Chapter 19

Morphology in LFG

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Lexical-Functional Grammar has been consistent over the past 4+ decades about its conception of syntactic structure and the sorts of rules that license it. However, despite being a highly lexicalist model of grammar, LFG has not developed a similarly consistent model of morphology. LFG has in fact assumed a variety of different models of morphology and interfaces with distinct 'morphological' modules and theories in this time. This is perhaps because LFG early on solved the problem of how morphology and syntax can communicate in a common formal language — the language of functional descriptions, which can be both associated with words and their parts and with syntactic elements. We first introduce some important concepts from morphological theory. We then look at some early LFG analyses which treated morphology *incrementally*. Subsequently, we review work on the syntax–morphology interface in LFG. We end with a discussion of *realizational* approaches to morphology in LFG.

1 Introduction

Lexical-Functional Grammar has been fairly consistent over the past more than four decades about its conception of syntactic structure and the sorts of rules that license it. However, despite being a highly lexicalist model of grammar, LFG has not developed a similarly consistent model of word-formation. LFG has in fact assumed a variety of different models of word-formation and interfaces with distinct 'morphological' modules and theories in this time. This is perhaps because

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LFG early on solved the problem of how morphology and syntax can communicate in a common formal language — the language of *functional descriptions*, which can be both associated with words and their parts and with syntactic elements. Together with the Lexicalist Hypothesis (Lapointe 1980, Chomsky 1970, Bresnan et al. 2016: 92), this entailed that syntactic terminals are morphologically complete words, with possibly complex associated f-descriptions, but the theory did not have to really say anything about the exact mechanism for word formation or how contributions were made to complex f-descriptions by specific parts of words. In addition, LFG has distributed what might be considered aspects of word-formation to various components besides a lexicon, including for example prosodic or phonological structures (Dalrymple & Mycock 2011, Bögel 2015).

In this context, it is perhaps better to start this chapter with a brief overview of some of the range of variation in morphological theory so that we can better situate LFG in the landscape of morphological possibilities (Section 2). We then look at early LFG analyses which treated morphology incrementally (Section 3). Then we review work on the syntax–morphology interface in LFG (Section 4). This sets the stage for a look at current approaches to morphology in LFG, which are realizational (Section 5). We will not have anything to say about the interactions of morphology, syntax, and prosody in LFG, because that is covered by another chapter in this volume, Bögel 2023 [this volume].

2 Morphological theory and terminology

The landscape of morphological theory is defined by many key 'decision points' that we summarize here for subsequent use. These decision points are pretheoretically distinct from each other, but they have a tendency to cluster together in ways that will be reflected in morphological theories interfacing with LFG. We attempt to be neutral for each decision point, and also as brief as possible. We leave the detailed description of these distinctions to sources like Hockett (1954), Beard (1995), and Stump (2001), but also textbooks like Haspelmath & Sims (2010), which does an especially good job of describing these decisions.

2.1 Morphemes vs. words

The first of these is also the most basic. What are the 'atoms' of morphological theory? What are the inputs to morphological rules? What are the elements that morphology manipulates? Morphological theories fall into two basic classes:

those that subscribe to the *morpheme hypothesis* and those that do not. The former are typically called *morpheme-based* theories (or *morphemic* theories). The latter are typically called *word-based* theories (or *lexemic* theories).

In morpheme-based models, the inputs to morphological operations are idealized as one-to-one pairings of sound and meaning called *morphemes*. Later morpheme-based models, such as Distributed Morphology (Halle & Marantz 1993), have redefined 'morpheme' to mean 'abstract morphological feature'. In these models, the sound-meaning pairing is better considered a *listeme* (Di Sciullo & Williams 1987) but is often called a *vocabulary item*. Historically, a 'word' is the morphological domain above morphemes. In most contemporary models of this kind, the 'word' is mostly epiphenomenal or refers to an extra-morphological domain (typically prosodic/phonological). In this context, a so-called 'simplex word' is nothing more than a domain containing only a single morpheme, while a so-called 'complex word' is a domain containing more than one morpheme.

In word-based models (Aronoff 1976), words are the atoms of the grammar. Morphological operations have words as their input and words as their outputs. In contemporary instantiations of word-based models, the *input* and *output* are not really the appropriate terms. Rather, 'words' have both abstract representations and phonological representations. The abstract form of a word is called a *lexeme*.[1] A lexeme is the basic representation of a word (often analogized to a dictionary entry). A lexeme may be derived from another lexeme via derivational morphology or compounding (and thus can be complex) but is never inflected. The phonological form of a word, which is fully inflected, is called a *word-form*, which can be conceptualized as a particular, (grammatically) context-sensitive, instantiation of a word. The word-forms of a lexeme are typically organized into paradigms.

There are many reasons why a theory might choose to assume words or morphemes — more than we could possibly summarize in this space. We posit the following as an oversimplified summary. The basic tendency observed in the crosslinguistic state of affairs is that morphology is affixal and morpheme boundaries are clearly identifiable. This is tautologically true in isolating and agglutinative languages, but even fusional languages, which almost always have *portmanteau* (many-to-one) morphemes, tend to have clear morpheme boundaries. On the other hand, divergences from this tendency are legion and likely exist in

[1] Word-based and lexeme-based models are not strictly the same (Aronoff 1994: 7). For example, not all word-based models assume lexemes, and some lexeme-based models are actually not word-based in the strict sense (lexemes are taken to be atoms of morphological descriptions, but words are not). For the purposes of this overview this simplification suffices. We thank an anonymous reviewer for helping us sharpen this point.

every language. *Templatic* (or root-and-pattern) morphology, such as found in Semitic languages, is not easily accounted for as affixation. *Stem allomorphy* and *suppletion*, especially in high frequency words, often involves a morphological alternation without clear morpheme boundaries. Furthermore, complex words frequently have lexicalized meaning, i.e. non-compositional meaning that is more than the sum of the contained meanings. These exceptional data are usually given exceptional explanations, such as diachronic ones. Put simply: the morpheme hypothesis captures the basic concatenative cross-linguistic tendency of morphology, but lacks synchronic empirical coverage of seemingly exceptional data. The word hypothesis is its opposite, capturing all the data, but needing to attribute the basic concatenative tendency to something else, such as diachronic pressures like grammaticalization.

2.2 Arrangement vs. Process vs. Paradigm

The second decision point is the types of rules that operate on the atoms. This distinction is originally described by Hockett (1954) as the contrast between *item-and-arrangement* (IA), *item-and-process* (IP), and *word-and-paradigm* (WP) models. The names for these models reflect their workings. In an IA model, morphology is simply the set of morphemes in a word and the arrangement of those morphemes. Thus, the arrangement itself (which is essentially simple concatenation) is the only 'morphological process'. In an IP model, rules (such as *affixation*, *reduplication*, *juxtaposition*, *suppletion*, etc.) are applied to a *base* (or *stem*), which may be complex or simplex, to generate a new complex form. IP models are compatible with both morphemes or words being the 'base'. Finally, WP models assume the morphology is the process through which all the word-forms in a word's paradigm are inferable from each other via some mechanism that generates a paradigm.

The reasons for adopting any of these three are similar to the reasons in Section 2.1. IA models have two strengths. Firstly, they capture the basic cross-linguistic generalization: the vast majority of morphology can be explained with simple concatenation. Secondly, many practitioners of IA models find such a simple operation to have an elegance and restriction that are laudable metatheoretical goals. Because of this, IA would be preferred by those theorists for whom such theoretical elegance is a high-ranking concern. Again, we find that such practitioners are satisfied that putatively non-concatenative processes have potential diachronic explanations.

There are familiar reasons to assume IP models, which again, as in Section 2.1 appear to be the opposing reasons. Chief among them is that IA models under-describe the data. IA models end up accounting for everything with affixation, including apparently non-affixal morphology like *functional shift*, *back-formation*, *stem allomorphy*, *suppletion*, *stress shift*, *truncation*, and *reduplication*. Affixal explanations for these phenomena tend to be fairly stipulative and lead to a proliferation of null morphemes that condition these changes (which are themselves a violation of theoretical parsimony, despite this concern being a primary motivation of such approaches). IP practitioners point out that there is also a ready-made counter-explanation from diachrony for the prevalence of concatenation: the chief source of morphology is grammaticalization, which (ultimately) leads to affixes. Furthermore, although rule-based morphological models are undoubtedly much more powerful than IA models, that power comes with significant empirical coverage, which is arguably worth the trade-off. In many varieties of both WP and IP models, in the idealized case, any two word-forms can be mutually predictive. This allows rules to apply 'backwards', capturing phenomena such as *backformation* or *cross-formation* (see, e.g., Becker 1993). These types of morphological alternations are difficult to capture in an IA model.

The appeal of WP models over the other two is the ability to make reference to the paradigm as an abstract entity. In the domain of inflection, many generalizations, especially *morphomic* ones, can be captured by referring to the paradigm itself. A *morphome*, as described in Aronoff (1994) and Luís & Bermúdez-Otero (2016), among others, is a purely morphological pattern. The existences of morphomes is controversial (a debate captured well in Luís & Bermúdez-Otero 2016). The most salient of proposed morphomes in this debate are root allomorphy patterns like the 'L pattern' and the 'N pattern' (see Maiden 2018), which are literally described as patterns in a paradigm (e.g., cells arranged in an L or an N). Thus WP models are uniquely well-situated to account for these. On the other hand, arrangement accounts usually deny the existence of morphomes as paradigm effects and instead account for them via some other mechanism (see Trommer 2016).

Similarly, patterns of syncretism lend themselves to paradigmatic explanations. Paradigmatic explanations are especially well suited to highly fusional languages as are common in Indo-European. They also lend themselves easily to complex agreement patterns that are cross-linguistically ubiquitous. Furthermore, because a paradigm cell can contain multiple forms or even no forms, WP models allow explanations for both *optionality* and *defectiveness*/*ineffability*. The tradeoff here is paradoxical: on the one hand, paradigmatic models tend to have little to say about derivation[2] and compounding, so they under-describe the data;

[2] There are some notable exceptions, though, such as Booij (2010) and Spencer (2013).

on the other hand, paradigms are much more powerful than needed for most of the world's languages, so in another respect, they over-describe the data.[3]

2.3 What is the lexicon?

The third decision point is the nature of the word-storage component of the grammar. For example: Is the lexicon a productive component of the grammar or simply a passive list of memorized forms? While the terminology here is far from consistent in the literature, for the purposes of this chapter we will use *lexicon* to denote a generative/productive component of the grammar responsible for word-formation. We will use *vocabulary* for a passive component which is simply a list of memorized items. There is nothing inherently contradictory about a model having both a lexicon and a vocabulary. It just happens that most models with a productive component typically assume that that component is also the one responsible for word-storage. Indeed, this dual role is central to many models of *blocking*, such as the original one developed by Aronoff (1976). On the other hand, Di Sciullo & Williams (1987) argue for both a lexicon and a vocabulary (without using those terms).

There are some downstream effects of the decision to have a component dedicated to word-formation. If it is assumed that the lexicon is productive, a decision must be made on how much it is responsible for. The *Single Component Hypothesis* claims that all three distinct types of morphology (derivation, inflection, and compounding) are handled by the same generative component. On the other hand, the *Split Morphology Hypothesis* claims that derivation and inflection are handled by separate components. Thus, it is not uncommon to have two distinct word-formation components, one for derivation and one for inflection, depending on a particular model's definition of *lexeme*. This is made explicit in the WP model of Anderson (1982, 1992), where the paradigms are only responsible for inflection.[4]

Provided you assume that morphology is not its own domain, there seem to be two obvious non-morphological components involved in ordering morphological elements. One of these is prosody/phonology, as seen in models such as Optimality Theory (Prince & Smolensky 2004). The other, more common, account for ordering morphological elements outside of a lexicon is the syntactic component. The *Morphosyntax Hypothesis* — this is not its common name but will suit our purposes — assumes that all of morphology and syntax are handled

[3] Word and Paradigm models encompass more than just what is described here, including adaptive discriminative models such as Blevins et al. (2016), but these have not yet been meaningfully interfaced with LFG, so we set them aside here.

[4] Split morphology theories are properly ambivalent about the place of compounding; we do not address compounding in this chapter.

by the same component of the grammar. This entails the strong claim that autonomous morphological phenomena do not exist, and are instead attributable to the morphological interfaces with phonology and syntax. The *Weak Lexicalist Hypothesis* separates derivation from inflection: Derivation is handled by a lexicon while inflection is part of the syntactic structure. By contrast, the *Strong Lexicalist Hypothesis* assumes that all of word-formation is Lexical/non-syntactic.

We won't get into the reasons why a syntax model might adopt variations on the Lexicalist Hypothesis. We leave that to elsewhere in this handbook. From the point of view of morphological theory, there are distinct reasons to consider breaking the class of things called 'word-formation' into distinct components. Data on morphological structure suggests compounding and derivation are of a kind that is distinct from inflection. In the domain of derivation and compounding, fully productive morpheme ordering overwhelmingly generalizes as *headed hierarchical structure* (the type of structure usually represented by trees in syntactic theory). In inflection, on the other hand, to the extent that morpheme boundaries are even identifiable, they tend to be arranged in ordered flat structure (i.e., a *list*). Constituency tests that show hierarchical structure tend to fail, despite strict ordering. Alternatively, when boundaries are less identifiable, the morphology appears to be arranged *paradigmatically.* This difference is mostly captured by the distinction between an agglutinative and a fusional inflectional system. A key reason for treating inflection as different from other kinds of morphology is precisely because of the apparent structural distinction between a linear structure (inflection) and a hierarchical structure (derivation). Conversely, while inflection is overwhelmingly productive and expresses compositional meaning, derivation and compounding have a much greater (but still small) likelihood of having non-compositional meaning and being less than fully productive. This is yet another reason to partition morphology into distinct classes.

Finally, and perhaps most importantly, to the extent that we can today justify that derivation is a distinct empirical category from inflection, following Anderson (1982), the chief generally observed distinction (outside of the hierarchical/ linear/paradigmatic ones above) is that inflection is relevant to the syntax. Inflection comes in two varieties. The first empirical category is those inflections that express grammatical configurations (*contextual inflection;* Booij 1996). For example, case and subject/object agreement on verbs express the relationship between verbs and their dependents. Similarly, nominal concord expresses the relationship between nouns and their dependents. Importantly, languages appear to have the option of expressing these relationships either via morphology or through a fixed word order (or both). The other empirical category of inflection is those morphological reflexes of so-called 'morphosyntactic' or 'morphosemantic' categories (*inherent inflection;* Booij 1996). These are such properties as tense, aspect, voice, mood, number, definiteness, etc. Again, languages appear to have the choice of expressing these properties morphologically or syntactically (through separate categories such as auxiliaries, clitics, prepositions, etc).

Given these differences, it makes sense to split a *lexicon* into two pieces: one that handles so-called *lexeme-formation* and another that handles inflection (but see Booij 1996 for counter-arguments). These two components can then have fundamentally different types of processes and can have different relationships with the syntactic component. And indeed, this division of labor is common in Word-and-Paradigm models today. For a review of the history and state-of-the-art of WP models, see Blevins (2018).

Since syntax is also naturally represented, at least in part, by headed hierarchical structures, the parsimonious approach to grammar is to identify the extent to which all such structure can be done with the same component — in other words, to assume a single component that generates headed hierarchical structure, whether the structure represents 'syntax' or 'morphology'. Compounding and derivation can similarly easily be accommodated to a component that generates headed hierarchical structure, especially if we restrict the model to only the most productive processes and we are willing to assume that non-compositional morphological meaning is fundamentally the same as non-compositional idiomatic syntactic constructions. We would have to then be willing to postulate vacuous hierarchical structure in inflection, but this postulation is arguably worth the trade-off for overall parsimony. The call of parsimony is heightened by the definitional interdependence of syntax and inflection. In fact, an Item-and-Arrangement model has already made certain empirical sacrifices for parsimony and restriction goals. It seems that no further sacrifices are needed to assume a single morphosyntactic component. The gain in parsimony is even further support for Item-and-Arrangement from this point of view, so it is not surprising that most models today that assume an Item-and-Arrangement model reject the Lexicalist Hypothesis and adopt a passive *vocabulary.* But deciding to approach morphology by reducing it to syntactic (and/or phonological) operations is not restricted to Item-and-Arrangement approaches. Similarly, *construction-based* approaches to morphology (Booij 2010, Masini & Audring 2018) generally assume that the *construction* is both a morphological and syntactic mechanism. This property of having a shared mechanism is often summarized as 'X all the way down', where X is *constructions* in construction-based approaches, *syntax* in standard Distributed Morphology, and *constraints* in Lexical-Realizational Functional Grammar.

Approaching morphology via a single morphosyntactic component has significant empirical justifications as well. There are several commonplace phenomena that blur the lines between word and phrase, suggesting that distinction is more one of convenience than a justifiable categorical contrast. Such phenomena include for example: clitics, phrasal affixes, phrasal compounds, valence changing devices, separable prefixes (of the Germanic variety; e.g., Booij 2002), object incorporation (of the Mohawk variety; e.g., Baker 1988). Because these phenomena appear to be both syntactic and morphological, it is appealing to these practitioners to find unitary explanations, which ultimately rest on not positing a syntax/ morphology distinction.

2.4 Lexical vs. inferential

While not strictly distinct from our classification above, it is worth taking a moment to describe a distinction that is common in the literature, especially within models that interface with LFG. Stump's (2001) typology of morphological theories of inflection includes a distinction between two types of theory: *Lexical* and *Inferential.* In a lexical model, the lexicon (or vocabulary) stores associations of inflectional properties and phonological properties. A complex word is an ordered set of these associations. Conversely, in an inferential model, the systematic associations are between a lexeme and its word-forms. Word-forms are inferred from their stems by rules (not restricted to concatenation) that associate aspects of form with aspects of grammatical content. In sum, lexical models are concerned with listed lexical objects (words or morphemes), whereas inferential ones are concerned with rules.

In the typology that we are describing here, these distinctions are not basic. Instead, they are composites of the distinctions above. While it may not be the case that Stump (2001) intends "lexical" to comprise these four properties, the examples of *lexical* models that Stump (2001) lists all share in common that they are *morpheme-based*, *Item-and-Arrangement*, and *morphosyntactic* with a passive *vocabulary.* In contrast, an *inferential* model is *word-based*, and assumes *Strong Lexicalism* (at least for inflection, which is what Stump 2001 is concerned with).

2.5 Incremental vs. realizational

The final distinction that we describe here concerns the relationship between information and morphology. In an incremental model, morphology is *information-adding*. That is, a word gains grammatical complexity (i.e., morphosyntactic properties) at the same time, or as a function of, gaining complex morphology. For example, on this conception, adding the plural morpheme to the word is what makes it plural. In opposition to this stand *realizational* models. In a realizational model, morphology is *information-expressing*. Some aspect of grammar that is external to the morphology supplies a set of morphosyntactic properties (which may or may not include a *root*). What we conceptualize as morphology then expresses that set of morphosyntactic features. Depending on other choices made, this expression might be a passive mapping to phonology or the application of a realizational rule. In these models, morphology provides the *exponence* of morphological properties (the *exponenda*).

This distinction is not so much an active distinction today since most contemporary morphologists assume *some* variety of realizational morphology. This can be achieved via paradigms (Paradigm Function Morphology; Stump 2001, 2016, Spencer 2013), morpheme-insertion (Distributed Morphology; Halle & Marantz 1993), or constructions (Construction Morphology; Booij 2010, Masini & Audring 2018; Optimal Construction Morphology; Inkelas et al. 2006, Caballero & Inkelas 2013, Inkelas 2016). The simple reason for this is that morphology, especially inflection, both under- and overdetermines its featural content.

The underdetermination part has always been well-known. For example, a fundamental property of inflection and primary explanandum of morphological theory is the fact that the morphosyntactic features overtly expressed by an inflected form are often a subset of those properties that are associated with the word. For example, it is common for gender to be unexpressed in combination with participant persons (1st and 2nd). Similarly, it is also common for person features to be unexpressed in combination with past tense or plural number (see, for example, Bjorkman et al. 2021).

Interestingly, the reverse is true as well, which demonstrates the case of overdetermination. Morphosyntactic properties are often expressed *multiply* without additive meanings; this is usually called *multiple exponence*. For example, *children* is not ‘multiply plural’ despite having three distinct reflexes of plural (vowel change, historic *-r* plural, historic *-en* plural). What is noteworthy here is that the multiple expression of plurality is *grammatical*. One wouldn’t expect this of an iterated plural function, which is what multiple applications of a plural morpheme might lead one to expect (see, for example, Harris 2016).

3 Incremental morphology and LFG

3.1 Phrase structure rules as word-formation rules

An obvious approach to concatenative morphology is to capture morphological well-formedness using similar (annotated) phrase structure rules to the ones that license c-structures (Selkirk 1982). The difference is that the morphological ones use morphological categories. However, standard LFG assumes *Strong Lexicalism*, so it is important to note that this is happening in different combinatorial components of the grammar — morphology versus syntax. Pedagogical presentations, such as Bresnan et al. (2016), out of necessity simplify representations in such a way that this important distinction is masked. In the problem set on West Greenlandic (Bresnan et al. 2016: 364–369), we find the example in (1) below, analyzed with the assistance of the morphological rule in (2), and the sketch of an analysis for (1) in (3).[5]

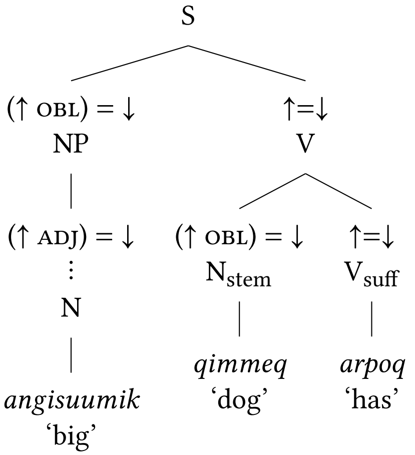
(1) West Greenlandic
Angisuu-mik qimmeq-arpoq.
big-INS dog-have.IND.3.SG
'He has a big dog.'

(2) $$\begin{array}{lccc} \mathrm{V} & \longrightarrow & \mathrm{N}_{\mathrm{stem}} & \mathrm{V}_{\mathrm{suff}} \\ & & (\uparrow \textsc{obl}) = \downarrow & \uparrow{=}\downarrow \end{array}$$

Note that this rule looks just like a c-structure rule, except with a c-structure category on the lefthand side of the rule and morphological categories on the righthand side. In other words, it is the *outputs* of these morphological rules that form the *inputs* to the c-structure rules.

[5] We have left the morphological glosses off the free English translation in (3), which is not present in Bresnan et al. (2016: 446); this is just a rough approximation of the glossing in (1). We have also elided some annotations from the original.

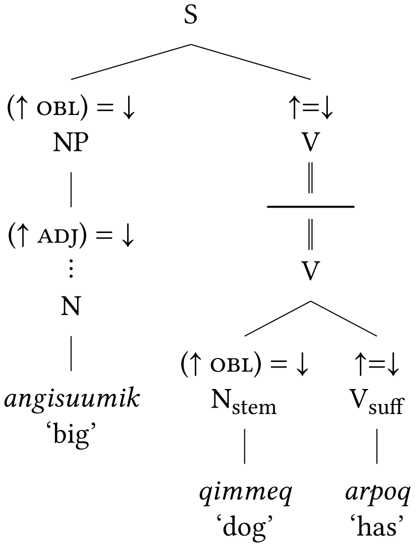
(3)



However, notice that the node labelled V in this tree is actually licensed by the *morphological* rule in (2). In another sense, this very same V is also licensed by the c-structure rule for S, which is easily inferable from (3).

However, if morphology and syntax are distinct grammatical modules, per Strong Lexicalism, then it can't actually be a single rule set that captures both aspects of V, as implied by (3), even if the mechanisms involved are the very same for both syntax and morphology (annotated phrase structure rules) in this incremental approach to LFG morphology. Thus, a more transparent way to represent (3) may be something like the following (based on Ishikawa 1985: 285):

(4)



The horizontal line represents the syntax/morphology 'boundary' and we see that V has a foot on each side. This representation is arguably more transparent about the full set of theoretical claims behind (3). But it also highlights that the licensing mechanisms for c-structure and morphology are redundant in this sort of incremental morphology for LFG.

It is important to realize, though, that in early LFG, incremental morphology through phrase structure rules was not merely a pedagogical simplification. There were proposals in early LFG research on morphologically rich languages that involved phrase-structural incremental morphology, such as Baker (2006 [1983]), Ishikawa (1985: ch. 3)[6] and Nordlinger (1997, 1998). For example, Nordlinger (1997: 107) proposes the following morphological rule for case affixation in various dependent-marking languages of Australia (including, e.g., Kayardild, Martuthunira, Thalanyji, Wambaya):

(5) $$\begin{array}{llcc} \text{N} & \longrightarrow & \text{N} & \text{Aff} \\ & & \uparrow=\downarrow & \uparrow=\downarrow \end{array}$$

Nordlinger subsequently revised this incremental analysis in favour of a realizational approach (Sadler & Nordlinger 2004, 2006), which will be discussed further in Section 5.1.

In sum, the early incremental approach to morphology that was commonly assumed by LFG was a straightforward, even traditional, *morpheme-based*, *item-and-arrangement* approach.

3.2 Finite-state morphology

Another question that arises with incremental phrase-structural morphology is one of computational complexity/power. One way of expressing the intuition that morphology is generally concatenative is to observe that regular languages/ finite state automata, which are the Type 3 grammars in the Chomsky Hierarchy (Chomsky 1957, 1965, Partee et al. 1990: part E), are computationally sufficient for generating concatenative morphology. One can make an even stronger claim, which is that almost all of morphology requires no more than finite-state power, except for total reduplication (Beesley & Karttunen 2003, Roark & Sproat 2007: 25, 53–60), which is beyond finite-state power, since it requires exactly matching a preceding string of potentially unlimited length.[7]

[6] See Bresnan et al. (2016: 396) for a simplified presentation of some of Ishikawa's proposals.

[7] Note that Beesley & Karttunen (2003) build their system around the operation of *concatenation*, whereas Roark & Sproat (2007) argue that the operation of *composition* is more general and is to be preferred. Among other considerations, *composition* gives a more natural finite-state solution to templatic (root-and-pattern) morphology (Kiraz 2001, Roark & Sproat 2007: 41–44).

Let's now turn back to the particular kinds of proposals for phrase-structural morphology that we saw in Section 3.1. The computational power of phrase-structural morphology is at least context-free, which is more powerful than required and corresponds to a higher level in the hierarchy. In other words, representing concatenative morphology in a phrase structure format gives the morphological component more potential power than seems justified by linguistic data. Moreover, once we add f-structure annotations to morphological phrase structure rules, we are potentially in the yet more powerful class of mildly context-sensitive languages (Joshi et al. 1991), since we would have the full power of LFG. This seems too powerful.

For example, if morphology were mildly context-sensitive, we might expect to see *morphological* long-distance dependencies or cross-serial dependencies, but we are not aware of any morphological phenomena that straightforwardly demand such analyses. It might seem that phenomena such as circumfixion or vowel harmony are candidates for morphological long-distance dependencies, but these can in fact be handled by finite-state means (Beesley & Karttunen 2003). Some agreement phenomena, like the Ojibwe PERSON discontinuity in (35) below, might similarly seem long-distance, but are in fact clause-bounded, so we expect that finite-state morphology (FSM) could handle them. We are aware of so-called 'long-distance agreement' (Butt 1993, Bhatt 2005), but we are not aware of any such case for which there is no viable non-long-distance solution. Lastly, it might seem that templatic morphology shows a morphological need for an indexed language (mildly context-sensitive) to line up consonants and vowels properly. However, it has been shown that a composition-based finite-state approach can indeed handle templatic morphology (Kiraz 2001, Roark & Sproat 2007).

It should be noted that actual computational work on LFG, in the context of the Parallel Grammars (ParGram) project (Butt et al. 1999; Forst & King 2023 [this volume]), uses finite-state morphology, rather than incremental phrase-structure morphology. Indonesian is among the languages in the ParGram project and does have productive total reduplication. The ParGram Indonesian grammar only allows for reduplication of words already in the dictionary/lexicon. This means that the FSM can extract the morphological feature encoded by the reduplication (because there is a finite vocabulary). However, on encountering a word for the first time, such a system cannot recognize the reduplication and so cannot extract the morphological feature encoded.[8] Thus, the full productivity of Indonesian reduplication is not modelled in the ParGram grammar.

In sum, the FSM approach is a restrictive approach that also yields broad coverage of morphological phenomena; for example, see the many case studies in

[8] We thank Ron Kaplan (p.c.) for discussion of this point. Any remaining errors are our own.

Roark & Sproat (2007). The restrictiveness of the FSM approach makes it very attractive, even more so when coupled with the fact that FSM approaches have revolutionized applications that require morphological analysis, such as spell-checkers, part-of-speech taggers, and speech recognition and production systems (Kaplan & Kay 1994, Beesley & Karttunen 2003, Roark & Sproat 2007). Nevertheless, this does not mean that we should conflate theories with their formal or computational bases. Using an analogy from syntax, the mildly context-sensitive formalisms of Lexicalized Tree-Adjoining Grammar, Categorial Grammar, and LFG form a computational equivalence class but nevertheless underpin distinct theories. As Roark & Sproat (2007) themselves emphasize, theoretical distinctions may matter even if the options are computationally equivalent. For example, they consider Tagalog *-um-* infixation, as in *tawag* ('call') versus *tumawag* ('call (perfective)'). They note that it is computationally "immaterial" from an FSM perspective whether we conceive of the infix as attaching to *t-* or to *-awag* (Roark & Sproat 2007: 30–31). However, from a theoretical perspective, these two solutions are clearly not equivalent. In particular, Tagalog *um* is an infix in consonant-initial words (with some exceptions, where it cannot appear at all), but is a *prefix* in vowel-initial words, such as *abot*, which becomes *umabot* ('reach for (perfective)') (Orgun & Sprouse 1999: 204). On theoretical grounds, it therefore seems preferable to think of *um* as attaching to the element to its right, as McCarthy & Prince (1993) and Orgun & Sprouse (1999) conclude, but to FSM the two options (dependency on the preceding or following element) are equivalent and the distinction immaterial.

3.3 Lexical rules

Throughout the early history of LFG, theorists made crucial use of *lexical rules*, such as found in Bresnan (1982). These lexical rules were almost always employed to capture argument structure alternations, like passivization. Another way to think about the effect of lexical rules is that they concern the remapping of grammatical functions. These rules frequently had morphological reflexes in addition to their argument-structure-changing properties, but they also frequently did not (see the example lexical rules for gerundives in Bresnan et al. 2016: 316–317). In fairness, these rules were not normally postulated from the point of view of morphological theory, so the emphasis was not on their morphological reflexes or how to use them to capture morphological generalizations. Moreover, lexical rules were not systematically codified into a model that we could discuss explicitly here.

Nevertheless, it was clear that these rules are explicitly non-syntactic. For example, in Falk's textbook they are described thus (Falk 2001: 93):

> [A] lexical rule of this kind is not monotonic: it takes existing information and changes it. This is ruled out in principle in the syntax on grounds of processing: syntactic information cannot be changed. But a lexical rule is not a syntactic rule. Lexical rules do not represent on-line processing, but rather regularities relating stored lexical items. When a lexical rule is applied productively, the result is stored as a new lexical item. For this reason, the usual LFG constraint against changing information is inapplicable here.

Falk's pedagogical point is revealing of an important foundational tenet of LFG: syntax is monotonic, so no non-monotonicity can be syntactic. It therefore follows that argument alternations are non-syntactic, since they are non-monotonic. In other words, allowing the lexical rules to behave non-monotonically shields the syntax.

On the other hand, Baker (1985) explicitly considers lexical rules from the point of view of morphological theory, arguing precisely that because GF-rules (argument structure rules) and word-formation rules align on the same element in LFG (i.e., the lexical rule as developed in Bresnan 1982), LFG was especially well equipped to capture the "lexicalist approach" to the Mirror Principle (Baker 1985: 409). To the extent that these lexical rules were codifiable in the categories we have laid out, these rules often generated affixation as in the types described by Baker (1985), but most frequently required the power and mechanisms of an *Item-and-Process* approach to morphology, especially because they were often expressed with non-concatenative (frequently null) morphology and were explicitly both information-adding and information-destroying, the latter of which cannot be done with concatenation alone.

4 The syntax–morphology interface

Some work on morphologically conditioned syntactic order (e.g., restrictions on verbal sequences, as found in English 'affix hopping'; Chomsky 1957) has proposed a structure called m(orphological)-structure to shield f-structure from features that are morphological in nature (Butt et al. 1996, Frank & Zaenen 2002). This unfortunately gives the impression that m-structure is the morphological component of LFG, but this is not really the case, as we'll see in Section 4.2. First, though, we turn to a general framework for the interface between an LFG syntax and a realizational morphology (Dalrymple 2015). This better sets the context for the discussion of m-structure.

4.1 A general framework

Dalrymple (2015) presented a new, systematic approach to realizational morphology for LFG (see also Dalrymple et al. 2019: ch. 12). It is clear, though, that the morphological output is intended to be something similar or identical to Paradigm Function Morphology (Stump 2001, 2016). We return to that aspect of the Dalrymple analysis in Section 5.1, where we discuss it along with other approaches to a PFM interface with LFG (Ackerman & Stump 2004, Sadler & Nordlinger 2004, Spencer 2013, Thomas 2021).

Dalrymple (2015) assumes, following Dalrymple & Mycock (2011), Mycock & Lowe (2013), that the traditional lexical phonological string is comprised of two aspects, the *s-string* which interfaces with c-structure via the π correspondence function and the *p-string* which interfaces with prosodic structure (via the β correspondence function; Dalrymple et al. 2019: 409). This is illustrated explicitly in Figure 1.

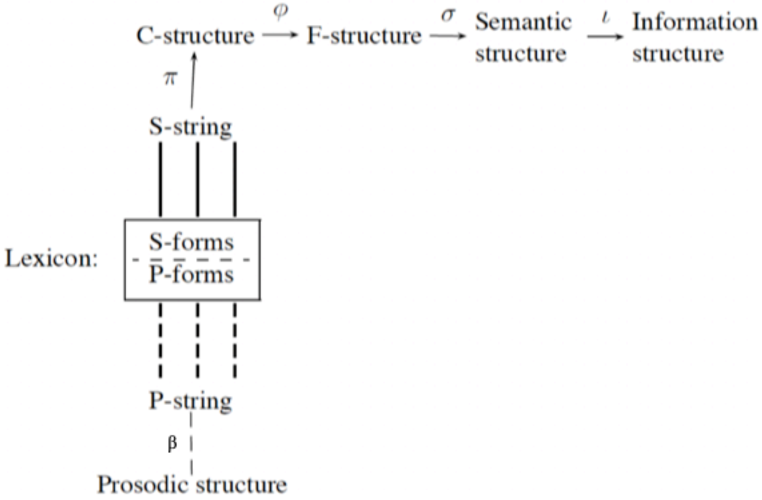


Figure 1: Proposed LFG Correspondence Architecture. From Dalrymple & Mycock (2011: 178, (5); see also Dalrymple et al. 2019: 409); used with permission.

A sample lexical entry for *dogs* from Dalrymple (2015: 67, (3)) is shown here:[9]

[9] This simplified lexical entry sets information structure aside; see Dalrymple (2015: 66).

(6)	*s-form*	(• fm)	=	dogs
	c-structure category	$\lambda(\pi(\bullet))$	=	N
	f-description	(↑ pred)	=	dog
		(↑ num)	=	pl
	p-form	/dɔgz/		

It is convenient to represent the information in lexical entries as a relation (Dalrymple 2015: 67 (4)):

(7) $\mathcal{L}$⟨s-form, p-form, category, f-description⟩

The particular information in (6) can therefore compactly be represented as (Dalrymple 2015: 67 (5)):

(8) $\mathcal{L}$⟨dogs, /dɔgz/, N, {(↑ pred) = dog, (↑ num) = pl}⟩

This lexical entry generates the structures and correspondences in Figure 2.

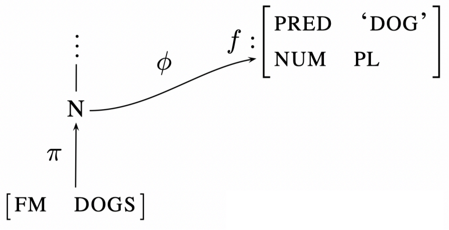


Figure 2: *Dogs*, contributions to the s-string, c-structure, and f-structure. Adapted from Dalrymple (2015: 66, (2)); used with permission.

Dalrymple (2015: 68) assumes, following Spencer (2013), that a *lexemic entry* consists of information about the form of the root (and any non-predictable alternations), any syntactic information and requirements, a representation of the semantics of the lexeme, and an arbitrary unique lexemic index. Dalrymple (2015: 68, (7)) therefore defines a lexemic entry as follows:

(9) *Lexemic entry*
⟨root & idiosyncratic stem forms, f-description, lexemic index⟩

She gives the following particular examples (Dalrymple 2015: 68 (8–9)):

(10) a. ⟨{root: dog}, { (↑ pred) = dog }, dog1⟩

b. ⟨{root: child; stem1: children}, { (↑ pred) = child }, child1⟩

The question is how these lexemic entries interact with the morphological component to produce complete lexical entries. For example, how does the lexemic entry for DOG1 produce the lexical entry (8)?

The answer is illustrated in the diagram in Figure 3. The realization of the s-string form (*s-form*) and the p-string form (*p-form*) are handled by the morphological realization function, *R*, which also contributes morphological features (*m-features*) based on the ID of the lexemic entry (LI). The morphosyntactic description function, *D*, uses the m-features to represent the syntactic category and morphologically contributed f-description. The final lexical entry has the s-form and p-form that are computed by the realization function *R* (based on the m-features), the syntactic category that is computed by the description function *D* (again based on the m-features), and the f-description that is the union of the lexically contributed f-description from *LE* and the morphologically contributed f-description from *D*.

The relations between the different elements can be illustrated in a logic-programming-style representation, as in Figure 4. This representation reveals some redundancy. In particular, it's not clear why *R* and *D* each need access to both the lexemic index (LI) and the set of m-features (M), especially given that M must be computed based on LI. A more streamlined representation would eliminate LI from *D*. It would certainly be theoretically elegant if the set of m-features was sufficient to determine the category C and the morphologically contributed f-description G. However, there are empirical cases that show that *D* must be directly conditioned on LI, such as the syntactically singular but morphologically plural *measles* (Dalrymple 2015: 75).

As we mentioned above, Dalrymple's (2015) model is not a theory of morphology, but rather a theory of the interface between syntax and morphology. Nevertheless, it is most compatible with a morphological theory that is *lexemic*, is *Word-and-Paradigm*, and assumes *Strong Lexicalism*.

4.2 M-structure

As noted above, Dalrymple (2015) sees her framework as a general framework for realizational morphology and it is a feature of the approach that it is very much backwards-compatible with existing LFG proposals about morphological conditioning of syntax, such as the proposals for adding a m(orphological)-structure to the Correspondence Architecture proposed by Butt et al. (1996) and Frank & Zaenen (2002), which are both LFG accounts of affix ordering restrictions (e.g., English 'affix hopping'). The main distinction between the two proposals is that the first holds that m-structure is projected from c-structure (Butt et al. 1996),

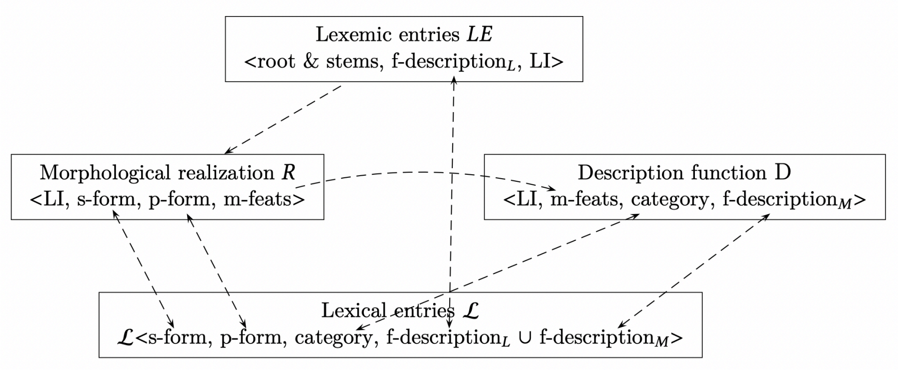

Lexemic entries *LE*
<root & stems, f-description$_L$, LI>
Morphological realization *R*
<LI, s-form, p-form, m-feats>
Description function D
<LI, m-feats, category, f-description$_M$>
Lexical entries $\mathcal{L}$
$\mathcal{L}$<s-form, p-form, category, f-description$_L$ ∪ f-description$_M$>

Figure 3: How the set of lexical entries, $\mathcal{L}$, is computed from the set of lexemic entries, *LE*, using a morphological realization function, *R*, and a description function, *D* (Dalrymple 2015: 70 (15); used with permission)

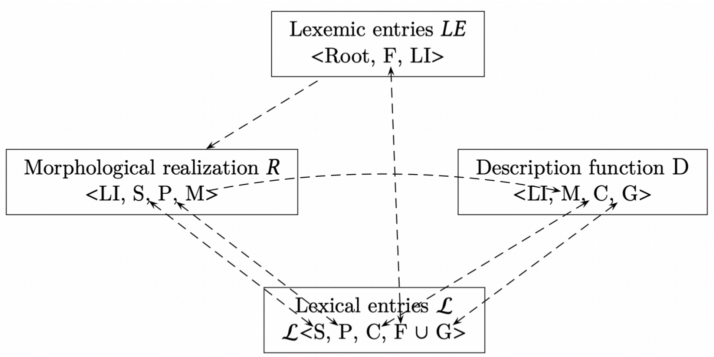

Lexemic entries *LE*
<Root, F, LI>
Morphological realization *R*
<LI, S, P, M>
Description function D
<LI, M, C, G>
Lexical entries $\mathcal{L}$
$\mathcal{L}$<S, P, C, F ∪ G>

Figure 4: Logic-programming-style representation of the relations between $\mathcal{L}$, *LE*, *R*, and *D*

whereas the second holds that m-structure is projected from f-structure (Frank & Zaenen 2002).

The *morphological entry* (m-entry), i.e. instance of *R*, based on Butt et al. for *swimming* is shown here:

(11) *R*⟨SWIM1, swimming, /swɪmɪŋ/, {M-CAT:VERB, M-VFORM:PRESPART}⟩

The relevant *D* mapping would then be:

(12) M-VFORM:PRESPART $\overset{D}{\Rightarrow}$ {($\hat{*}_\mu$ VFORM) = PRESPART, (↑ ASPECT) = PROG)}

Given the same m-entry in (11), the relevant *D* mapping based on Frank & Zaenen would instead be:

(13) $\textsc{m-vform:prespart} \overset{D}{\Rightarrow} \{((\phi(\hat{*})_{\mu}\ \textsc{vform}) = \textsc{prespart}, (\uparrow \textsc{aspect}) = \textsc{prog})\}$

We have represented things this way for maximum comparability with (12), but $\phi(\hat{*})$ is just ↑, so we could have written $\uparrow_{\mu}$ instead:

(14) $\textsc{m-vform:prespart} \overset{D}{\Rightarrow} \{((\uparrow_{\mu}\ \textsc{vform}) = \textsc{prespart}, (\uparrow \textsc{aspect}) = \textsc{prog})\}$

Note that there are other differences between the Butt et al. theory and the Frank & Zaenen theory, but we've kept things as simple as possible for direct comparison. See Dalrymple (2015) for further details regarding both of these approaches to m-structure. It's important to realize, though, that m-structure concerns morphological conditioning on syntactic order and is not a theory of morphology per se. However, we have seen that the Dalrymple (2015) framework, which *can* provide the foundation for a theory of morphology, accommodates both approaches. This demonstrates the Dalrymple framework's generality. M-structure is most compatible with a morphological theory that is *lexemic*, is *Word-and-Paradigm*, and assumes *Strong Lexicalism.*

5 Realizational morphology and LFG

As noted in Section 2.5, realizational morphology is done today in three major ways:

1. The word-based approach, such as Paradigm Function Morphology (Stump 2001, 2016, Spencer 2013).

2. The morpheme-based approach, such as Distributed Morphology (Halle & Marantz 1993) and Nanosyntax (Starke 2009, Caha 2009)

3. The construction-based approach, such as Construction Morphology (Booij 2010) or Optimal Construction Morphology (Caballero 2008)

To our knowledge, neither Construction Morphology nor Optimal Construction Morphology has been interfaced with LFG, so we set them aside here. We focus in particular on PFM and DM interfaces to LFG. PFM and LFG have a history going back at least to Sadler & Spencer (2004). There has also been renewed interest in PFM+LFG (Dalrymple 2015, Dalrymple et al. 2019), as well as recent interest in DM+LFG (Melchin et al. 2020, Asudeh et al. 2021, Everdell et al. 2021, Asudeh & Siddiqi 2022).

5.1 LFG interfaced with PFM

The first attempts to interface LFG with Paradigm Function Morphology (Stump 2001, 2016, Spencer 2013) were undertaken by Sadler & Nordlinger (2004, 2006) to account for highly complex case-stacking in certain Australian languages and by Ackerman & Stump (2004) to deal with the general problem of *periphrasis*. However, the complexity of the data and phenomena involved precluded either of these collaborations from simultaneously providing a general theory of realizational morphology for LFG. As we have seen, steps in that direction were taken by Dalrymple (2015) and Dalrymple et al. (2019). Although the Dalrymple framework is general and not specifically geared towards PFM, there is a deep compatibility between LFG's version of Strong Lexicalism, the Lexical Integrity Principle (see (38) below), and PFM. As Dalrymple (2015) presumably wishes to preserve Lexical Integrity/Strong Lexicalism — the traditional/default stance in LFG theory — then it is natural that she envisages a word-based morphology. Thomas (2021: 22) aptly sums up this underlying compatibility as follows:

> Unlike many other theories of morphology, the concept of a 'morpheme' is irrelevant to PFM: there is no conception of a form-meaning pair below the level of the word, as only fully inflected forms are associated with morphosyntactic property sets. This aligns with the Lexical Integrity Principle of LFG, by which terminal nodes must correspond to fully inflected words, rather than to morphemes or other sub-word elements.

If one wishes to retain LFG's Strong Lexicalism, such that the fundamental building blocks of syntax are words, then it makes sense to interface the syntax with a word-based theory of morphology. And PFM is arguably the most formally well-developed realizational, word-based morphological theory, making it a natural choice. Indeed Thomas (2021: 23) notes in passing that PFM's rigorous formalization offers another natural point of compatibility between PFM and LFG: "PFM also shares with LFG a commitment to being formally explicit and rigorously testable, as well as computationally implementable."

PFM's fundamental claim is that lexemes are represented as pairs of a form and a set of morphological properties (captured as features). Thus, in $\langle X,\sigma \rangle$, X is the form and σ is the set of properties. A paradigm function relates the lexeme to its inflectional realizations, by mapping the input form to an output form given the morphological properties:

(15) $\langle X,\sigma \rangle \xrightarrow{f} \langle Y,\sigma \rangle$

These paradigm functions are defined in terms of realization rules, which consist of *rules of exponence* and *rules of referral.* Rules of exponence realize the property set directly. Rules of referral instead refer the realization of their property sets to one or more other realization rules. There is a limited number of additional rule types; furthermore Stump's (2001) notion of paradigm has been refined in Stump (2016), which is typically called PFM2. However, this simple account will have to serve our purposes.

The realization rules in PFM are arranged into ordered rule *blocks*; however, there is no ordering within blocks. Given Panini's principle, the effect of block ordering mimics concatenation, but allows a morphologically synthetic form (*portmanteau*[10]) to block a morphologically analytic form. Selection of the correct rule in any given block is governed by Paninian blocking: the most specific rule that can apply in any given rule block must apply. PFM also assumes a principle called the Identity Function Default (IFD), which states that the identity function is a member of every rule block: If no other rule applies, the output is identical to the input.

This is exemplified by the following rules for Swahili future and past tenses (Stewart & Stump 2007: 402–403), which Thomas (2021: 22) presents in simplified form.[11] We have adapted the representation for maximal consistency with (15) above.

(16)	Block A	⟨X,σ:{cat:verb,tns:fut}⟩	⟶ ⟨*ta*X,σ⟩
		⟨X,σ:{cat:verb,tns:past}⟩	⟶ ⟨*li*X,σ⟩
		⟨X,σ:{cat:verb,pol:neg,tns:past}⟩	⟶ ⟨*ku*X,σ⟩
	Block B	⟨X,σ:{cat:verb,agr(su):{pers:1,num:sg}}⟩	⟶ ⟨*ni*X,σ⟩
		⟨X,σ:{cat:verb,agr(su):{pers:2,num:sg}}⟩	⟶ ⟨*u*X,σ⟩
		⟨X,σ:{cat:verb,agr(su):{pers:3,num:sg},gen:{1,2}}⟩	⟶ ⟨*a*X,σ⟩
		⟨X,σ:{cat:verb,agr(su):{pers:1,num:pl}}⟩	⟶ ⟨*tu*X,σ⟩
		⟨X,σ:{cat:verb,agr(su):{pers:2,num:pl}}⟩	⟶ ⟨*m*X,σ⟩
		⟨X,σ:{cat:verb,agr(su):{pers:3,num:pl},gen:{1,2}}⟩	⟶ ⟨*wa*X,σ⟩
	Block C	⟨X,{cat:verb, pol:neg}⟩	⟶ ⟨*ha*X,σ⟩

Recall that the identity function, ⟨X,σ⟩ ⟶ ⟨X,σ⟩, is a member of every rule block, according to the IFD. Thus, we see for example, that the negated third singular past tense form is correctly predicted to be *ha-a-ku*-root and not **ha-a-li*-root,

[10] Note that, in this literature, the term *portmanteau* has a more restrictive use than how we use it here. What we have been calling a portmanteau would be called *cumulative exponence.*

[11] The simplification does not account for all the nuances of the paradigms that are captured by the rules in Stewart & Stump (2007).

because the portmanteau form *ku* expresses both the past tense and the negation. From Block A, then, the third rule must be chosen. From Block B, the third rule best expresses the features. Lastly, the rule in Block C can apply, given the input features. The result is the well-formed *ha-a-ku*-ROOT, which undergoes phonological shortening to *ha-ku*-ROOT.

Sadler & Nordlinger (2004) presented an LFG interface to PFM for case-stacking in Australian languages that display that phenomenon (e.g., Kayardild, Martuthunira, Thalanyji, Wambaya). Sadler & Nordlinger (2006) subsequently presented the actual PFM morphology, i.e. realization, of case-stacking morphology. The two papers together constitute an instance of LFG interfaced with PFM. Sadler & Nordlinger (2004: 172–180) provide a detailed analysis of the following example from Martuthunira (Dench 1995: 60, (3.15)):

(17) Martuthunira
Ngayu nhawu-lha ngurnu tharnta-a mirtily-marta-a
I saw-PST that.ACC euro-ACC joey-PROP-ACC
thara-ngka-marta-a.
pouch-LOC-PROP-ACC
1 saw the euro with a joey in (its) pouch.

Sadler & Nordlinger (2004: 174, (28)) provide the following lexemic entry[12] for the word *tharangkamartaa* in (17):

(18) $\langle$*thara*, {Case_C: LOC, {Case_C: PROP, {Case_C: ACC}}}$\rangle$

Sadler & Nordlinger (2004: 174, (25)) provide the following interpretations of these case features:[13]

(19)

M-feature	F-description
Case_C: LOC	$(\uparrow \text{CASE}) = \text{LOC}$ $(\text{ADJ}_{loc} \in \uparrow)$
Case_C: PROP	$(\uparrow \text{CASE}) = \text{PROP}$ $(\text{ADJ}_{prop} \in \uparrow)$
Case_C: ACC	$(\uparrow \text{CASE}) = \text{ACC}$ $(\text{OBJ} \uparrow)$

[12] We use the terminology of Dalrymple 2015; see Section 4 above.

[13] Their table does not include ACC but what its entry should be is clear from their (30) (Sadler & Nordlinger 2004: 175). Also, we have adjusted for the feature ADJ being set-valued by using the symbol ∈.

In the Dalrymple (2015) notation this would be:[14]

(20) *LE*⟨{ROOT: pouch}, {(↑ PRED) = POUCH}, POUCH1⟩

R⟨POUCH1, tharangkamartaa, /ṯaraŋkamaʈaa/,
m-features:{M-CAT:N, M-CASE: LOC, {M-CASE: PROP, {M-CASE: ACC}}}⟩

D⟨POUCH1, m-features, N, (↑ NUM) = SG
(↑ CASE) = LOC
(ADJ$_{loc}$ ∈ ↑)
((ADJ$_{loc}$ ∈ ↑) CASE) = PROP
(ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)
(((ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)) CASE) = ACC
(OBJ ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)⟩

$\mathcal{L}$⟨tharangkamartaa, /ṯaraŋkamaʈaa/,
N, {(↑ PRED) = POUCH
(↑ NUM) = SG
(↑ CASE) = LOC
(ADJ$_{loc}$ ∈ ↑)
((ADJ$_{loc}$ ∈ ↑) CASE) = PROP
(ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)
(((ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)) CASE) = ACC
(OBJ ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)}⟩

This complex lexical entry $\mathcal{L}_{tharangkamartaa}$ licenses the following f-structure:

(21)
$$\begin{bmatrix} \text{OBJ} & \begin{bmatrix} \text{CASE} & \text{ACC} \\ \text{ADJ}_{prop} & \left\{ \begin{bmatrix} \text{CASE} & \text{PROP} \\ \text{ADJ}_{loc} & \left\{ \begin{bmatrix} \text{PRED} & \text{POUCH} \\ \text{NUM} & \text{SG} \\ \text{CASE} & \text{LOC} \end{bmatrix} \right\} \end{bmatrix} \right\} \end{bmatrix} \end{bmatrix}$$

Thus, we can observe that the Dalrymple (2015) notation accurately reconstructs the intended f-structure from Sadler & Nordlinger (2004: 178, (36)).[15]

However, some work remains to be done. How is the realization of *tharangkamartaa* determined based on the root, lexemic ID, and the m-features? The Dalrymple (2015) framework is silent on this issue, because it is meant to be a *general*

[14] The (↑ NUM) = SG part of the f-description occurs by default, following the assumption in Dalrymple (2015: 76) that singular number is the default for nouns (i.e., M-CAT:N in the absence of M-NUM introduces the f-description {(↑ NUM) = SG}).

[15] Modulo our use of ∈, which they simplify away, and the [NUM SG], which comes from Dalrymple's default; see footnote 14 above.

interface between LFG syntax and realizational morphology. In order to preserve its generality, the framework remains silent on the question of exponence. As mentioned above, Sadler & Nordlinger (2006) provide a PFM account, which we can plug into the Dalrymple framework. Adapting their proposal (Sadler & Nordlinger 2004: 471, 23) — which in any case is for Kayardild, not Martuthunira — we get the following case rule block, using the Dalrymple (2015) *R* function:

(22) a. *R*⟨pouch1, tharangka, /t̪araŋka/,
{m-cat:n, m-case: loc}⟩

b. *R*⟨pouch1, tharangkamarta, /t̪araŋkamaʈa/,
{m-cat:n, m-case: prop}⟩

c. *R*⟨pouch1, tharangkamartaa, /t̪araŋkamaʈaa/,
{m-cat:n, m-case: acc}⟩

The effect of these functions on the s-form can be captured in the following simplified PFM representation, based on (15).[16]

(23) $\langle \mathrm{X},\sigma{:}\{\textsc{m-cat:n, m-case:loc}\}\rangle \longrightarrow \langle \mathrm{X}\textit{ngka},\sigma\rangle$
$\langle \mathrm{X},\sigma{:}\{\textsc{m-cat:n, m-case:prop}\}\rangle \longrightarrow \langle \mathrm{X}\textit{marta},\sigma\rangle$
$\langle \mathrm{X},\sigma{:}\{\textsc{m-cat:n, m-case:acc}\}\rangle \longrightarrow \langle \mathrm{X}\textit{a},\sigma\rangle$

In other words, in the context of the features m-cat:n and m-case:loc, the input exponent becomes extended with additional morphological information, the suffix *ngka*. In the context of the features m-cat:n and m-case:prop, the input exponent becomes extended with additional morphological information, the suffix *marta*. And, in the context of the features m-cat:n and m-case:acc, the input exponent becomes extended with additional morphological information, the suffix *a*.

In sum, much work in LFG has adopted Paradigm Function Morphology as its morphological theory. PFM is an *inferential-realizational* theory of morphology. It is *lexemic*, it is *Word-and-Paradigm*, and it assumes *Strong Lexicalism*.

5.2 The targets of exponence

What realizational theories have in common is that morphology realizes things; what they don't have in common is what those things are. In a paradigm model, like PFM, morphology realizes a lexeme and a valuation of a fixed set of attributes.

[16] Note that the simplified formalization in (23) does not account for the set-based embedding in (17) above. But it should be easy enough to replace the second coordinate of the input to their function with **contains**(f), where **contains** is a function that recursively searches σ for its argument, f, a feature, e.g. m-case:loc.

It must be a *fixed* set of attributes, by definition of a paradigm. As Spencer (2013) notes:

> On this [...] conception we abstract away from actual word forms and just consider the set of oppositions or contrasts that are available in principle to a lexeme. (Spencer 2013: 9)

"The set of cells embodying the set of oppositions open to a lexeme" is what Spencer (2013: 9) calls the *property paradigm*. It's *this* abstraction, the property paradigm, that is realized by word forms (the *form paradigm*) in what Spencer calls the *form-property paradigm* (Spencer 2013: 9). In this kind of conception, in order to preserve Strong Lexicalism one must simply have an intervening function that maps a lexeme to a syntactic word:

(24) form-property paradigm $\xrightarrow{f}$ set of instantiated lexical entries for syntax

The mapping f can be a structured mapping, if there are features of the mapping itself that the grammar needs to refer to. This could be represented as an attribute-value matrix. In other words, m-structure (see above) is one possible characterization of the structured mapping f. And an AVM is also indeed how Spencer (2013) models the structured mapping f; see Figure 5. This paradigm shows the lexeme DELAT′ ('make') from Russian, which has stem alternants in the present (*delaj-*), infinitive (*dela-*), and predicative adjective (*delal-*).

Ackerman & Stump (2004) make an antecedent proposal to that of Spencer (2013) which is very similar, although not as well-developed (as a consequence of the former being a paper and the latter a monograph). However, it is worth reading the following passage from Ackerman & Stump (2004) to get a different perspective on the form-property paradigm of Spencer (2013), especially because it refers more directly to LFG structures:

> In distinguishing a lexeme's content-theoretic aspects from its form-theoretic aspects, we will pursue an innovative conception of the lexicon and its relation to c-structure, f-structure, and morphological realization. On this conception, a language's lexicon is bipartite with respect to content and form: one part of its lexicon is its LEXEMICON, whose individual entries are lexemes bearing lexical meanings: the complementary part is its RADICON, whose individual entries are roots, i.e. elements of form. Every member L of a language's lexemicon has an associated CONTENT-PARADIGM C-P(L) such that each cell in C-P(L) consists of the pairing of L with a complete set of morphosyntactic properties; we refer to any such pairing as a

> content-cell. Crucially, content-cells represent ensembles of semantically interpretable information. In contrast, every member r of a language's radicon has an associated form-paradigm F-P(r) such that each cell in F-P(r) consists of the pairing of r with a set of differentiating morphosyntactic property labels; we refer to any such pairing as a form-cell. A language's paradigms of form-cells house the information necessary to deduce the morphological realization of the cells in that language's content-paradigms. (Ackerman & Stump 2004: 117–118)

Although their terminology is different, there are obvious correspondences with Spencer (2013). Ackerman & Stump (2004) assume that a lexicon consists of two parts. The first part is the lexemicon, which "has an associated content-paradigm". Their content-paradigm corresponds to Spencer's property paradigm. The second part of the lexicon for Ackerman & Stump (2004) is

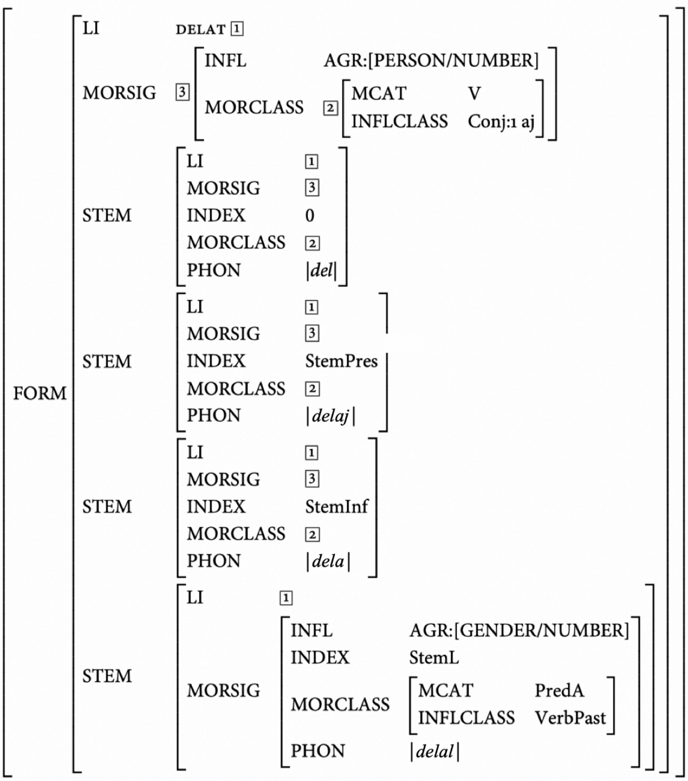


Figure 5: The form-property paradigm for Russian delat′ ('make'). From Spencer (2013: 263, (56)); used with permission.

the RADICON, which "has an associated FORM-PARADIGM". Their form-paradigm corresponds to Spencer's form paradigm. Taken together, then, Ackerman & Stump's (2004) lexicon is equivalent to a set of Spencer's (2013) form-property paradigms. As a consequence, the mapping in (24) above also accurately characterizes the Ackerman & Stump (2004) proposal, which is about periphrasis — when a paradigm cell is filled by more than one word. Further work in this vein can be found in, e.g., Ackerman et al. (2011) and Spencer (2015). We have chosen to describe the Spencer (2013) and Ackerman & Stump (2004) work because of their close connection to LFG, but PFM2 (Stump 2016) incorporates similar principles.

The important takeaway here is that in lexemic morphology there is a mapping (structured or not) from an abstract property paradigm — whose features are purely morphological — to syntax. One could imagine instead having morphology realize the syntactic representation(s) directly, which is the approach taken in Distributed Morphology (DM; Halle & Marantz 1993), and theories like it (e.g., Nanosyntax; Starke 2009, Caha 2009). This comes at the expense of (at least some of) Strong Lexicalism, as discussed below in reference to (38), but it does away with the abstraction of the property paradigm. In a morphemic model, like DM, morphology realizes the information in the terminals of some syntactic representation. There will necessarily be information about syntax, but also possibly about semantics and other aspects of grammar (if they are modelled separately).

5.3 LFG interfaced with DM

In Section 5.1, we explored LFG paired with PFM, an inferential-realizational framework for morphology. In this section, we see LFG paired with Distributed Morphology, a lexical-realizational framework. This combination is called Lexical-Realizational Functional Grammar (L$_{\text{R}}$FG; Asudeh & Siddiqi 2016, Melchin et al. 2020, Everdell et al. 2021, Asudeh & Siddiqi forthcoming). L$_{\text{R}}$FG accomplishes this synthesis of LFG and DM by mapping information from the c-structure to a realization, or *exponent*, called *vocabulary structure*.

Importantly, L$_{\text{R}}$FG assumes that c-structure terminals are not *words*, but just grammatical and semantic information, with no associated information about the form (e.g., *s-form*; see Section 4.1) included in the c-structure. This fact, together with the fact that L$_{\text{R}}$FG follows DM in postulating highly articulated morphological structure, differentiates L$_{\text{R}}$FG c-structures from LFG c-structures. However, L$_{\text{R}}$FG uses the LFG formal machinery and assumes the same kinds of annotated c-structure rules. In L$_{\text{R}}$FG, the categorial information in c-structure *preterminals* and the other information in c-structure *terminals* are realized by L$_R$FG's *ν* correspondence function as v(ocabulary)-structures. Since L$_R$FG assumes a version of LFG's Correspondence Architecture (Kaplan 1989, 1995), the information that v-structures express is not *purely* syntactic. V-structures also express information about semantics (encoded in Glue Semantics *meaning constructors*: see Asudeh 2023 [this volume]) and can indeed express information structure or any other aspect of grammar that is encoded in distinct modules in the Correspondence Architecture.

L$_R$FG seeks to add to LFG's strengths in accounting for *nonconfigurationality* by adding DM's strengths in accounting for *polysynthesis*. These two properties co-occur with some frequency in non-European languages. L$_R$FG also seeks to account for highly agglutinative languages like Finnish and Turkish. Additionally, because the realizational module, v-structure, interfaces with prosodic structure, L$_R$FG draws on existing LFG work, especially Bögel (2015), on clitic ordering and extends it to affixation. Asudeh et al. (2022) develops the interface between v-structure and p(rosodic)-structure (by the *ρ* correspondence function) and the mapping from p-structure to the p(honological)-string (by the *ο* correspondence function).

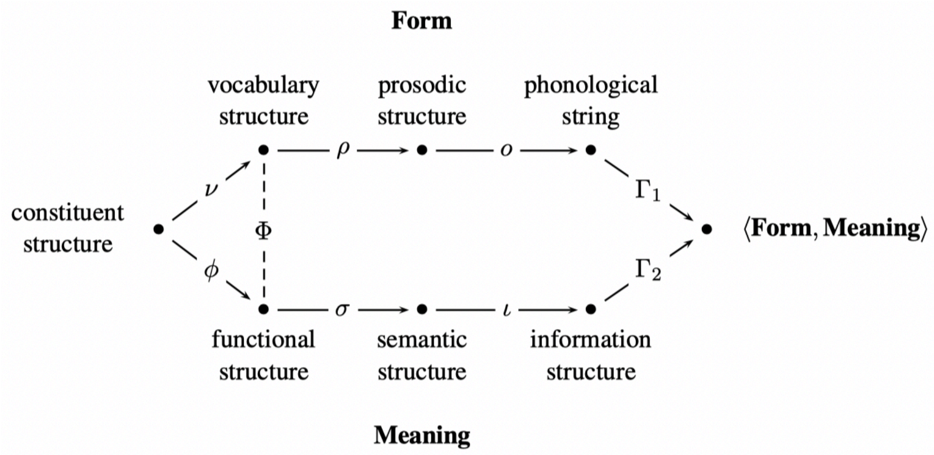


Figure 6: L$_R$FG's version of LFG's Correspondence Architecture. From Melchin et al. (2020: 271); used with permission.

L$_R$FG's version of LFG's Correspondence Architecture is shown in Figure 6, which shows that there is a lot shared between L$_R$FG and LFG. However, there is no lexicon feeding the c-structure in L$_R$FG. Rather, there is a Vocabulary in L$_R$FG that consists of a set of mappings from n-tuples that contain categorial information and an f-description to vocabulary structures that realize the content of the input. In recent L$_{\text{R}}$FG work on morphosemantics (Asudeh & Siddiqi 2022), we suggest that, for the purposes of the ν-mapping, the f-description could be usefully partitioned into a set consisting of information about non-f-structural aspects of the grammar (in particular, Glue meaning constructors for compositional semantics) and the set consisting of the rest of the f-description, which is information about f-structure.[17] The following example shows Vocabulary Items (VIs) for Ojibwe and English roots for *see* (Asudeh & Siddiqi 2022):[18]

(25) Ojibwe

$$\langle\ [\sqrt{}], \Phi\{(\uparrow \text{PRED}) = \text{SEE}\}, \{\mathbf{see} : (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap {\uparrow_\sigma}\}\ \rangle \xrightarrow{\nu} \textit{waab}$$

(26) English

$$\langle\ [\sqrt{}], \Phi\{(\uparrow \text{PRED}) = \text{SEE}\}, \{\mathbf{see} : (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap {\uparrow_\sigma}\}\ \rangle \xrightarrow{\nu} \textit{see}$$

The first coordinate of the input is a list of c-structure categories, typically of length 1. However, it is actually an ordered list of preterminals from the c-structure, such that the list can be longer in cases of *spanning* (Ramchand 2008, Haugen & Siddiqi 2016, Svenonius 2016, Merchant 2015), which is used in some versions of DM for *portmanteau* phenomena. The result is similar to the Lexical Sharing model proposed for LFG by Wescoat (2002, 2005, 2007), but maintains, like DM, that the complex internal structures of words are part of syntax.

In the cases above, the list is of length 1 and has the sole category $\sqrt{}$, the category of all roots. The second coordinate uses the *bridging function*, Φ, to map the f-description to the set of f-structures that it describes. The third coordinate is not subject to Φ and contains semantic information modelled in Glue meaning constructors.

Meaning constructors are pairs of terms from two logics (the colon is an uninterpreted pairing symbol):

(27) $\mathcal{M} : G$

$\mathcal{M}$ is an expression of the *meaning language* — anything that supports the lambda calculus. G is an expression of *linear logic* (Girard 1987), which specifies semantic composition based on a syntactic parse that instantiates the general terms in G to a specific syntactic structure.

The meaning constructors serve as premises in a linear logic proof of the *compositional semantics.* Consider example (28).

[17] The new third coordinate could potentially also include i-structural information; or perhaps this would be better captured in a separate fourth coordinate. We plan to explore this in future work.

[18] We will present the *bridging function*, Φ, shortly.

(28) Alex likes Blake.

We obtain the following meaning constructors from the relevant VIs.

(29) Meaning constructors:

$$\begin{array}{l} \mathbf{alex} : a \\ \mathbf{blake} : b \\ \lambda y.\lambda x.\mathbf{like}(y)(x) : b \multimap a \multimap l \end{array}$$

Note that $\lambda y.\lambda x.\mathbf{like}(y)(x)$ is η-equivalent to just **like**, but it is useful to use the expanded form to make the structure of the following proof more obvious.

(30)

$$\dfrac{\boxed{\mathbf{alex} : a} \qquad \dfrac{\boxed{\lambda y.\lambda x.\mathbf{like}(y)(x) : b \multimap a \multimap l} \qquad \boxed{\mathbf{blake} : b}}{\lambda x.\mathbf{like}(\mathbf{blake})(x) : a \multimap l}}{\mathbf{like}(\mathbf{blake})(\mathbf{alex}) : l}$$

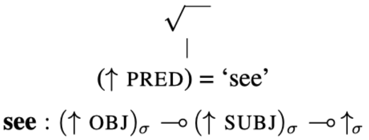
In the proof, the meaning constructors in (29) are shown in boxes to aid the reader less familiar with Glue; this is not a part of the proof as such. It highlights the meaning constructors versus the compositionally derived meanings. For brief overviews of Glue Semantics, see Asudeh (2022); Asudeh 2023 [this volume].

Recall the Vocabulary Item for Ojibwe *waab* in (25):

(31) $\langle\ [\sqrt{\ }], \Phi\{(\uparrow \textsc{pred}) = \textsc{see}\}, \{\mathbf{see} : (\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap {\uparrow_\sigma}\}\ \rangle \xrightarrow{v}$ *waab*

This information can be represented as follows in a c-structure:

(32)



The c-structure is licensed by c-structure rules of the usual kind, but containing categories like $\sqrt{\ }$, which are less familiar in LFG. Thus, the annotated c-structure rule for licensing (32) in a c-structure would be as follows, leaving the mother category underspecified and similarly the sister of $\sqrt{\ }$:

(33)

$$\begin{array}{lccc} \mathrm{X}^n & \longrightarrow & \sqrt{\ } & \mathrm{X}^{m,\ m\leq n} \\ & & \uparrow=\downarrow & \uparrow=\downarrow \end{array}$$

Note that it is X^m that projects the c-structure mother X^n in a co-head structure with $\sqrt{\ }$. Thus, X is necessarily a functional category (Bresnan et al. 2016: ch. 6).

In short, we can think of the lefthand side of a Vocabulary Item as a tree admissibility condition (McCawley 1968) on a subtree whose preterminal yield is the list of categories in the first coordinate of the v function such that the f-description in the second coordinate and the meaning constructors in the third are the union of its terminal yield. Alternatively, we can think of it in terms of terminal expansions, such as:

(34) $$\sqrt{} \longrightarrow \left\{ \begin{matrix} \{(\uparrow \textsc{pred}) = \textsc{see}, \textbf{see} : (\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap \uparrow_\sigma\}, \\ \vdots \end{matrix} \right\}$$

We prefer the tree admissibility route, but observe that whether we go that route or the terminal expansion route, there is no information about form in the input side of the Vocabulary Item. That is the job of the *ν* correspondence function. Recall that *ν* maps the information in c-structure terminals and c-structure categorial information to v-structures, as shown in (25–26).

Here is an example from Ojibwe (*Anishinaabemowin*, Algonquian; Melchin et al. 2020: 288):

(35) Ojibwe
gi- gii- waab -am -igw -naan -ag
2 PST see VTA INV 1PL 3PL
'They saw us(incl).'

The L_RFG c-structure and f-structure and the *ν* correspondence from c-structure to v-structure are shown in Figure 7 (Melchin et al. 2020: 288). Note that we have only shown the form part of each v-structure, and only using an orthographic rather than phonemic representation. V-structures also minimally contain prosodic information — such as information about phonological dependency (e.g., for *clisis*) and the identity of the host (e.g., for *affixation*) — and any purely morphological information (e.g., *inflectional class*). Asudeh et al. (2022) propose the v-structure representation that is schematized in (36).

(36) $$\begin{bmatrix} \textsc{phon(ological)} & \\ \textsc{rep(resentation)} & \textit{phonological realization \& conditions} \\ \textsc{p(rosodic)frame} & \textit{prosodic unit} \\ \textsc{p(rosodic)level} & 1|2 \\ \textsc{dep(endence)} & \{\textsc{left,right}\} \\ \textsc{class} & \{\textit{inflectional classes}\} \\ \textsc{type} & \textsc{verbal}|\textsc{nominal}|\textsc{adjectival} \\ \textsc{host} & \begin{bmatrix} \textsc{identity} \;\; \textsc{aunt}|\textsc{niece} \\ \left\{ \left(\begin{bmatrix} \textsc{phon.rep} & \ldots \\ \textsc{pframe} & \ldots \\ \textsc{plevel} & \ldots \\ \textsc{class} & \ldots \\ \textsc{type} & \ldots \end{bmatrix} \right) \right\} \end{bmatrix} \end{bmatrix}$$

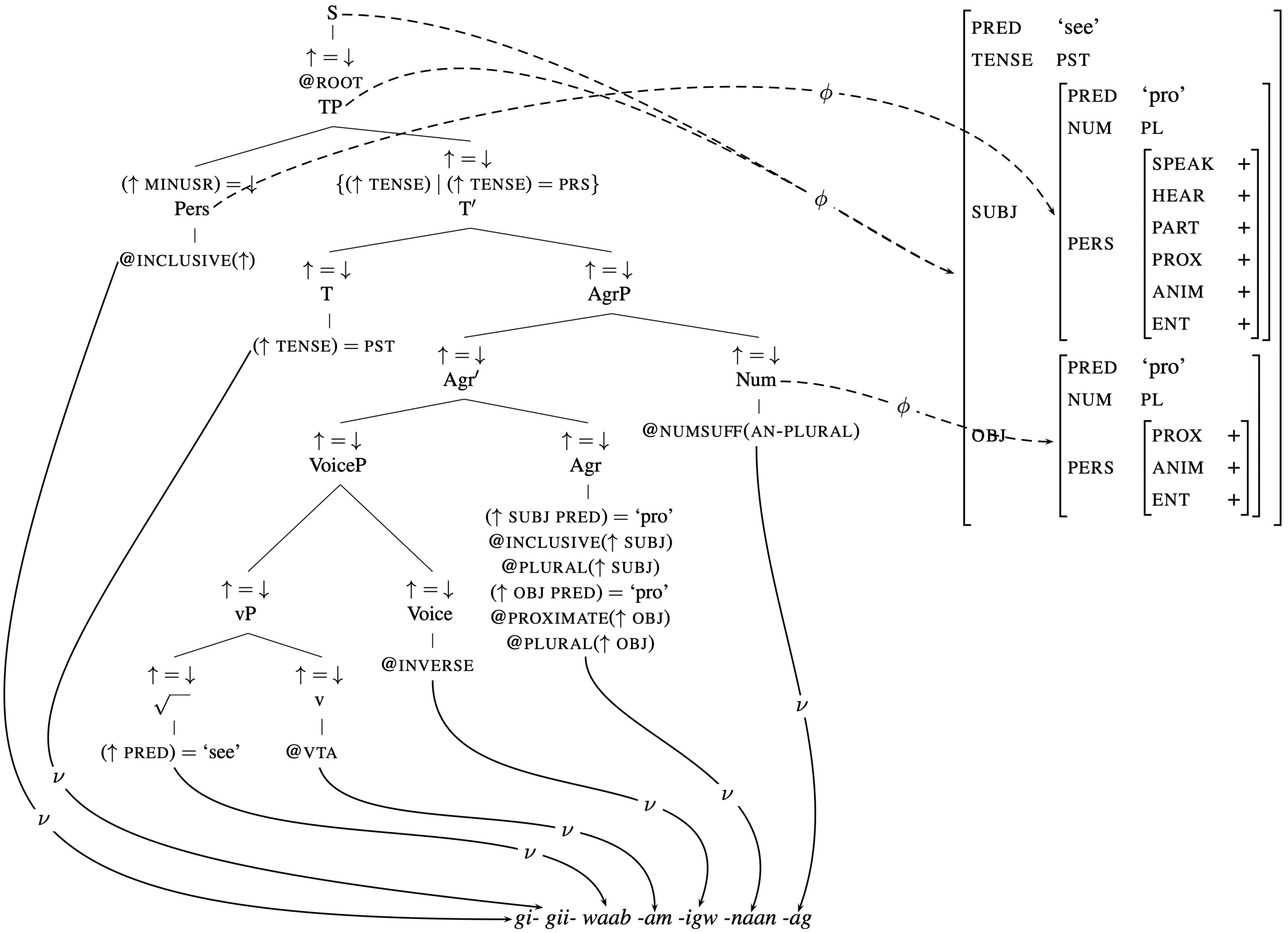


Figure 7: $\mathrm{L_RFG}$ c-structure, f-structure, and (simplified) v-structure for Ojibwe *gigiiwaabamigwnaanag* ('They saw us(incl)')

A v-structure is thus a feature structure that minimally contains information about form and morphophonology (PHON.REP, PFRAME, PLEVEL, and DEP), properly morphological information (CLASS, TYPE), and morphosyntactic information about its HOST, where relevant. All features can be left underspecified (i.e., when they are not mentioned in the description that defines the v-structure).

The obvious point of contrast between L$_R$FG and LFG concerns the Lexicalist Hypothesis (Chomsky 1970, Lapointe 1980):

(37) *Lexicalist Hypothesis*
No syntactic rule can refer to elements of morphological structure.
(Lapointe 1980: 8)

In LFG, this is captured in the *Lexical Integrity Principle*, through formulations like the following:

(38) *Lexical Integrity*
Morphologically complete words are leaves of the c-structure tree, and each leaf corresponds to one and only one c-structure node.
(Bresnan et al. 2016: 92)

This statement has two parts:

1. L$_R$FG *upholds* the part that states that "each leaf corresponds to one and only one c-structure node".
2. L$_R$FG *rejects* the part that states that "morphologically complete words are leaves of the c-structure tree".

Clearly, the c-structure leaves/terminals in L$_R$FG are not "morphologically complete words". The c-structure leaves/terminals are feature bundles that *map* to form, but the form itself is not part of the terminal node; hence 2. Yet there is never multidominance in an L$_R$FG c-structure; hence 1.

However, notice that the notion *morphologically complete word* is left unanalyzed in the definition in (38). In fact, it is far from clear that "morphologically complete word" is a coherent notion (for discussion, see e.g., Anderson 1982). The essential problem is that there are multiple relevant notions of wordhood, and they don't align on a single type of object that we can point to and unambiguously and confidently call a word (Di Sciullo & Williams 1987).[19] In fact, there can be mismatches between the phonological, syntactic, and semantic aspects of words (Marantz 1997). Of course, the LFG Correspondence Architecture is designed around the notion of mismatches between modules, which is carried over into L$_R$FG.

[19] This is a long and broad discussion that we cannot possibly do justice to here.

5.3.1 Conditions on exponence

Recall that the exponence function ($\overset{\nu}{\rightarrow}$) maps a triple to a v-structure. The first argument of the triple is a list of preterminal categories, typically of length 1, which are taken in the linear order they appear in the tree. The second argument is itself a function, Φ, which maps an f-description to the set of f-structures that satisfy the description; i.e. $\Phi(d \in D) = \{f \in F \mid f \vDash d\}$, where D is the set of valid f-descriptions and F is the set of f-structures.[20] The third argument is a set that includes *meaning constructors* from Glue Semantics (Glue; Dalrymple 1999, 2001, Dalrymple et al. 2019, Asudeh 2012, 2022).

Let V^i be the domain of the exponence function ν in some language L, i.e. the set of inputs to Vocabulary Items in L. We write $V^i(\alpha)$ to indicate the domain of some particular Vocabulary Item, α. We write $\pi_n(V^i(\alpha))$ to indicate the nth projection of $V^i(\alpha)$. For example, $\pi_1(V^i(\alpha))$ returns the c-structure list in the first projection of the input to Vocabulary Item α.[21] The following conditions on exponence hold based on the input side of the ν correspondence function (Asudeh & Siddiqi 2022).[22]

(39) **MostInformative**$_c(\alpha, \beta)$ returns whichever of α,β has the longest list of overlapping c-structure categories.
Intuition. Prefer portmanteau forms, whenever possible, on c-structural grounds. Choose the VI that realizes the greater list of categories.

Formalization. We define a function **span** that compares two lists for overlap.[23]
Given two Vocabulary Items, α and β,

$$\textbf{MostInformative}_c(\alpha,\beta) = \begin{cases} \alpha \textbf{ if } \pi_1(V^i(\alpha)) = f \wedge \pi_1(V^i(\beta)) = g \ \wedge \ \textbf{span}(f,g) \\ \beta \textbf{ if } \pi_1(V^i(\alpha)) = f \wedge \pi_1(V^i(\beta)) = g \ \wedge \ \textbf{span}(g,f) \\ \perp \textbf{ otherwise} \end{cases}$$

(40) **MostInformative**$_f(\alpha, \beta)$ returns whichever of α,β has the most specific f-structure in the set of f-structures returned by Φ applied to α/β's collected f-description.

[20] We thank Ron Kaplan (p.c.) for discussion of this point. Any remaining errors are our own.

[21] This π is just standard notation for retrieving arguments to functions and should not be mistaken for a correspondence function.

[22] Note that all these conditions are Paninian, as is typical in morphological analysis. The analog in PFM is actually called Panini's Principle (Stump 2001) and in DM it is called the Subset Principle (Halle & Marantz 1993).

[23] Asudeh & Siddiqi (2022) define **span** as follows:

$$\textbf{span}(list_1, list_2) = \begin{cases} \mathsf{first}(list_1) = \mathsf{first}(list_2) \wedge \ \textbf{span}(\mathsf{rest}(list_1), \mathsf{rest}(list_2)) \\ list_1 \neq elist \ \wedge \ list_2 = elist \end{cases}$$

Intuition. Prefer portmanteau forms, whenever possible, on f-structural grounds. Choose the VI that defines an f-structure that contains the greater set of features.

Formalization. The proper subsumption relation on f-structures (Bresnan et al. 2016: ch. 5) is used to capture the intuition.
Given two VIs, α and β,

$$\mathbf{MostInformative}_f(\alpha,\beta) = \begin{cases} \alpha \textbf{ if } \exists f \forall g. f \in \pi_2(V^i(\alpha)) \wedge g \in \pi_2(V^i(\beta)) \wedge g \sqsubset f \\ \beta \textbf{ if } \exists f \forall g. f \in \pi_2(V^i(\beta)) \wedge g \in \pi_2(V^i(\alpha)) \wedge g \sqsubset f \\ \bot \textbf{ otherwise} \end{cases}$$

(41) **MostInformative**$_s(\alpha,\beta)$ returns whichever Vocabulary Item has the more specific meaning.

Intuition. Prefer portmanteau forms, wherever possible, on semantic grounds. Choose the VI whose denotation is more semantically contentful.

Formalization. The proper subset relation on set-denoting expressions is used to capture the intuition.
Given two Vocabulary Items, α and β,

$$\mathbf{MostInformative}_s(\alpha,\beta) = \begin{cases} \alpha \textbf{ if } f = \pi_3(V^i(\alpha)) \wedge g = \pi_3(V^i(\beta)) \wedge [\![f]\!] \subset [\![g]\!] \\ \beta \textbf{ if } f = \pi_3(V^i(\alpha)) \wedge g = \pi_3(V^i(\beta)) \wedge [\![g]\!] \subset [\![f]\!] \\ \bot \textbf{ otherwise} \end{cases}$$

In addition, there is a constraint on exponence that concerns the output of the ν correspondence function (Asudeh & Siddiqi 2022), i.e. the expression of prosodic and phonological information. Let V^o be the co-domain of the exponence function ν in some language L, i.e. the set of outputs of Vocabulary Items in L. We write $V^o(\alpha)$ to indicate the co-domain of some particular Vocabulary Item, α (i.e., the output vocabulary structure).

(42) **MostSpecific**(α,β) returns whichever Vocabulary Item has the most restrictions on its phonological context.

Intuition. Prefer affixes whenever possible.

Formalization. The proper subsumption relation on feature structures — i.e., v-structures — is used to capture the intuition.
Given two Vocabulary Items, α and β,

$$\mathbf{MostSpecific}(\alpha,\beta) = \begin{cases} \alpha \textbf{ if } (V^o(\beta)\ \textsc{host}) \sqsubset (V^o(\alpha)\ \textsc{host}) \\ \beta \textbf{ if } (V^o(\alpha)\ \textsc{host}) \sqsubset (V^o(\beta)\ \textsc{host}) \\ \bot \textbf{ otherwise} \end{cases}$$

The upshot is that **MostSpecific** chooses the VI whose output v-structure has more specific content in the HOST feature.[24]

Note that **MostInformative**$_c$ and **MostInformative**$_f$ are *morphosyntactic* constraints, **MostInformative**$_s$ is a *morphosemantic* constraint, and **MostSpecific** is a *morphophonological* constraint. Note also that each constraint can result in a tie, represented by $\bot$. However, there are regularities in the mappings/interfaces between structures, so it would be unlikely for all four constraints to yield $\bot$. We are not currently aware of any empirical case that would merit such an analysis. Lastly, it is important to note that these constraints apply simultaneously and universally (whenever they can), much like standard constraints and equations in LFG. There is no constraint-ordering and the constraints are not soft constraints.[25]

In sum, L$_R$FG is a daughter framework of LFG that uses the LFG formalism in a conservative fashion. However, L$_R$FG theory makes some different assumptions from traditional LFG theory. Namely, it rearranges the Correspondence Architecture, adds a new structure with new properties (v-structure), upholds only part of the Lexical Integrity Principle, and has a more articulated c-structure than standard LFG, in order to provide a morphemic theory of morphology. These theoretical distinctions are due to the influence of DM, since L$_R$FG is also a daughter framework of DM.

As its name states, Lexical-Realizational Functional Grammar is a *lexical-realizational* theory of morphology. It is *morphemic*, *Item-and-Arrangement*, and *morphosyntactic*.

6 Conclusion

A feature of LFG is its f-descriptions, which can occur in both lexical entries and on c-structure nodes. The result is that both morphology and syntax can contribute information to f-structure. This 'common language' between morphology and syntax has allowed LFG to remain agnostic about the precise nature of

[24] Note that if (f FEAT) does not exist, (f FEAT) resolves to the empty feature structure, notated $\bot$ (not to be confused with the $\bot$ explicitly mentioned in the constraints above). as it's the bottom of the f-structure lattice. The empty f-structure subsumes all f-structures. Therefore, if (v HOST) does not exist, but (v' HOST) does exist, then (v HOST) $\sqsubset$ (v' HOST) returns true. If (v' HOST) also does not exist, then (v HOST) $\sqsubset$ (v' HOST) returns false, since it is false that $\bot$ *properly* subsumes $\bot$.

[25] An anonymous reviewer wonders what the system would do if one constraint picks α and another picks β. This is an interesting point that deserves further investigation and we thank the reviewer for highlighting it.

morphology. In its initial construal as just a theory of syntax, based around c-structure and f-structure, this was pretty harmless. But once a general grammatical architecture, the Correspondence Architecture, was proposed (Kaplan 1989, 1995), LFG began to owe a better account of how it interfaces with morphology.

In early LFG, morphology was generally done incrementally, using annotated phrase structure rules of the same kind that license c-structures, but whose categories are morphological instead of syntactic. Morphological theory in general, though, has been converging on the idea that morphology is realizational, not incremental. Therefore, more recent work has focused on exploring the syntax–morphology interface (Dalrymple 2015, Dalrymple et al. 2019: ch. 12) in light of an interface with realizational morphology. This work can be thought of as providing a universal adapter between LFG syntax and some kind of realizational morphology. Much of the theoretical work on morphology for LFG over the last couple of decades has focused on interfacing LFG with Paradigm Function Morphology. Other recent work has presented an alternative in the guise of L$_{\text{R}}$FG, a framework that instead interfaces LFG with Distributed Morphology.

The existence of two different approaches to morphological realization in LFG, i.e. PFM and L$_{\text{R}}$FG, mirrors two different interpretations of 'morphological complexity' as a set of phenomena requiring explanation. *Paradigmatic* morphological complexity (see, e.g., Baerman et al. 2017) concerns complex patterns of syncretism, root allomorphy, and templatic morphology. *Syntagmatic* morphological complexity concerns concatenative morphology whose structures seem to encode syntactic structure, in other words structure *within* what we pretheoretically call words. PFM addresses the former kind of morphological complexity, while L$_{\text{R}}$FG addresses the latter.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

INV	inverse voice	VTA	verb transitive animate object
PROP	proprietive case		

References

Ackerman, Farrell & Gregory T. Stump. 2004. Paradigms and periphrastic expression: A study in realization-based lexicalism. In Louisa Sadler & Andrew Spencer (eds.), *Projecting morphology*, 111–157. Stanford: CSLI Publications.

Ackerman, Farrell, Gregory T. Stump & Gert Webelhuth. 2011. Lexicalism, periphrasis, and implicative morphology. In Robert D. Borsley & Kersti Börjars (eds.), *Non-transformational syntax: Formal and explicit models of grammar*, 325–358. Oxford: Wiley-Blackwell. DOI: 10.1002/9781444395037.ch9.

Anderson, Stephen R. 1982. Where's morphology? *Linguistic Inquiry* 13(4). 571–612.

Anderson, Stephen R. 1992. *A-morphous morphology*. Cambridge, UK: Cambridge University Press. DOI: 10.1017/cbo9780511586262.

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

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

Asudeh, Ash. 2012. *The logic of pronominal resumption* (Oxford Studies in Theoretical Linguistics). Oxford: Oxford University Press. DOI: 10.1093/acprof:oso/9780199206421.001.0001.

Asudeh, Ash. 2022. Glue semantics. *Annual Review of Linguistics* 8. 321–341. DOI: 10.1146/annurev-linguistics-032521-053835.

Asudeh, Ash. 2023. Glue semantics. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 651–697. Berlin: Language Science Press. DOI: 10.5281/zenodo.10185964.

Asudeh, Ash, Tina Bögel & Daniel Siddiqi. 2022. Modelling exponents. Presented at MoMOT 2022, UQAM.

Asudeh, Ash, Paul B. Melchin & Daniel Siddiqi. 2021. Constraints all the way down: DM in a representational model of grammar. In *Proceedings of the 39th West Coast Conference on Formal Linguistics*. To appear. Somerville, MA: Cascadilla Press.

Asudeh, Ash & Daniel Siddiqi. 2016. Realizational-Lexical Morphology for LFG. Presented at the Analyzing Morphological Systems Conference, Lyon, France, 20 June, 2016.

Asudeh, Ash & Daniel Siddiqi. 2022. Realizational morphosemantics in L_RFG. In Miriam Butt, Jamie Y. Findlay & Ida Toivonen (eds.), *Proceedings of the LFG '22 conference*, 20–40. Stanford: CSLI Publications. https://ojs.ub.uni-konstanz.de/lfg/index.php/main/article/view/20/20.

Asudeh, Ash & Daniel Siddiqi. Forthcoming. *Constraint-based morphosyntax*. Cambridge, UK: Cambridge University Press. With Oleg Belyaev, Bronwyn M. Bjorkman, Tina Bögel, Michael Everdell, Paul B. Melchin, and Will Oxford.

Baerman, Matthew, Dunstan Brown & Greville G. Corbett. 2017. *Morphological complexity*. Cambridge, UK: Cambridge University Press. DOI: 10.1017/9781316343074.

Baker, Mark C. 1985. The Mirror Principle and morphosyntactic explanation. *Linguistic Inquiry* 16. 373–415.

Baker, Mark C. 1988. *Incorporation: A theory of grammatical function changing*. Chicago: University of Chicago Press.

Baker, Mark C. 2006 [1983]. Objects, themes and lexical rules in Italian. In Miriam Butt & Tracy Holloway King (eds.), *Lexical semantics in LFG*, 11–57. Stanford: CSLI Publications. Originally published as Levin, Rappaport & Zaenen (1983: 1–45).

Beard, Robert. 1995. *Lexeme-morpheme base morphology*. Albany, NY: State University of New York Press.

Becker, Thomas. 1993. Back-formation, cross-formation, and 'bracketing paradoxes' in paradigmatic morphology. In Geert Booij & Jaap Van Marle (eds.), *Yearbook of morphology 1993*, 1–25. Dordrecht: Springer Netherlands. DOI: 10.1007/978-94-017-3712-8_1.

Beesley, Kenneth R. & Lauri Karttunen. 2003. *Finite state morphology*. Stanford: CSLI Publications.

Bhatt, Rajesh. 2005. Long distance agreement in Hindi-Urdu. *Natural Language & Linguistic Theory* 23. 757–807. DOI: 10.1007/s11049-004-4136-0.

Bjorkman, Bronwyn M., Elizabeth Cowper, Daniel Curry Hall, Jennice Hinds, Louise Koren & Dan Siddiqi. 2021. Morphological upstaging and 'markedness'. In Angelica Hernández & Chris Plyley (eds.), *Proceedings of the Canadian Linguistic Association '21*.

Blevins, James P. 2018. *Word and paradigm morphology*. Oxford: Oxford University Press.

Blevins, James P., Farrell Ackerman, Robert Malouf & Michael Ramscar. 2016. Morphology as an adaptive discriminative system. In Daniel Siddiqi & Heidi Harley (eds.), *Morphological metatheory*, 59–94. Amsterdam: John Benjamins. DOI: 10.1075/la.229.10ble.

Bögel, Tina. 2015. *The syntax-prosody interface in Lexical Functional Grammar*. Konstanz: University of Konstanz. (Doctoral dissertation).

Bögel, Tina. 2023. Prosody and its interfaces. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 779–821. Berlin: Language Science Press. DOI: 10.5281/zenodo.10185970.

Booij, Geert. 1996. Inherent versus contextual inflection and the split morphology hypothesis. In Geert Booij & Jaap van Marle (eds.), *Yearbook of morphology 1995*. Dordrecht: Kluwer. DOI: 10.1007/978-94-017-3716-6_1.

Booij, Geert. 2002. *The morphology of Dutch*. Oxford: Oxford University Press. DOI: 10.1093/oso/9780198838852.001.0001.

Booij, Geert. 2010. *Construction morphology*. Oxford: Oxford University Press.

Bresnan, Joan. 1982. The passive in lexical theory. In Joan Bresnan (ed.), *The mental representation of grammatical relations*, 3–86. Cambridge, MA: The MIT Press.

Bresnan, Joan, Ash Asudeh, Ida Toivonen & Stephen Wechsler. 2016. *Lexical-Functional Syntax*. 2nd edn. (Blackwell Textbooks in Linguistics 16). Malden, MA: Wiley-Blackwell.

Butt, Miriam. 1993. A reanalysis of long distance agreement in Urdu. In Joshua S. Guenter, Barbara A. Kaiser & Cheryl C. Zoll (eds.), *Proceedings of the 19th annual meeting of the Berkeley Linguistics Society*, vol. 19, 52–63. DOI: 10.3765/bls.v19i1.1495.

Butt, Miriam, Tracy Holloway King, María-Eugenia Niño & Frédérique Segond. 1999. *A grammar writer's cookbook*. Stanford: CSLI Publications.

Butt, Miriam, María-Eugenia Niño & Frederique Segond. 1996. Multilingual processing of auxiliaries in LFG. In D. Gibbon (ed.), *Natural language processing and speech technology: Results of the 3rd KONVENS conference*, 111–122. Berlin: Mouton de Gruyter.

Caballero, Gabriela. 2008. *Choguita Rarámuri (Tarahumara) phonology and morphology*. University of California, Berkeley. (Doctoral dissertation).

Caballero, Gabriela & Sharon Inkelas. 2013. Word construction: Tracing an optimal path through the lexicon. *Morphology*. DOI: 10.1007/s11525-013-9220-x.

Caha, Pavel. 2009. *The nanosyntax of case*. University of Tromsø. (Doctoral dissertation).

Chomsky, Noam. 1957. *Syntactic structures*. The Hague: Mouton. DOI: 10.1515/9783110218329.

Chomsky, Noam. 1965. Formal properties of grammars. In Duncan Luce, Robert Bush & Eugene Galanter (eds.), *Handbook of mathematical psychology*, vol. 2, 323–418. New York: Wiley & Sons.

Chomsky, Noam. 1970. Remarks on nominalization. In Roderick A. Jacobs & Peter S. Rosenbaum (eds.), *Readings in English transformational grammar*, 184–221. Waltham, MA: Ginn.

Dalrymple, Mary (ed.). 1999. *Semantics and syntax in Lexical Functional Grammar: The resource logic approach* (Language, Speech, and Communication). Cambridge, MA: The MIT Press. DOI: 10.7551/mitpress/6169.001.0001.

Dalrymple, Mary. 2001. *Lexical Functional Grammar* (Syntax and Semantics 34). New York: Academic Press. DOI: 10.1163/9781849500104.

Dalrymple, Mary. 2015. Morphology in the LFG architecture. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG '15 conference*, 64–83. Stanford: CSLI Publications.

Dalrymple, Mary, John J. Lowe & Louise Mycock. 2019. *The Oxford reference guide to Lexical Functional Grammar*. Oxford: Oxford University Press. DOI: 10.1093/oso/9780198733300.001.0001.

Dalrymple, Mary & Louise Mycock. 2011. The prosody-semantics interface. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG '11 conference*, 173–193. Stanford: CSLI Publications.

Dench, Alan. 1995. *Martuthunira: A language of the Pilbara Region of Western Australia*. Canberra: Pacific Linguistics.

Di Sciullo, Anna Maria & Edwin Williams. 1987. *On the definition of word* (Linguistic Inquiry Monographs 14). Cambridge, MA: The MIT Press.

Everdell, Michael, Paul B. Melchin, Ash Asudeh & Daniel Siddiqi. 2021. Beyond c-structure and f-structure: On the argument-adjunct distinction in O'dam. In Miriam Butt, Jamie Y. Findlay & Ida Toivonen (eds.), *Proceedings of the LFG '21 conference*, 125–145. Stanford: CSLI Publications. https://csli-publications.stanford.edu/LFG/LFG-2021/lfg2021-emas.pdf.

Falk, Yehuda N. 2001. *Lexical-Functional Grammar: An introduction to parallel constraint-based syntax*. Stanford: CSLI Publications.

Forst, Martin & Tracy Holloway King. 2023. Computational implementations and applications. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 1083–1123. Berlin: Language Science Press. DOI: 10.5281/zenodo.10185986.

Frank, Anette & Annie Zaenen. 2002. Tense in LFG: Syntax and morphology. In Hans Kamp & Uwe Reyle (eds.), *How we say WHEN it happens: Contributions* *to the theory of temporal reference in natural language*. Reprinted in Sadler & Spencer (2004: 23-66). Tübingen: Niemeyer. DOI: 10.1515/9783110923537.

Girard, Jean-Yves. 1987. Linear logic. *Theoretical Computer Science* 50. 1–102. DOI: 10.1016/0304-3975(87)90045-4.

Halle, Morris & Alec Marantz. 1993. Distributed morphology and the pieces of inflection. In Kenneth Hale & Samuel Jay Keyser (eds.), *The view from Building 20: Essays in linguistics in honor of Sylvain Bromberger*, 111–176. Cambridge, MA: The MIT Press.

Harris, Alice C. 2016. *Multiple exponence*. Oxford: Oxford University Press. DOI: 10.1093/acprof:oso/9780190464356.001.0001.

Haspelmath, Martin & Andrea Sims. 2010. *Understanding morphology*. 2nd edn. New York: Routledge. DOI: 10.4324/9780203776506.

Haugen, Jason D. & Daniel Siddiqi. 2016. Towards a restricted realizational theory: Multimorphemic monolistemicity, portmanteaux, and post-linearization spanning. In Daniel Siddiqi & Heidi Harley (eds.), *Morphological metatheory*, 343–386. Amsterdam: John Benjamins. DOI: 10.1075/la.229.12hau.

Hockett, Charles. 1954. Two models of grammatical description. *Word* 10(2–3). 210–234. DOI: 10.1080/00437956.1954.11659524.

Inkelas, Sharon. 2016. Affix ordering in Optimal Construction Morphology. In Daniel Siddiqi & Heidi Harley (eds.), *Morphological metatheory*, 479–511. Amsterdam: John Benjamins. DOI: 10.1075/la.229.16ink.

Inkelas, Sharon, Teresa McFarland & Anne Pycha. 2006. The flip side of blocking: Multiple exponence in an optimization framework. Unpublished manuscript, University of California, Berkeley.

Ishikawa, Akira. 1985. *Complex predicates and lexical operations in Japanese*. Stanford: Stanford University. (Doctoral dissertation).

Joshi, Aravind K., K. Vijay-Shanker & David Weir. 1991. The convergence of mildly context-sensitive formalisms. In Peter Sells, Stuart M. Shieber & Thomas Wasow (eds.), *Foundational issues in natural language processing*. Cambridge, MA: The MIT Press.

Kaplan, Ronald M. 1989. The formal architecture of Lexical-Functional Grammar. *Journal of Information Science and Engineering* 5. 305–322. Revised version published as Kaplan (1995).

Kaplan, Ronald M. 1995. The formal architecture of Lexical-Functional Grammar. In Mary Dalrymple, Ronald M. Kaplan, John T. III Maxwell & Annie Zaenen (eds.), *Formal issues in Lexical-Functional Grammar*, 7–27. Stanford: CSLI Publications. Earlier version published as Kaplan (1989).

Kaplan, Ronald M. & Martin Kay. 1994. Regular models of phonological rule systems. *Computational Linguistics* 20. 331–478.

Kiraz, George Anton. 2001. *Computational nonlinear morphology: With emphasis on Semitic languages*. Cambridge, UK: Cambridge University Press.

Lapointe, Steven. 1980. *A theory of grammatical agreement*. University of Massachusetts, Amherst. (Doctoral dissertation).

Levin, Lori S., Malka Rappaport & Annie Zaenen (eds.). 1983. *Papers in Lexical-Functional Grammar*. Bloomington, IN: Indiana University Linguistics Club.

Luís, Ana & Ricardo Bermúdez-Otero (eds.). 2016. *The morphome debate*. Oxford: Oxford University Press. DOI: 10.1093/acprof:oso/9780198702108.001.0001.

Maiden, Martin. 2018. *The Romance verb: Morphomic structure and diachrony*. Oxford: Oxford University Press.

Marantz, Alec. 1997. No escape from syntax: Don't try morphological analysis in the privacy of your own lexicon. *University of Pennsylvania Working Papers in Linguistics* 4(2).

Masini, Francesca & Jenny Audring. 2018. Construction morphology. In *The Oxford handbook of morphological theory*, 365–389. Oxford: Oxford University Press. DOI: 10.1093/oxfordhb/9780199668984.013.25.

McCarthy, John J. & Alan Prince. 1993. Generalized alignment. In Geert Booij & Jaap van Marle (eds.), *Yearbook of morphology*, 79–153. Dordrecht: Kluwer Academic Publishers. DOI: 10.1007/978-94-017-3712-8_4.

McCawley, James D. 1968. Concerning the base component of a transformational grammar. *Foundations of Language* 4(3). 243–269.

Melchin, Paul B., Ash Asudeh & Daniel Siddiqi. 2020. Ojibwe agreement in Lexical-Realizational Functional Grammar. In Miriam Butt & Ida Toivonen (eds.), *Proceedings of the LFG '20 conference*, 268–288. Stanford: CSLI Publications. https://csli-publications.stanford.edu/LFG/LFG-2020/lfg2020-mas.pdf.

Merchant, Jason. 2015. How much context is enough? Two cases of span-conditioned stem allomorphy. *Linguistic Inquiry* 46(2). 273–303. DOI: 10.1162/ling_a_00182.

Mycock, Louise & John J. Lowe. 2013. The prosodic marking of discourse functions. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG '13 conference*, 440–460. Stanford: CSLI Publications.

Nordlinger, Rachel. 1997. *Constructive case: Dependent-marking nonconfigurationality in Australia*. Stanford: Stanford University. (Doctoral dissertation).

Nordlinger, Rachel. 1998. *Constructive case: Evidence from Australian languages*. Stanford: CSLI Publications.

Orgun, Cemil Orhan & Ronald L. Sprouse. 1999. From "MParse" to "Control": Deriving ungrammaticality. *Phonology* 16(2). 191–224. DOI: 10.1017/s0952675799003747.

Partee, Barbara H., Alice ter Meulen & Robert E. Wall. 1990. *Mathematical methods in linguistics*. Dordrecht: Kluwer Academic Publishers. DOI: 10.1007/978-94-009-2213-6.

Prince, Alan & Paul Smolensky. 2004. *Optimality theory: Constraint interaction in Generative Grammar*. Oxford/Malden: Blackwell. DOI: 10.1002/9780470759400.

Ramchand, Gillian. 2008. *Verb meaning and the lexicon: A first phase syntax*. Cambridge, UK: Cambridge University Press. DOI: 10.1017/cbo9780511486319.

Roark, Brian & Richard Sproat. 2007. *Computational approaches to morphology and syntax*. Oxford: Oxford University Press.

Sadler, Louisa & Rachel Nordlinger. 2004. Relating morphology to syntax. In Louisa Sadler & Andrew Spencer (eds.), *Projecting morphology*, 159–186. Stanford: CSLI Publications.

Sadler, Louisa & Rachel Nordlinger. 2006. Case stacking in realizational morphology. *Linguistics* 44(3). 459–487. DOI: 10.1515/ling.2006.016.

Sadler, Louisa & Andrew Spencer (eds.). 2004. *Projecting morphology*. Stanford: CSLI Publications.

Selkirk, Elisabeth O. 1982. *English word structure*. Cambridge, MA: The MIT Press.

Spencer, Andrew. 2013. *Lexical relatedness: A paradigm-based model*. Oxford: Oxford University Press.

Spencer, Andrew. 2015. Participial relatives in LFG. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG '15 conference*, 378–398. Stanford: CSLI Publications.

Starke, Michal. 2009. Nanosyntax: A short primer to a new approach to language. *Nordlyd* 36(1). 1–6.

Stewart, Thomas & Gregory T. Stump. 2007. Paradigm Function Morphology and the morphology–syntax interface. In Gillian Ramchand & Charles Reiss (eds.), *The Oxford handbook of linguistic interfaces*, 383–421. Oxford: Oxford University Press. DOI: 10.1093/oxfordhb/9780199247455.013.0013.

Stump, Gregory T. 2001. *Inflectional morphology: A theory of paradigm structure*. Cambridge, UK: Cambridge University Press. DOI: 10.1017/cbo9780511486333.

Stump, Gregory T. 2016. *Inflectional paradigms: Content and form at the syntax-morphology interface*. Cambridge, UK: Cambridge University Press.

Svenonius, Peter. 2016. Spans and words. In Daniel Siddiqi & Heidi Harley (eds.), *Morphological metatheory*, 201–222. Amsterdam: John Benjamins. DOI: 10.1075/la.229.07sve.

Thomas, Amanda. 2021. *Divergence and mismatches in Portuguese morphology and syntax*. University of Oxford. (D.Phil. Thesis).

Trommer, Jochen. 2016. A postsyntactic morphome cookbook. In Daniel Siddiqi & Heidi Harley (eds.), *Morphological metatheory*, 59–94. Amsterdam: John Benjamins. DOI: 10.1075/la.229.03tro.

Wescoat, Michael T. 2002. *On lexical sharing*. Stanford: Stanford University. (Doctoral dissertation).

Wescoat, Michael T. 2005. English nonsyllabic auxiliary contractions: An analysis in LFG with lexical sharing. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG '05 conference*, 468–486. Stanford: CSLI Publications.

Wescoat, Michael T. 2007. Preposition-determiner contractions: An analysis in Optimality-Theoretic Lexical-Functional Grammar with lexical sharing. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG '07 conference*, 439–459. Stanford: CSLI Publications.