Models of Grammar*, pages 54–111. Oxford: Wiley-Blackwell.

Kay, Paul. 2002. An informal sketch of a formal architecture for Construction Grammar. *Grammars* 5:1–19.

King, Tracy Holloway. 1995. *Configuring topic and focus in Russian*. Stanford, CA: CSLI Publications.

Koenig, Jean Pierre. 1999. *Lexical Relations*. Stanford, CA: CSLI Publications.

Koenig, Jean-Pierre and Daniel Jurafsky. 1995. Type underspecification and online type construction in the lexicon. In R. Aranovich, W. Byrne, S. Preuss, and M. Senturia, eds., *Proceedings of WCCFL 13*, pages 27–85. Stanford, CA: CSLI Publications.

Krieger, Hans-Ulrich. 1993. Derivation without Lexical Rules. Tech. Rep. RR-93-27, DFKI, Saarbrücken.

Krieger, Hans Ulrich and John Nerbonne. 1991. Feature based inheritance networks for computational lexicons. Tech. Rep. RR-91-31, DFKI, Saarbrücken.

Krieger, Hans Ulrich and John Nerbonne. 1993. Feature based inheritance networks for computational lexicons. In T. Briscoe, V. de Paiva, and A. Copestake, eds., *Inheritance, Defaults and the Lexicon*. Cambridge: Cambridge University Press.

Kupść, Anna. 2000. *An HPSG Grammar of Polish Clitics*. Ph.D. thesis, Polish Academy of Sciences and Université Paris 7.

Kupść, Anna and Jesse Tseng. 2005. A new HPSG approach to Polish auxiliary constructions. In S. Müller, ed., *Proceedings of the 12th International Conference on Head-Driven Phrase Structure Grammar*, pages 253–273. Stanford, CA: CSLI Publications.

Lapointe, Steven. 1991. Constraints on Autolexical analyses. *Lingusitic Analysis* 18:123–55.

Lowe, John. 2016. English possessive 's: clitic *and* affix. *Natural Language and Linguistic Theory* 34(1):157–195.

Luis, Ana and Louisa Sadler. 2003. Object clitics and marked morphology. In C. B. et al, ed., *Empirical Issues in Formal Syntax and Semantics 4*, pages 133–154. Paris: Presses de l'Université de Paris, Sorbonne.

Luís, Ana R. 2004. *Clitics as Morphology*. Ph.D. thesis, University of Essex.

Luís, Ana R. and Ryo Otoguro. 2004. Proclitic contexts in European Portuguese and their effect on clitic placement. In M. Butt and T. H. King, eds., *Proceedings of LFG04*. Stanford, CA: CSLI Publications.

Luís, Ana R. and Ryo Otoguro. 2005. Morphological and syntactic well-formedness: the case of European Portuguese proclitics. In M. Butt and T. H. King, eds., *Proceedings of LFG05*. Stanford, CA: CSLI Publications.

Luis, Ana R. and Ryo Otoguro. 2011. Inflectional morphology and syntax in correspondence: Evidence from European Portuguese. In Alexandra Galani and Glyn Hicks and George Tsoulas, ed., *Morphology and its Interfaces*, pages 97–136. Amsterdam: John Benjamins Publishing Company.

Mahowald, Kyle. 2011. An LFG approach to word order freezing. In M. Butt and T. H. King, eds., *Proceedings of LFG 2011*, pages 381–400. Stanford, CA: CSLI Publications.

Malouf, Robert. 2001. A head-driven account of long-distance case assignment. In R. Cann, C. Grover, and P. Miller, eds., *Grammatical Interfaces in HPSG*, pages 201–214. Stanford, CA: CSLI Publications.

Meurers, Walt Detmar. 1995. Towards a semantics for lexical rules as used in HPSG. In *Proceedings of the Acquilex II Workshop on the Formalisation and Use of Lexical Rules*, pages 1–20. Cambridge, UK.

Meurers, Walt Detmar. 2001. On expressing lexical generalizations in HPSG. *Nordic Journal of Linguistics* 24(2):161–217. Special issue on 'The Lexicon in Linguistic Theory'.

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

Miller, Philip and Ivan Sag. 1997. French clitic movement without clitics or movement. *Natural Language and Linguistic Theory* 15(3):573–639.

Mitchell, Erika. 1991. Evidence from Finnish for Pollock's theory of IP. *Linguistic Inquiry* 22(2):373–379.

Mohanan, Tara. 1995. Wordhood and lexicality: Noun incorporation in Hindi. *Natural Language and Linguistic Theory* 13(1):75–134.

Monachesi, Paola. 1998. Decomposing Italian clitics. In S. Balari and L. Dini, eds., *Romance in HPSG*, pages 305–358. Stanford, CA: CSLI Publications.

Müller, Stefan. 1996. The Babel-System—an HPSG fragment for German, a parser, and a dialogue component. In *Proceedings of the Fourth International Conference on the Practical Application of Prolog*, pages 263–277. London. `http://hpsg.fu-berlin.de/~stefan/Pub/babel.html`.

Müller, Stefan. 2002. *Complex Predicates: Verbal Complexes, Resultative Constructions, and Particle Verbs in German*. No. 13 in Studies in Constraint-Based Lexicalism. Stanford: Center for the Study of Language and Information.

Müller, Stefan. 2007. Default Inheritance and Derivational Morphology. Unpublished paper, Universität Bremen.

Müller, Stefan. 2015a. HPSG - a synopsis. In A. Alexiadou and T. Kiss, eds., *Ein internationales Handbuch zeitgenössicher Forschung*, pages 937–973. Berlin: Mouton de Gruyter Verlag.

Müller, Stehan. 2015b. The Core-Gram Project: Theoretical linguistics, theory development and verification. *Journal of Language Modelling* 3(1):21–86.

Müller, Stefan and Stephen Wechsler. 2014. Lexical approaches to argument structure. *Theoretical Linguistics* 40:1–76.

Niño, María-Eugenia. 1997. The multiple expression of inflectional information. In F. Corblin, D. Godard, and J.-M. Marandin, eds., *Empirical Issues in Formal Syntax and Semantics*, pages 127–150. Berne: Peter Lang.

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

Nordlinger, Rachel. 2000. Australian case systems: Towards a constructive solution. In Miriam Butt and Tracy Holloway King, ed., *Argument Realization*, pages 41–72. Stanford, CA: CSLI Publications.

Nordlinger, Rachel and Joan Bresnan. 1996. Nonconfigurational tense in Wambaya. In M. Butt and T. H. King, eds., *Proceedings of LFG96*. Stanford, CA: CSLI Publications.

Nordlinger, Rachel and Joan Bresnan. 2011. Lexical-Functional Grammar: Interactions between morphology and syntax. In R. D. Borsley and K. Börjars, eds., *Non-Transformational Syntax: Formal and explicit models of grammar*, pages 112–140. Oxford: Wiley-Blackwell.

Nordlinger, Rachel and Louisa Sadler. 2004. Tense beyond the verb: Encoding clausal tense/aspect/mood on nominal dependents. *Natural Language and Linguistics Theory* 22:597–641.

Nordlinger, Rachel and Louisa Sadler. 2006. Case stacking in realizational morphology. *Linguistics* 44(3):459–488.

O'Connor, Rob. 2002. Clitics and phrasal affixation in Constructive Morphology. In M. Butt and T. H. King, eds., *Proceedings of LFG02*. Stanford, CA: CSLI Publications.

O'Connor, Rob. 2004. *Information Structure in Lexical-Functional Grammar: The Discourse-Prosody Correspondence in English and Serbo-Croation.*. Ph.D. thesis, University of Manchester.

Otoguro, Ryo. 2012. Constructional paradigm in constraint-based morphosyntax: A case of Japanese verb inflection. In K. Carpenter, D. Oana, F. Lionnet, C. Sheil, T. Stark, and V. Wauters, eds., *Proceedings of the 38th Annual Meeting of the Berkeley Linguistics Society*. Berkeley Linguistics Society, University of California, Berkeley.

Pollard, Carl and Ivan Sag. 1987. *Information-Based Syntax and Semantics*. Stanford, CA: CSLI Publications.

Pollard, Carl and Ivan Sag. 1994. *Head-Driven Phrase Structure Grammar*. Chicago: Chicago University Press.

Reape, Mike. 1993. *A Formal Theory of Word Order: A Case Study in West Germanic*. Ph.D. thesis, Edinburgh University.

Reape, Mike. 1994. Domain union and word order variation in German. In J. Nerbonne, K. Netter, and C. Pollard, eds., *German in Head-Driven Phrase Structure Grammar*, pages 151 – 197. Stanford, CA: CSLI Publications.

Reape, Mike. 1996. Getting things in order. In H. Bunt and A. van Horck, eds., *Discontinuous Constituency*, pages 209–54. Berlin: Mouton de Gruyter.

Riehemann, Susanne Z. 1998. Type-based derivational morphology. *The Journal of Comparative Germanic Linguistics* 2(1):49–77.

Riehemann, Susanne Z. 2001. *A Constructional Approach to Idioms and Word Formation*. Ph.D. thesis, Stanford University.

Sadler, Louisa. 1997. Clitics and the structure-function mapping. In M. Butt and T. H. King, eds., *Proceedings of LFG97*. Stanford, CA: CSLI Publications.

Sadler, Louisa. 1998. English auxiliaries as tense inflections. In *Special Issue of Essex Research Reports Produced on the Occasion of the Retirement of Keith Brown*.

Sadler, Louisa and Andrew Spencer. 2001. Syntax as an exponent of morphological features. *Yearbook of Morphology 2000* pages 71–97.

Sadler, Louisa and Andrew Spencer, eds. 2004. *Projecting Morphology*. Stanford, CA: CSLI Publications.

Sadock, Jerrold M. 1991. *Autolexical Syntax: A Theory of Parallel Grammatical Representations*. Chicago: The University of Chicago Press.

Sag, Ivan. 1997. English relative clause constructions. *Journal of Linguistics* 33(2):431–484.

Sag, Ivan. 2012. Sign-Based Construction Grammar: An informal synopsis. In H. C. Boas and I. Sag, eds., *Sign-Based Construction Grammar*, pages 69–203. Stanford, CA: CSLI Publications.

Sag, Ivan A., Thomas Wasow, and Emily Bender. 2003. *Syntactic Theory: A Formal Introduction*. Stanford, CA: CSLI Publications, 2nd edn.

Samvelian, Pollet and Jesse Tseng. 2010. Persian object clitics and the syntax-morphology interface. In S. Müller, ed., *Proceedings of the 17th International*

Conference on Head-Driven Phrase Structure Grammar, pages 212–232. Stanford, CA: CSLI Publications.

Seiss, Melanie. 2011. Implementing the morphology-syntax interface: Challenges from Murrinh-Patha verbs. In M. Butt and T. H. King, eds., *Proceedings of LFG 2011*, pages 482–502. Stanford, CA: CSLI Publications.

Seiss, Melanie and Rachel Nordlinger. 2010. Applicativizing complex predicates: a case study from Murrinh-Patha. In M. Butt and T. H. King, eds., *Proceedings of LFG 2010*, pages 416–436. Stanford, CA: CSLI Publications.

Selkirk, Elizabeth. 1982. *The Syntax of Words*. Cambridge, MA: MIT Press.

Sells, Peter. 2004. Syntactic information and its morphological expression. In Louisa Sadler and Andrew Spencer, ed., *Projecting Morphology*, pages 187–226. Stanford, CA: CSLI Publications.

Sharma, Devyani. 1999. Nominal clitics and constructive morphology in Hindi. In M. Butt and T. H. King, eds., *Proceedings of LFG99*. Stanford, CA: CSLI Publications.

Simpson, Jane. 1983. *Aspects of Warlpiri Morphology and Syntax*. Ph.D. thesis, MIT, Boston, MA.

Simpson, Jane. 1991. *Warlpiri Morpho-Syntax: A Lexicalist Approach*. Dordrecht: Kluwer Academic Publishers.

Spencer, Andrew. 1991. *Morphological Theory*. Oxford: Blackwell.

Spencer, Andrew. 2003. Periphrastic Paradigms in Bulgarian. In U. Junghanns and L. Szucsich, eds., *Syntactic Structures and Morphological Information*, pages 249–282. Berlin: Mouton de Gruyter.

Spencer, Andrew and Ana R. Luís. 2012. *Clitics: An introduction*. Cambridge: Cambridge University Press.

Stump, Greg. 2001. *Inflectional Morphology*. Cambridge: CUP.

Tseng, Jesse. 2003. Edge features and French liaison. In J.-B. Kim and S. Wechsler, eds., *Proceedings of HPSG 2002*. Stanford, CA: CSLI Publications.

Van Eynde, Frank. 1994. *Auxiliaries and verbal affixes— A Monostratal Cross-linguistic Analysis*. Katholieke Universiteit Leuven, Faculteit Letteren.

Walther, Géraldine. 2012. Fitting into morphological structure: accounting for Sorani Kurdish endoclitics. In *Proceedings of MMM8*, pages 299–321.

Wescoat, Michael. 2002. *On Lexical Sharing*. Ph.D. thesis, Stanford University.