

Minimalism and morphology*

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1 Introduction

The Minimalist Program (MP) has a fraught relationship with morphology, especially MP as represented in Chomsky’s own works. On the one hand, MP heaps a large empirical and theoretical burden onto morphology: morphology in a pre-syntactic (lexicon-internal) sense is the driver of all syntactic variation across languages, via features of lexical items (the Borer conjecture; Borer 1984);¹ morphology in a post-syntactic sense (operating over the output of syntax²) is responsible for all “complexity and variety” (Chomsky 2014:xi) in how syntactic structures are externalized, via a “Morphology module” in the phonological component (see, e.g., discussion in Chomsky 1995:Ch. 4). And yet, despite morphology bearing the outsized burden of explaining why languages actually look the way they do, MP over the years has given relatively little consideration to developing a theory of the lexicon or of the phonological component.

On the lexicon, MP (narrowly construed) makes few commitments. The lexicon is taken to include unitary collections (lexical items) built from features that are made available by Universal Grammar (UG), encoding only “exceptions”, properties unique to a given item. Lexical items, in the simplest and most general case, consist of phonological features (relevant for the phonological component), semantic features (relevant for semantic interpretation), and formal features (relevant for narrow syntax). While semantic features and formal features overlap, the latter proprietarily includes so-called uninterpretable (unvalued) features, which drive the syntactic derivation, as they must be (valued and) “deleted” in order for the derivation to converge. Every syntactic derivation draws from a “lexical array”, a one-time

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¹On the Borer conjecture, which MP largely adopts, Chomsky states that “parametric variation is restricted to the lexicon, and insofar as syntactic computation is concerned, to a narrow category of morphological properties, primarily inflectional” (Chomsky 2001:2). Further, “Minimalist assumptions suggest that the property [of displacement] should be reduced to morphology-driven movement” (Chomsky 1995:204).

²See Chapters 46-47 of this volume on the nature of spell-out.

collection of lexical items that may be accessed in the course of the derivation, reconceptualized in more recent work as part of the “workspace” (see, e.g., Chomsky 2020 and Chapter 51 of this volume). We won’t have much more to say about the lexicon in this chapter, but offer a number of references to the interested reader: see Pustejovsky and Batiukova 2019 for a recent overview of the lexicon across theoretical frameworks; for MP-driven work on the lexicon, see Ramchand 2008 and Pietroski 2018; and for more on features in MP, see Adger and Svenonius 2011 and Svenonius 2019, as well as Chapters 37-38 in this volume.

On the nature of the phonological component, Chomsky states he will “henceforth ignore” (Chomsky 1995:155) such concerns or at best “have little to say” (Chomsky 1995:210). The phonological component is explicitly taken to be “‘extraneous’ to language, relating to externalization by systems with nonlinguistic properties and capable of much variation while [the faculty of language] remains fixed” (Chomsky 2000:118), and “having nothing particular to do with core elements of language design” (Chomsky 2014:xi). Indeed, Chomsky (1995) several times alludes to the ridiculousness of even entertaining the possibility that morphology works the same across languages, quoting Jespersen, who famously said “no one ever dreamed of a universal morphology.” Chomsky does occasionally concede that “there are doubtless constraints on how externalization takes place” (Chomsky 2014:xi), but nevertheless, the implication is clear: UG is for syntax, while morphology is a grab bag of exceptions, arbitrariness, and relatively unconstrained variation.³

Prior to the rise of Minimalism, most work in morphology/syntax assumed that words were the atoms of syntax, and that the morphological module stood on its own, without any meaningful interaction with syntax;⁴ for example, see Chomsky 1970, Jackendoff 1972, Wasow 1977, Allen 1979, Roeper and Siegel 1978, Lapointe 1980, Lieber 1980, Kiparsky 1982, di Sciullo and Williams 1987, Spencer 1991, Bresnan and Mchombo 1995. Coinciding with the early days of Minimalist theorizing, Distributed Morphology (DM) was born (Halle and Marantz 1993, 1994), which takes “morphology” to begin with/in the syntax. On this view (not unique to DM), it is *morphemes* that are the atoms of syntax, and syntax provides the basis for all word formation, which may take place in or after the syntax. In the midst of these developments, early Minimalism threw its hands up and adopted a worst-case scenario morphology combining approaches, allowing for word formation and morphological processes to take place pre-syntactically, syntactically, and post-syntactically. Considering an inflected verb, for example, Chomsky (1995:219) states that “its tense and ϕ -features might be chosen optionally and assigned to the word as it enters the numeration, or they might result from overt V-raising to Agr and T. Or the word might reach the phonological component uninflected, the PF form resulting from interaction with functional elements

³Though see Samuels 2011 for an MP-driven account of the phonological component, pursuing the idea that (morpho)phonology is an ideal solution to mapping syntactic structures to the Sensory-Motor system. This work is in a number of respects compatible with what we have to say here. See also Samuels’ chapter on externalization in this volume, Chapter 5.

⁴Some exceptions to this generalization bear mentioning. First are Chomsky’s early works (e.g., Chomsky 1957, Chomsky and Halle 1968), in which the syntax is responsible for building both words and higher-level syntactic structure, and phonological forms (at least for inflectional morphemes) are supplied after the syntactic structure is built; these assumptions are quite like those of Distributed Morphology. Second are morphological theories that adopt what is known as the Split Morphology Hypothesis (e.g., Anderson 1982, 1992), where derivational morphology and inflectional morphology belong to different parts of the grammar, with the latter being introduced (at least featurally) in the syntax.

within the phonological component. The answers could vary across or within languages.”

In the almost three decades since the earliest work in MP, the field’s perspective on the morphology-syntax interface has changed substantially. The empirical and theoretical picture has become much more nuanced, and we now ask much more fine-grained questions about interactions among syntax, morphology, and phonology, as well as interactions between phenomena that sit at their interface(s).⁵ Some of these changes in perspective are reflected in later MP, including MP moving away from a model where words are built in a generative lexicon (though MP still shies away from making many commitments in this area).

The change of perspective in the field was undoubtedly facilitated by a number of related developments, especially: (a) MP’s adoption of valuation (via Agree) as opposed to checking (via a spec-head relationship), allowing for dynamic feature valuation and feature interactions during the course of the syntactic (and post-syntactic) derivation (see Chapters 23-27 of this volume); (b) the rise of DM, which in many ways blurred the distinction between syntactic and morphological processes and provided a novel toolset for describing and understanding the vast expanse of morphosyntactic diversity in the world’s languages; and (c) an explosion of empirical research into morphosyntactic phenomena, which has provided a fruitful testing ground for morphological theory, including DM but also others—see, e.g., Nanosyntax (Starke 2009, Caha 2009, 2020, and Chapter 9 of this volume) and Paradigm Function Morphology (Stump 2001, 2016). We do not attempt to do justice here to this rich body of literature and what it has uncovered about morphosyntactic variation.

In this chapter, we consider the *other* side of morphology, the one that early MP suggested might simply not exist. We ask, what (if anything) is universal about the morphology—in particular, the morphological engine—of human languages? In answering this question, we will see that research in the past few decades has pushed us significantly forward, offering (we argue) a resounding “yes” to the existence of universal principles of morphology. We consider and defend three specific candidates for universal aspects of morphology: late insertion (§2), bottom-up insertion (§3), and domains/cycles (§4). Finally, we step back and consider what we’ve gained through these developments (§5).

2 Late insertion

Most morphological theories of the past 30 years are *realizational* in nature, meaning that they take the abstract pieces/features that make up a word to be separate from—and logically prior to—the phonological exponents of those pieces/features. The core motivation for realization comes from the observation that natural language morphology lacks strict one-to-one mappings of form to meaning/function, e.g., the especially common phenomena of syncretism (one exponent, many meanings/functions) and allomorphy (many exponents, one meaning/function), which we will elaborate on in the coming sections.

A proper subset of realizational theories adopt what is referred to in the literature as *late insertion*: phonological realization (which we also will refer to as *exponence*) operates over structures built in the (narrow) syntax, with syntax being the primary structure-building engine of the grammar, both for words and phrases/clauses. To put it another way: syntax

⁵For some examples of this type of inquiry, see Chapters 12-13 of this volume.

feeds realization, hence insertion of phonological exponents is “late”. Late insertion is exemplified most prominently today by DM and Nanosyntax. (For an overview of the technical way that DM implements late insertion, see Chapter 48 of this volume.)

In The Minimalist Program, Chomsky positions himself as open to late insertion, on the basis of phonologically-suppletive forms like the English copula (*be, is, am, are, was, were*), but resistant to its universality, asserting that “it would be a methodological error to generalize the worst case [(late insertion)] to all cases—to infer from the fact that the worst case exists that it holds for all lexical items” (Chomsky 1995:220). In later Minimalist work, Chomsky continues in this vein, holding that early insertion and late insertion co-exist: “In the simplest case, the entry L[lexical] I[tem] is a once-and-for-all collection (perhaps structured) of (A) phonological, (B), semantic, and (C) formal features. [...] Lex is distributed when departure from the simplest account is warranted in favor of late insertion, typically for inflectional elements and suppletion” (Chomsky 2001:10-11).

In addition to a complexity-based argument against the Minimalist model mixing early and late insertion, there is actually a diverse array of other of motivations for positing uniform late insertion. In this section, we will discuss support for late insertion from (i) the role of syntax in word formation and exponence (§2.2, and also §2.3.4), (ii) the nature of exponents/exponence (§2.3), and (iii) the lack of phonological effects in syntax (§2.4). As we will see, a number of unrelated and otherwise mysterious crosslinguistic generalizations/observations fall out naturally given a late insertion theory. While non-late insertion theories can handle many of these observations in one way or another, under such models it is an accident that all the observations point to (indeed, in many cases are predicted by) late insertion.

We therefore put forward late insertion as our first candidate for a universal principle of natural language morphology. Before turning to arguments for late insertion, we first briefly lay out a typology of morphological theories (§2.1) that we will refer back to many times.

2.1 Late insertion in the context of morphological theory

Since the variety of morphological models that have been proposed in the literature is so vast (see Stewart 2016 for an attempt to list and discuss the most prominent ones), we want to define some relevant dimensions along which morphological theories can differ and, in doing so, clarify some of the terminology we will use. This terminology and basic typology of theories will help us be clear about which types of theories our different arguments for late insertion apply to. We differentiate theories along two dimensions:⁶ (i) where in the grammar words are built, and (ii) whether phonological exponents *introduce* (are tied directly to) meaning/features or *reflect* meaning/features.

With respect to (i), we make three distinctions: whether words are built (a) separate from (and potentially before) the syntax, (b) in the syntax only, or (c) in the syntax and post-syntax. Theories taking the (a) position are known as *lexicalist*,⁷ in that some/all words

⁶This classification is of course not exhaustive. See e.g. Stump 2001, Stewart 2016 for other important dimensions along which theories differ. Stump (2001) for example also classifies theories as to whether they assume the independent existence of affixal morphemes in the lexicon, an issue we do not address directly in this chapter, though this is generally assumed in late insertion theories.

⁷This term comes from the Lexicalist Hypothesis (Chomsky 1970), which states that the syntax manip-

are formed in one or more components of the grammar (including at least the lexicon) that are wholly separate from the syntax; such theories may be piece-based (taking words to be formed via concatenation of discrete pieces) or process-based (taking words to be formed via the sequential application of processes/rules). Theories taking the (b) and (c) positions hold that the atoms of syntax are smaller than words, at the size of what we will refer to as morphemes (roots and morphosyntactic features); such theories are *non-lexicalist*, and are inherently piece-based.

With respect to (ii), we are referring to the crucial differentiation among morphological theories termed by Stump (2001:Ch. 1) the *incremental* vs. *realizational* distinction. In incremental theories, the form of a word is tied directly to additive phonological pieces/processes that introduce meaning/features into the word, and thus words are built up *incrementally*. In realizational theories, on the other hand, the phonological form of a word reflects (hence, *realizes*) meaning/features that are independently given, either at the word level or at the morpheme level. (See also our brief discussion of realization at the outset of this section.)

Cross-classifying the two dimensions above, we arrive at the basic typology of morphological theories shown in Table 1; please note that the list of theories in this table is very far from exhaustive.

| | Lexicalist | Non-lexicalist | |
|----------------------|--|---|--|
| | <i>Non-syntactic word formation</i> | <i>Syntactic word formation</i> | <i>(Post-)syntactic word formation</i> |
| Incremental | Aronoff 1976; Wunderlich 1996; Stiebels 2002 | Lieber 1992; Collins & Kayne 2021 | (<i>unattested?</i>) |
| Realizational | Anderson 1992, 2005; Aronoff 1994; Beard 1995; Stump 2001, 2016; Müller 2021 | Starke 2009; Caha 2009, 2020; Bruening 2017 | Noyer 1992; Halle & Marantz 1993, 1994 |

Table 1: A typology of morphological theories

Lexicalist models featured in Table 1—some incremental, some realizational—include variations of A-morphous/Affixless Morphology (Aronoff 1976, 1994, Anderson 1992, 2005, Beard 1995), Minimalist Morphology (Wunderlich 1996, Stiebels 2002), Paradigm Function Morphology (Stump 2001, 2016), and Harmonic Serialism-based morphology (Müller 2021). Non-

ulates words, and is not in the business of manipulating word-internal structures. The (in)adequacy of the Lexicalist Hypothesis has been the subject of a long-standing and heated debate (see amongst many others, Lapointe 1980, Williams 1981, Bresnan 1982, Baker 1985, 1988, di Sciullo and Williams 1987, Bresnan and Mchombo 1995, Borer 2005, Stewart and Stump 2007, Bruening 2018, Müller 2018) and we will largely refrain from discussing its implications in what follows.

We also want to note that lexicalist theories are very diverse—as one of our reviewers aptly put it, “there are many shades of lexicalism”. In addition, the term *lexicalism* itself is a moving target, used in very different senses by different authors. We refer the reader to the excellent discussion of different aspects of lexicalism in Fábregas and Putnam 2020:22ff, which draws much more fine-grained distinctions than we are making here. For example, they distinguish among the following (logically-independent) aspects of (non-)lexicalism: whether the syntax can manipulate sub-word elements; whether elements drawn from the lexicon impose their will on the syntax; whether inflectional elements are introduced in the lexicon or in the (post-)syntax (see also our fn. 4); and whether (and to what extent) the syntax is involved in determining wordhood.

lexicalist models may be incremental or realizational as well, and we take the term *late insertion* in its conventional use to pick out just the realizational ones, i.e., the bottom right two cells of Table 1. The models included in these cells are DM (Noyer 1992, Halle and Marantz 1993, 1994), Nanosyntax (Starke 2009, Caha 2009), and Consolidated Morphology (Bruening 2017). (We refer the reader to Bobaljik 2017 and Baunaz and Lander 2018 for accessible overviews of DM and Nanosyntax, respectively.) Non-lexicalist models may instead be incremental in nature, and here we have included Word Syntax (Lieber 1992) and Morphology as Syntax (Collins and Kayne 2021) as examples of such frameworks; note that while we know of no incremental models that propose that word-formation can be post-syntactic, such a possibility is not ruled out conceptually.

As a caveat with respect to Table 1, it's important to note that frameworks vary widely in terms of how exactly word formation happens, and (in the case of non-lexicalist theories) what it means for word formation to be syntactic. In Lieber's Word Syntax and Bruening's Consolidated Morphology, for example, though complex words are built using syntactic operations, there is no substantial interaction between syntactic elements above and below the X^0 level (apart from licensing relationships). In contrast, in Distributed Morphology, such interactions abound, and in Nanosyntax, the distinction between above X^0 and below X^0 is non-existent. This difference among non-lexicalist theories—with respect to the degree of integration of morphology and syntax—will be relevant a number of times throughout this section, as some arguments point specifically to the need for a truly integrated syntax and morphology; this is especially true of the arguments in §2.2.

In the remainder of this section, we will present a variety of arguments for late insertion. The reader will soon see that any individual argument (taken apart from the others) is generally relevant for just one particular dimension of contrast in Table 1, namely, providing support for (i) non-lexicalist models (§2.2), or (ii) realizational models (§2.3); note that in some cases, an argument may cross-cut the classifications in Table 1, and if so, we specifically discuss this as well. Combining *all* the evidence, including the phonology-free nature of syntax (§2.4), is what triangulates to support late insertion.

2.2 Arguments for non-lexicalist models

In this section, we present a series of arguments for non-lexicalist models, i.e., models that take words to be formed in the syntax (and potentially also the post-syntax), rather than being wholly or partially formed in a dedicated module of the grammar. (See Table 1.)

2.2.1 The role of syntax in word formation

The most basic argument for an integrated syntax and morphology comes from the fact that word-internal structure commonly recapitulates (matches) syntactic structures/processes, an observation referred to as the Mirror Principle (Baker 1985). For example, in Quechua, the relative closeness of the causative and reciprocal morphemes to the verb root correlates with whether the arguments of the root are coindexed with each other (reciprocal inside causative) or whether the causer is co-indexed with one of the root's arguments (causative inside reciprocal); for more details, see Baker 1985:374f, who draws on observations and data from Muysken 1981a,b. Along similar lines, the relative closeness of tense, aspect, and mood

morphemes to the verb root correlate with their proposed syntactic/semantic hierarchy (see, e.g., Demirdache and Uribe-Etxebarria 2000, Julien 2002). Such Mirror Principle obeying orders are found across morphosyntactic and semantic domains.

The simplest way to account for the observation that word-internal structures generally obey the Mirror Principle is to have the morphological form of words fall out directly from the syntactic structure. Any other solution that aims to capture the Mirror Principle needs to duplicate structure-building operations, either in anticipation of the syntax, in parallel to the syntax, or as a recapitulation of the syntax, which in turn may necessitate (as it does in early Minimalism) a complex “checking” procedure. Even some of the non-lexicalist models we discussed above—those that lack a truly integrated syntax and morphology, like Consolidated Morphology and Word Syntax—also need a checking procedure.

The potential wrinkle, of course, comes from cases where the Mirror Principle seems to be violated—when morphological form does not (transparently, at least) match syntactic structure. However, it has been argued (compellingly, in our opinion) that such apparent morphological deviations from syntactic structure are still highly syntactically constrained. For example, different types of syntactic movements might interact to give the appearance of a Mirror Principle violation when there actually isn’t one (e.g., Speas 1991, Rice 2000, Cinque 2005, Koopman 2017, Myler 2017). Or, syntactic movement might interact with a later (syntactically constrained) morphological operation that obscures the underlying structure (e.g., Embick and Noyer 2001, Barragan 2003, Harris and Halle 2005, Arregi and Nevins 2012, Harley 2013, Guseva and Weisser 2018, Kalin 2020). There also appear to be syntax-morphology mismatches in terms of constituency, in particular where a morphological constituent does not correspond to a syntactic one. This is famously the case for English tensed verbs, though, again, morphological wordhood is still conditioned by syntactic factors (see discussion in Bobaljik 2017). Importantly, then, even when morphological form and syntactic structure are misaligned, they are best understood in a model where syntax is involved in word formation, prior to and constraining other operations.

As an example of syntax-morphology misalignment, consider Wolof factive relative clauses (Torrence 2021). In Wolof, what Torrence calls *bi*-factives involve a sort of copying operation, where instead of a head noun in the relative clause, there is a copy of the embedded verb, e.g., (1) (verb copy bolded):

- (1) Réccu-na-a [**naan** b-i ma naan diwtiir g-i]
 regret-FIN-1SG **drink** CL-C_{REL} 1SG drink palm.oil CL-the
 ‘I regret (the fact) that I drank the palm oil.’

Torrence shows that what gets copied in the head noun position can actually correspond to a larger syntactic constituent, including e.g. the object; Torrence analyzes this as due to the movement of a null FACT noun that pied pipes phrasal material along with it. Most relevantly for our purposes, high inflectional material—even when it morphologically joins with the verb—cannot be pied piped, (2) (copied material again bolded):

- (2) **dàgg-e(*-woon)** yoxos paaka b-i Awa dàgg-e-woon yoxos paaka
 cut-INSTR(-PAST) oyster knife CL-C_{REL} Awa cut-INSTR-PAST oyster knife
 ‘the fact that Awa cut an oyster with a knife’

In (2), the verb, the instrumental suffix on the verb, the direct object, and the instrument are all copied; but, past tense marking cannot be copied, even though tense is suffixal on the verb. These data are very difficult to explain if the verb is “born” (merged into the syntax) fully inflected, since if so, there should be no copyable constituent that contains the verb and lacks tense marking. However, the data can be naturally understood if tense originates syntactically outside of the VP, and joins with the verb either syntactically or post-syntactically. (For similar sorts of misalignments which may be related to the Wolof data above, we refer the reader to the literature on predicate cleft constructions; good entry points are Kandybowicz 2009 and Hein 2018, with many relevant references within.)

The role of syntax in word formation provides an argument against lexicalist approaches, as any attempt to model the types of facts discussed above without syntactic (and potentially post-syntactic) word formation will lead to redundancy in the model, as well as potentially predicting *unattested* ways a word’s form/structure might deviate from the syntax. In other words, the Mirror Principle and the constrained nature of syntax/morphology mismatches together suggest that word formation must primarily be an issue of syntax (plus potential additional operations in the post-syntax according to some theories).

The connection of late insertion to syntax-first word formation comes from recognizing that word formation (both syntactic and post-syntactic) feeds exponence. Take, for example, Bobaljik’s (2012) Root Suppletion Generalization, which states that “root suppletion is limited to synthetic (i.e., morphological) comparatives”. This generalization is based on Bobaljik’s finding that (e.g.) the root GOOD can supplet in the context of a comparative morpheme that is inside the word domain of GOOD (as in *bett-er*), but there are (arguably) no cases crosslinguistically that look like *more bett*, with suppletion of GOOD conditioned by an element external to the word containing GOOD. Suppletive allomorphy, then, seems to be word-bounded.⁸ Further cases of syntax and word formation feeding exponence are taken up in §2.2.4 and §2.3.

2.2.2 Dynamic wordhood

Non-syntactic (lexicalist) theories of morphology fundamentally rely on the notion of the word—words are for the most part built in the lexicon whereas phrases and clauses are built in the syntax. But a lot of evidence points to the fact that wordhood is not static, and that wordhood is not a predefined notion that grammatical processes refer to in a uniform way.

For starters, there are many cases where different grammatical processes that rely on the notion of the word do not seem to refer to the same types of objects. In the simplest case, this is seen in well-known mismatches between morphosyntactic words on the one hand and phonological words on the other (see among many others, Matthews 1991, 2002, Dixon and Aikhenvald 2002, Dixon 2009, Elordieta 2014). An extreme type of example of the mismatch between morphosyntactic and phonological words is found in polysynthetic languages, where words correspond to syntactically-constructed DP and CP ph(r)ases (Rice 1993, Compton and Pittman 2010, Compton 2017, Miller 2018, Ershova 2020). Since the binary distinction between morphosyntactic and phonological words is widely recognized

⁸There also appear to be further restrictions on what can influence exponent choice, though exactly what those restrictions are is much debated. See §2.3.1 for more on suppletive allomorphy, and §4.1 for some additional discussion of locality of allomorphy.

beyond specific frameworks (see Tallmann 2020 for a recent overview), many theories do have a way of capturing these kinds of mismatches, even without late insertion.

The hardest nuts for lexicalist theories of morphology to crack are arguably cases where morphosyntactic wordhood is not uniform even within a single language (see e.g. Julien 2002). In a recent paper, Georgieva et al. (2021) discuss the behavior of negation in the two Finno-Ugric languages Mari and Udmurt, and show that negation behaves like a proper, syntactically free, auxiliary in the sense that it bears higher verbal features (tense, mood, subject agreement) and determines the form of the dependent lexical verb. But at the same time, negation behaves like a bound morpheme with respect to word order and morphophonological processes. Thus, even a very specific notion such as *morphosyntactic word* does not yield fixed/consistent results. Another case is discussed in Fenger (2020): certain restructuring verbs in Japanese behave like they are part of the same morphosyntactic word as their complement verb for word order and morphophonological processes, but behave like a separate morphosyntactic word in other ways, e.g., in coordinations.

In late insertion models, such facts can be accommodated fairly straightforwardly since wordhood can be dynamically determined during the course of a derivation. A word can count as a free element for (some) syntactic purposes but may very well be incorporated into a larger word at a later stage of the derivation, yielding a mixed pattern. Consider, for example, that words can productively be zero-derived from phrases, like “Bonnie and Clyde” and “know-it-all” (Bruening 2018:4-5; see Bruening 2018 as well as Carnie 2000 for many more). A similar point has been made for word-internal agreement processes in Dutch and German A-N-N compounds (Ackema and Neeleman 2004, Barnickel 2014, de Belder and van Koppen 2014).

Syntactic (and post-syntactic) word formation makes it possible to model distinctions and embeddings among various stages of morphosyntactic words and phonological words.

2.2.3 Clitics and affixes

Another related argument for non-lexicalist theories is the observation that it is often hard to distinguish between affixes and clitics. Lexicalist theories crucially rely on there being a fundamental distinction between the building blocks of morphology and the building blocks of syntax. Thus most of the literature that seeks to identify reliable, crosslinguistic diagnostics of one or the other (see e.g., Zwicky 1977, Zwicky and Pullum 1983, Klavans 1985, 1995, Miller 1992, Halpern 1995, Monachesi 1996, Miller and Sag 1997, Crysman 2000) comes from lexicalist frameworks. However, despite these concerted efforts, there is to date no set of diagnostics that would unambiguously allow us to distinguish the two categories.

Consider the discussion by Crysman (2000), who meticulously applies all the relevant clitic vs. affix diagnostics to weak pronouns and some non-argument elements in European Portuguese. Crysman shows that these items obligatorily attach only to verbs, and display semantic and morphophonological idiosyncrasies as well as arbitrary paradigmatic gaps; all of these characteristics are usually taken as clear indicators of affixhood (as in Miller 1992 for French). Further, and this is probably the most compelling evidence for affixhood, these items can even appear in between the verb and tense/mood markers in future or conditional contexts, (3) (Crysman 2000, citing Spencer 1991:366):

- (3) Monstrar-no-los-á.
 show-us-them-FUT
 ‘He will show them to us.’

Importantly, Crysman independently identifies the tense and mood morphemes as affixes. Substantial evidence, then, points to the affixal nature of (e.g.) *no* and *los* in (3).

On the other hand, however, these weak pronouns (and certain non-argument elements) show a certain amount of word order freedom: they can appear pre- or post-verbally, (4a,b), a choice which depends not only on the features of the element itself but also on the syntactic context. Further, these items can take wide scope over coordinated constituents, (4c) (from Barbosa 1996), a diagnostic that has been claimed as a strong argument in favor of a clitic status (see Miller 1992).

- (4) a. Os alunos telefonaram=**Ihe** todos.
 The students phoned=him all.
 ‘All the students phoned him.’
- b. Os alunos todos **Ihe**=telefonaram.
 the students all him=phoned.
 ‘All the students phoned him.’
- c. ...que não **te**= [trouxera ao hospital e levara à casa].
 ...that not you= brought to.the hospital and took to house
 ‘...that I hadn’t brought you to the hospital and taken you home.’

Against the background of the conflicting results of the diagnostics, Crysman concludes that “transitional types do indeed occur” (2000:121). The account he proposes, which is couched in HPSG, is based on the crucial assumptions that (i) constituent structure and linear order are dissociated, and (ii) lexical items created by the morphological component can contain independent morphs, which may, at least potentially, be linearized discontinuously by the syntax.⁹ Finally, Crysman needs to assume that non-constituent coordination is possible, essentially rendering useless Miller’s (1992) much-employed Coordination Criterion for diagnosing clitics.

Such drastic measures as proposed by Crysman for reconciling “transitional types” are not necessary in a framework in which the difference between affixes and clitics is less important. As discussed in the previous section, under a non-lexicalist approach, it is in fact expected to find mismatches (for example of the sort observed in European Portuguese) where an element syntactically behaves like an independent item (i.e., for the purposes of coordination or word order) but morphologically and phonologically behaves like a bound item (see e.g. Embick and Noyer 2001, Embick 2010, Shwayder 2015, Fenger 2020, Georgieva et al. 2021).

The general difficulty in distinguishing between clitics and affixes can be taken as an argument against lexicalist theories and, thus, for non-lexicalist theories. Moreover, cases of this sort are also potentially problematic for the non-integrated non-lexicalist theories, such as Consolidated Morphology, where affixes are base-generated as adjoined to their host and then licensed via Agree throughout the derivation.

⁹For a discussion of linearization in Minimalism, see chapters 42-44 of this volume.

2.2.4 Valuation over pre-specification

Early Minimalism adopted the lexicalist view that inflectional features generally enter the syntax with a pre-specified value, as part of pre-formed words. For example, in a sentence like *Rosie loves spiders*, it was assumed that the verb enters the syntax fully-formed, *loves*, with both a present tense feature and a 3rd person singular agreement feature. In order to be licensed, inflectional features need to be “checked” against a syntactic terminal bearing the feature, e.g., for an inflected verb, against T and Agr. Checking theory is elaborated in Chomsky 1995:Ch. 3-4, with a complex calculus involving special checking domains and special checking positions. (For more on features in Minimalism, see Chapters 37-38 of this volume.)

Later Minimalism moved to a valuation model, where inflectional features enter the syntax without a value, and get valued in the course of the derivation through the operation Agree (see Chapters 23-24 of this volume). There are a number of (types of) arguments for a valuation model over a checking model. One is an argument of theoretical simplicity—valuation circumvents the need for extensive lookahead in choosing what features/exponents should enter the syntax, and it obviates the need for checking-motivated covert movement. There are empirical arguments for valuation, as well, which we review briefly below.

The first piece of evidence for a valuation-based model comes from possible (and impossible) ellipsis mismatches, like those discussed for Brazilian Portuguese by Nunes and Zocca (2005), exemplified in (5) (bracketed constituent elided, mismatched exponent bolded).

- (5) a. O João é alt-**o** e a Maria também é [alt-**a**]
the João is tall-MASC.SG and the Maria also is tall-FEM.SG
'João is tall and Maria is [tall] too.'
- b. *O João est-**eve** aqui e a Maria também vai [est-**ar** aqui].
the João be-PST here and the Maria also goes be-INF here
Intended: 'João was here and Maria will [be here] too.'

Under a model where both adjectives and verbs are fully inflected upon entering the syntax, there needs to be a story about why the type of inflectional mismatch in (5a) is tolerated under ellipsis, but not the type in (5b). A valuation model gives us tools for understanding constraints on allowable mismatches—in particular, such mismatches are arguably limited to features that enter the syntax without a value, such as agreement features, (5a).

Another argument for valuation over checking comes from the fact that agreement acts like an “obligatory operation” (in Preminger 2011’s words)—an unvalued feature can actually *fail* to get a value in the course of the derivation and thus take a default form (Béjar 2003, López 2007, Preminger 2011, 2014; see also Chapter 23 in this volume).¹⁰ The appearance of some affixes is thus negatively defined. López (2007) gives the following simple example from Icelandic (from Sigurðsson 1996:9, gloss adapted), where the verb and the participle inflect for default values (3SG.NEUT) when there is no accessible nominative subject to agree with.¹¹

¹⁰For similar findings in the domain of case, see Schütze 1997.

¹¹Note that default agreement shows up in Icelandic in a variety of contexts including in expletive constructions (Jónsson 2009) and with conjoined subjects (Thorvaldsdóttir 2019).

- (6) Stelpunum var hjálpað
 girls.DAT.PL.DEF be.PST.3SG helped.3SG.NEUT
 ‘The girls were helped.’

This pattern is easy to account for in a valuation-based model of Agree, where default agreement is the result of the probe having tried to find an accessible argument but ultimately failing. In a checking-based model, on the other hand, this pattern is hard to account for: we expect agreement to always require some sort of licensing, but there is nothing in the structure of (6) that would seem to license a third singular neuter affix. And if we assume that default agreement does not have to be licensed, we would crucially expect such agreement to be possible in all configurations, e.g., even with first person nominative subjects, counter to fact.

A final argument we offer is that a valuation model straightforwardly allows us to explain why certain elements exhibit fundamental asymmetries at different stages of the derivation, i.e., before and after they receive a value. For example, Murugesan (2019, 2022) argues that differences between languages which do exhibit the Anaphor Agreement Effect—a widely-observed ban on anaphors controlling verbal agreement (Rizzi 1990, Woolford 1999)—and those which do not can be attributed to the relative order of two instances of Agree. The proposal goes as follows. By assumption, an anaphor receives its features via Agree with its binder (antecedent). If Agree between the (relevant) verbal head and the anaphor happens *after* Agree between the binder and the anaphor, then the anaphor *can* participate in verbal agreement. However, if verbal agreement happens *before* the anaphor has undergone Agree with its binder, then the anaphor will not be able to participate in verbal agreement, giving rise to the Anaphor Agreement Effect. Such asymmetries are straightforwardly captured in a valuation model. In checking models, where the items in question already have their features from the outset, such asymmetries are not predicted, and some stipulation must rule out such agreement.¹²

The above arguments in favor of a valuation model over a checking model show that the syntax plays a central role in determining the features present in words. While thus in general supporting non-lexicalist approaches, nevertheless these arguments cross-cut our classifications in the table to some extent. Some lexicalist theories, like Paradigm Function Morphology, have a matching procedure between fully-formed words and the output of syntax (see, e.g., Stewart and Stump 2007), and can therefore accommodate a syntactic valuation approach to inflectional features straightforwardly. And conversely, some non-lexicalist models, like Consolidated Morphology, employ checking as opposed to valuation and so cannot be reconciled with a valuation approach.

2.3 Arguments for realizational models

The previous section focused on arguments that primarily speak to the need for an integrated syntax and morphology, i.e., that speak against lexicalist models. This section turns to argu-

¹²In principle, it might be possible to stipulate that only features that are checked can participate in subsequent syntactic processes, but it is unclear why this should be the case. Note also that such a stipulation would clash with the common assumption that only *unchecked* features count as interveners for Agree (see for example Béjar and Rezac 2003).

ments for a realizational theory of morphology, where exponents *reflect* features/structures that are given independently, rather than an incremental theory of morphology, where exponents *introduce* features into words/structures. The arguments in this section thus focus on the nature of exponents and exponence, including in particular suppletive allomorphy (a many-to-one correspondence between phonological form and function/meaning) and what is in some ways its inverse, syncretism (a one-to-many correspondence between phonological form and function/meaning).

2.3.1 Suppletive allomorphy, first pass

Suppletive allomorphy describes a situation where there are multiple replacive (non-phonologically-derived) exponents for a particular feature (set) or root. Plural marking in English, for example, comes in a number of suppletive forms, depending on the root being pluralized—e.g., *cat-s*, *child-ren*, *ox-en*, *fish-Ø*. Roots can have suppletive forms too,¹³ like the case of GOOD in *good* vs. *bett-er* discussed above. Suppletive allomorphy is found throughout the languages of the world, especially commonly for inflectional items, and has been the focus of much discussion over the past few decades (see, e.g., Carstairs 1987, Inkelas 1990, Bobaljik 2000, Paster 2006, Veselinova 2006, Siddiqi 2009, Kilbourn-Ceron et al. 2016, Kalin To Appear).

Suppletive allomorphy is an issue for any theory that assumes a strict one-to-one mapping between form and meaning/function, which is true of many incremental theories. In such a theory, there must be rampant partial overlap across lexical items, where multiple distinct lexical items contain the *same* feature/root. For example, *-ren* and *-s* must have partially overlapping lexical entries, both corresponding to the feature plural. In addition, a mechanism is needed for regulating which lexical item is compatible with a given environment, a mechanism that is straightforward just in case the following conditions hold of the allomorphy: (i) the environment can be positively stated, (ii) the environment is immediately local, and (iii) the environment is found *inward* relative to the lexical item being inserted (i.e., the relevant environment is already present). The case of the English plural suffix *-ren* fits this bill: *-ren* combines only with the root *child*, which is immediately local and is already present at the point of introducing the plural. However, as will be elaborated below (in this section and following sections), suppletive allomorphy often deviates from this simplest type of case.

One significant challenge for incremental models is the fact that the contextual environments that condition suppletive allomorphy may be *outward* relative to the choice point. Root suppletion, for example, is always outwardly-sensitive, with the root’s form determined by morphosyntactic features that are outside of the root. Consider again that the adjective GOOD appears as *bett* in the context of the comparative suffix, *-er*. If exponents are introduced incrementally while words are built, from the root outward, then there should be no accessible outer material for the choice of a lexical item to be sensitive to—e.g., how does the root GOOD know it should be paired with the form *bett* without also being able to see the (yet-to-be-added) comparative morpheme? To achieve this, an incremental model would need to do one of the following: (i) deny the existence of suppletive allomorphy altogether (as Collins and Kayne 2021 do), (ii) build in significant checking/look-ahead, or (iii) adopt

¹³Though see Bonet and Harbour 2012:§3.2 and Harley 2014 for an overview of the debate surrounding roots and root suppletion within DM.

Chomsky's strategy in early MP of allowing exceptional late insertion in cases of suppletive allomorphy (as discussed at the start of §2 here).

In a realizational model, on the other hand, form-meaning mismatches and inward/outward conditioning of suppletive allomorphy are both straightforwardly possible, since exponents are chosen for an already-given structure or set of features. In the coming sections, we'll return at times to suppletive allomorphy, to see other ways in which its nature is challenging for incremental models, as well as (in some cases) being challenging for lexicalist realizational models like Paradigm Function Morphology (see especially §2.3.4).

2.3.2 Syncretism and elsewhere distributions

Syncretism describes a situation where one exponent appears with distinct (but related) functions/meanings. Put another way, exponents may be *underspecified* (less specific than possible) relative to the set of features/morphemes in a language. Syncretism is quite common, again largely in the realm of inflectional morphology (see, e.g., Stump 2001, 2016). Exponents can also have *elsewhere* (negatively-defined) environments. In this section, we elaborate on these overlapping types of underspecificity, and discuss the theoretical implications they have.¹⁴

Consider “L” agreement marking in Turoyo (Neo-Aramaic; Turkey; Jastrow 1993, Kalin 2020): *li* (1SG), *lan* (1PL), *lox* (2M.SG), *lax* (2F.SG), *lxu* (2PL), *le* (3M.PL), *la* (3F.SG), *lle* (3PL).¹⁵ Under a model where agreement is the result of feature valuation (see §2.2.4), it must be that the feature set being valued for L agreement includes person, gender, and number features, since all are visible in one exponent or another. However, the exponed contrasts are not maximal. First person singular marking lacks a gender contrast, as does all plural marking. Both of these instances of gender leveling can be dealt with through underspecification—the exponents that map to the valued person-number-gender feature bundles realize a *subset* of the features in those feature bundles themselves. Thus, where (e.g.) *la* realizes [3,F,SG], *li* realizes only [1,SG], and so will be inserted when the feature bundle is [1,M,SG] or [1,F,SG]; in other words, [1,M,SG] and [1,F,SG] are realized syncretically (by the same exponent). Note that while it is plausible to take the lack of gender differentiation in *plural* exponents to reflect a general lack of gender features for plurals in the language (see §2.3.3 for more on such “metasycretisms”), it is not plausible to make the same move for *first person*, as first person nominals do trigger gender agreement in the adjectival system.¹⁶ The Turoyo example shows how underspecification of an exponent (e.g., *li* being underspecified for gender) can be used in a realizational framework to model syncretism across a natural class of feature bundles (in the case of *li*, syncretism across feature bundles containing 1PL); we call such cases *shared feature syncretism*, adopting a term from Kramer 2016.

¹⁴See Anderson 1992, Marantz 1997, Stump 2001, who make similar points as we make here. Stump 2001:Ch. 1.2 also discusses extended/multiple exponence—“a given property may be expressed by more than one morphological marking in the same word”—as a motivation for realizational theories, which we do not take up here.

¹⁵These can be decomposed into an initial *l* piece, hence the label L agreement, plus a piece that varies by phi-features, but this segmentation is not relevant here.

¹⁶This example/argument is similar to points made by Noyer 1998, using Arabic, Stump 2001:8, using Bulgarian, and Bobaljik 2017, using Russian.

Relative featural underspecification can also be used to model *nonshared feature syncretism* (again adopting a term from Kramer 2016)—syncretism across a *non-natural* class via an elsewhere distribution. (Note that even in such cases, there is still a shared feature, just not one that picks out the syncretic set exclusively.) Kramer (2009, 2016) discusses the Amharic determiner in this context, which has two forms, one specific to singular feminine, *-wa*, and the other for all other definite determiners, *-u*. This is a nonshared feature syncretism because *-u* appears with a non-natural class of determiners, namely, whenever the definite determiner is plural *and/or* not feminine.

Nonshared feature syncretisms can be modeled naturally in a realizational model via the Elsewhere Principal (also called the Paninian Principle), which states that more specific exponents take priority over less specific ones.¹⁷ In the Amharic case discussed above, the Elsewhere Principle derives an elsewhere distribution for an exponent (*-u*) by virtue of the presence of a competing exponent that realizes a more specific feature set (*-wa*)—thus the non-feminine and plural determiners display a syncretism of the nonshared feature type, all being realized by *-u*. Nonshared feature syncretisms can also be intuitively thought of as *elsewhere syncretisms*.

Turning away from syncretism for a moment, elsewhere distributions may also result from differences in specificity across the *contextual environment* for insertion of different exponents for the same morpheme; this gives rise to suppletive allomorphy (see §2.3.1). For example, consider the nominalizer in Bahnar (Banker et al. 1979, Kalin To Appear), which has three suppletive forms: *a-* with a single root ('tie up'), *bɔ-* with all stems that begin with an *m*, and the infix *-ɔn-* elsewhere. Whereas the distribution of *a-* and *bɔ-* can each be stated straightforwardly using a natural class (lexical and phonological, respectively), to state the distribution of *-ɔn-* would require saying it combines with non-*m*-initial stems and roots that are not TIE.UP, which is obviously *not* a natural class. Again, a realizational model makes this elsewhere distribution trivial to account for (with the Elsewhere Principle), and examples of this type of exponent distribution abound.

The discussion above shows that the relation between roots/feature sets and exponents must be indirect to a certain extent. In an incremental model (such as Wunderlich 1996 or Collins and Kayne 2021), where exponents are tied to the morphosyntactic features directly, such indirect relations are difficult to model. Syncretisms pose a problem for incremental models because there would need to be multiple homophonous exponents introducing closely-related feature sets (assuming there's independent evidence/need for the presence of the features being syncretized). Elsewhere distributions pose a different sort of problem, as they require putting negative conditions on the appearance of an exponent.

On the other hand, in a realizational model, syncretisms and elsewhere distributions can be modeled straightforwardly using the Elsewhere Principle (or in the case of Nanosyntax, the Superset Principle). This, in turn, suggests that a realizational model is empirically more adequate than an incremental model.

¹⁷See Anderson 1992:132, fn. 29 for a brief tracing of the Elsewhere Principle's origin.

2.3.3 Meta-syncretisms

When a particular potential contrast in a feature set is *never* expressed with distinct exponents in a particular language, this is a *metasyncretism*. To use an oft-cited example from the foundational theoretical work on metasyncretism, Williams 1994, consider Latin nominal declension. In Latin, nouns all take an inflectional suffix that encodes (some subset of) case, number, and noun class. In the plural, no matter the noun class, there is *never* a distinction between dative and ablative case, both of which are “indirect” cases; in other words, there is a metasyncretism of ablative and dative in the plural.¹⁸ Metasyncretisms, and their relevance for morphological theory, have been much discussed over the years (see, e.g., Williams 1994, Halle 1997, Noyer 1998, Frampton 2002, Bobaljik 2003, Harley 2008, Henze and Zimmermann 2011, Nevins 2011).

Metasyncretisms are challenging for incremental theories of morphology because such syncretism patterns would either have to be *accidental* or there would need to be a constraint on possible lexical items, ruling out the relevant feature contrast across the entire lexicon. Such an absence in the lexicon predicts, in turn, that there should be no trace at all of those leveled features, e.g., in the syntax or in other morphological processes.

A realizational theory—due to the lateness of exponence—affords a way to understand metasyncretisms without such syncretisms needing to be accidental, and without committing to the wholesale absence of that feature contrast (when part of the relevant feature set). One specific type of mechanism that has been proposed to derive metasyncretisms, in particular within the theory of DM, is called *impoverishment*, and involves feature deletion prior to exponence.^{19,20} Impoverishment often seems to happen in response to two *marked* features (like plural and feminine) coinciding.²¹ Hence, there is a well-known observation that marked parts of the paradigm (e.g., in the plural or in the negative) show fewer morphological distinctions than unmarked ones (e.g. in the singular or in the affirmative). Returning to the Latin example, impoverishment would, post-syntactically, get rid of the featural contrast between ablative and dative (e.g., by deleting the oblique feature, cf. fn. 18) in the context of a plural feature. After impoverishment, no exponent will be able to realize this case contrast in the plural, because the contrast is simply gone; thus, there is a metasyncretism across the language.

Impoverishment has other benefits within a realizational theory, as well. Harley (2008), for example, shows that impoverishment makes it possible to account for an otherwise mys-

¹⁸Though theories of the features involved in case marking vary, this seems to be a shared feature type of syncretism, e.g., for Williams 1994, with both ablative and dative being “indirect” cases, and for Halle 1997, with both being nonstructural dependent cases, differing only in their obliqueness.

¹⁹Impoverishment originates with Bonet 1991. For an excellent recent overview of impoverishment and the different ways it might be implemented, the reader is referred to Keine and Müller To appear.

²⁰In realizational word-and-paradigm theories like Paradigm Function Morphology, a mechanism of *property mapping* (controlling the mapping from feature cells to form cells in a paradigm) is used to capture metasyncretisms, rather than impoverishment. See Kramer 2016 for a comparison of impoverishment and property mapping.

²¹Various definitions of markedness have been proposed in the literature. In Weisser to appear, markedness as an empirical phenomenon is defined as “the observation that there is a systematic asymmetry in the way grammatical rules refer to a proper subset of members of a grammatical opposition.” See Weisser to appear for more examples of added markedness effects, technical ways to implement them, and other uses of the concept in morphology.

tifying pattern of case syncretism in Baoan. In the next section, we turn to yet another use for this mechanism.

2.3.4 Retreat to the unmarked

Our next argument for a realizational model combines a number of the observations we've made above: in a syntactically derived environment (see §2.2.1 for a discussion of the role of syntax in word formation), an exponent may display an unexpected default/elsewhere form (see §2.3.2 on elsewhere distributions) that can be understood as a retreat to the unmarked in a marked environment (via feature deletion; see §2.3.3). This is evidence specifically for a non-lexicalist realizational model. (Credit for this argument goes to Eulàlia Bonet, who presented it in the *Linguistics Flash-Mob* virtual talk series.)

Consider the famous example of Spanish spurious *se*, so-called by Perlmutter (1970, 1968). When the indirect and direct objects are both clitics (and so are adjacent, both preceding the verb), the indirect object must be realized as the (otherwise reflexive) clitic *se*, rather than its expected dative person-bearing form, (7b).

- (7) a. Lo recomendé a él
3SG.ACC recommended to him
'I recommended it to him.'
b. Se/*le lo recomendé
se/3SG.DAT 3SG.ACC recommended
'I recommended it to him.'

(Adapted from Perlmutter 1970:191)

There have been many analyses of this unexpected appearance of *se* in environments like that in (7b), but all are united in taking the appearance of *se* to reveal a retreat to a less marked exponent in a marked context, e.g., due to deletion of a dative case feature in the context of an accusative (Halle and Marantz 1994, who cite Harris 1993), due to deletion/impoverishment of (3rd) person features in the context of another 3rd person (Bonet 1994, Nevins 2007), or due to reduced feature content as a result of (the failure of) syntactic licensing (Walkow 2012). Under all these accounts, there is some kind of feature clash in a derived syntactic configuration—exponence of the dative clitic as *se* is the result of an interaction among lexical, syntactic, and potentially post-syntactic factors. For other examples of derived feature clashes feeding exponence, see Nevins 2012, Walkow 2012, among others.

Instances of a retreat to the unmarked in a marked environment show again that it is crucial to have exponence/exponents separate from the features they seem to express—the features must be present, independent of their corresponding exponents, with exponents only being supplied later (realizationally). The role of syntax in creating marked environments shows further that a realizational model is best paired with a non-lexicalist integrated syntax and morphology. To account for these types of facts, other types of models—like Paradigm Function Morphology—would be forced to have significant look-ahead and/or complex negatively-specified checking environments for exponents.

2.4 Syntax is phonology-free

Our final argument for late insertion is one of the classic ones for a general modular theory of grammar. It is based on the longstanding observation that the ways in which syntax and phonology interact are very restricted. This well-known restriction is captured most clearly in the Principle in (8), which originates in Zwicky and Pullum 1986:

- (8) The Principle of Phonology-Free Syntax (PPFS): In the grammar of a natural language, rules of syntax make no reference to phonology. (Miller et al. 1997:68)

The PPFS predicts that phonological factors should never directly influence syntactic operations.

At first glance, there are quite a number of apparent counterexamples where phonological or prosodic considerations seem to play a role for the application of syntactic rules or processes. A straightforward example of this type concerns the placement of adjectives in French, which is often explained in terms of the number of syllables involved, with prosodically light adjectives placed pre-nominally and heavier adjectives placed post-nominally. However, as Miller et al. (1997) show, this explanation is a mere statistical tendency and thus fails to explain the empirical pattern. The authors note that such tendencies may be best explained by assuming that the syntax includes some optional rules/processes, and the speaker may make their choice between alternative outputs based on prosodic or phonological considerations. This kind of approach, according to which the syntax includes optionality and the phonology then filters among the different options, has since been applied to several other phenomena with the same profile. Most notably, Heavy NP Shift (see amongst many others Zwicky 1986, Inkelas and Zec 1990, Grimshaw 2005, Bresnan et al. 2007, Anttila et al. 2010) and Object Shift (Holmberg 1999, Erteschik-Shir 2005) have been treated along these lines.²² So, despite the apparent counterexamples, the vast majority of current frameworks adopt the PPFS in one way or another.²³ (For further discussion, see e.g. Zwicky 1969, Hetzron 1972, Zwicky and Pullum 1986, Miller et al. 1997).

In this short section, we want to focus on the contrast between PPFS and the lesser-known Principle of Superficial Constraints in Phonology (PSCP) from Zwicky (1970) (see also Kaisse 1985):

²²Another prominent account that uses this mechanism is Bošković 2001, where phonological filtering (in particular, phonologically-determined copy choice) is taken to explain prosodically-driven clitic placement in South Slavic languages. However, it has been argued that this mechanism is not adequate to capture all cases of phonology-sensitive clitics (see e.g. Embick and Noyer 2001, Chung 2003, Legate 2008, Harizanov 2014, Franks 2017, Weisser 2020). These works argue instead that clitic displacement is at least partially post-syntactic/phonological in nature (cf. §2.3.4).

²³For a recent exception, see Bruening 2017, who provides the interesting observation that, in many cases, syntactic operations also do not see *syntactic* properties of lexical items. Thus, he concludes, the PPFS is not general enough. He posits that, for example, just like there is no language in which only verbs starting with a labial consonant undergo head movement, there is also no language in which only (in)transitive verbs do. And while this is certainly an interesting hypothesis that deserves further investigation, we believe that, even if his hypothesis turns out to be right, it is no reason to throw out the baby with the bathwater. The point is that there are some syntactic rules that refer to transitivity, but there can never be any syntactic rules which are sensitive to labial/non-labial contrasts.

- (9) The Principle of Superficial Constraints in Phonology (PSCP): The only syntactic conditions or constraints on phonological rules are those referring to surface structure.
 (Zwicky and Pullum 1986:71)

This principle elucidates a stark asymmetry between syntax and phonology: syntactic rules can never see phonological information, whereas phonological rules can see syntactic information to a certain extent. Even more suggestive, perhaps, is the fact that phonological rules only see syntactic information at the very end of the syntactic derivation; phonological rules never see the underlying (deep) structure of syntax. The most natural way to have the two principles in (8) and (9) fall out from the architecture of grammar is to agree with Zwicky and Pullum’s assessment that the phonological module as a whole must follow the syntactic module, and therefore phonological information simply is not present in the syntax and can therefore not be referred to by syntactic rules.²⁴

The argument coming from the PPFS and the PSCP crosscuts the classification of morphological theories we started out with. Some strongly lexicalist theories, such as PFM (Stump 2001, 2016), can naturally accommodate these observations: PFM takes morphology to happen essentially in parallel to the syntax (with the syntax operating purely over abstract features/roots). On the other hand, some syntactic theories of word formation such as Collins and Kayne (2021) or Bruening (2017) at least potentially do have a problem capturing the PPFS and the PSCP, the former because phonological forms are part of the lexical items that constitute the atoms of syntax, and the latter because realization is intra-syntactic.²⁵ Finally, for Nanosyntax and Distributed Morphology, in which realization is late and phonological forms do not ever enter the syntax, both PPFS and the PSCP fall out automatically from the nature of the system.²⁶

2.5 Interim comments

The preponderance of empirical evidence points us to late insertion: a realizational model of morphology, where word formation is syntactic (and potentially also post-syntactic), and realization follows some/all syntactic structure-building. In contrast to the idea that late insertion is the “worst case” (Chomsky 1995:220), in fact, adopting late insertion solves many empirical puzzles in one fell swoop.

Unsurprisingly, there are some challenges for late insertion models. For space reasons, we do not expound on these here, but we will mention two that we take to be prominent. First, syncretism can, in some cases, save an otherwise illicit syntactic configuration, where a single item in the syntax has multiple conflicting feature specifications. For example, in German free relatives, the relative pronoun must receive the same case internal to and external to the relative clause, *except* when the internal and external cases happen to be syncretic, in which case strict matching is not necessary (Groos and van Riemsdijk 1981, cf. Vogel 2002).

²⁴See Zwicky and Pullum (1986) for a much more detailed discussion of the issues at stake here.

²⁵Note that such approaches could always make some sort of stipulation as to why the phonological forms are not visible to the syntax, but the point here is that it does not follow automatically.

²⁶An interesting wrinkle is introduced by cyclic spell-out, where syntactic structures (or sub-parts of them) are exponed and then structure-building continues. Cyclic spell-out opens the door to morphophonological aspects of spelled-out structures influencing later syntactic operations. This back door is exploited by Martinović (2019), who proposes it makes the right predictions in Wolof.

Importantly, facts like these are problematic for many theories of morphology, but can be reconciled with a late insertion approach in various ways—see, e.g., Himmelreich (2017), who derives these effects as the result of bidirectional Agree and featural containment, or Bergsma (2019), who pursues an account in terms of structural containment, and Bjorkman (2021), who suggests that there may be multiple paths to resolution-by-syncretism, including (i) unexpected featural/syntactic identity; and (ii) constraints that hold at the point of exponent choice, on the realization of conflicting feature sets.

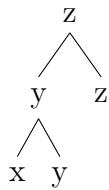
Second, the jury is still out about whether there are or are not (empirically-observed) restrictions on possible syncretisms. Late insertion seems to predict that there should be, as syncretisms come about due to the nature of (and interactions among) realization rules, in particular, with respect to (relative) underspecification and (relative) contextual conditioning. If words are built non-syntactically, in a divorced grammatical module, that opens up the possibility of “morphemic” distributions of exponents (that cannot be accounted for by appealing to natural classes of features or elsewhere distributions), which in turn is much more permissive in terms of possible syncretisms. For the issues at stake, as well as some ways to reconcile late insertion with morphemic distributions, we refer the reader to Luís and Bermúdez-Otero 2016, Kramer 2016, Trommer 2016, and Hein and Weisser (to appear).

3 Bottom-up insertion

While late insertion (§2) is commonly adopted these days within the Minimalist syntactic tradition, a somewhat more controversial hypothesis is that, in the process of realizing a morphosyntactic structure, exponence starts from the most embedded node and proceeds upward—this is known as *bottom-up insertion* (sometimes referred to as inside-out insertion, and subsumed in DM under the term *cyclicity*). Bottom-up insertion is found in some form across many different types of morphological frameworks, both incremental and realizational, both lexicalist and non-lexicalist (e.g., Anderson 1982, 1992, Kiparsky 1982, 2000, Wunderlich 1996, Bobaljik 2000, Stump 2001, Paster 2006, Starke 2009, Embick 2010, Bruening 2017). The two basic proposed alternatives to bottom-up insertion are simultaneous insertion within a domain (e.g., Prince and Smolensky 1993, Mester 1994, Mascaró 1996, Svenonius 2012, Bonami and Crysmann 2016, Svenonius 2016, Rolle 2018, Fábregas and Putnam 2020) or a hybrid model where bottom-up insertion is possible (perhaps even default), but so is simultaneous or top-down/outside-in insertion (e.g., Carstairs 1990, Wolf 2008, Deal and Wolf 2017).

Two preliminary notes are in order. First, determining what the most embedded node is in a structure is not always trivial. We adopt Myler’s (2017) formulation, based on containment and distinctness, whereby a node x is more deeply embedded than another node y just in case the maximal projection of y contains and is categorially distinct from x . This definition establishes that in (10) below, x is the most embedded, followed by y , followed by z .

(10)



According to bottom-up insertion, then, node x would be exponed before node y, and node y before node z. To see how this definition would order exponence in more complex structures generated by phrasal movement, the reader is referred to §3.5 below, and to Myler 2017.

Second, in much of the discussion below, a differentiation will be made between *inward* and *outward* directionality, a terminological distinction originating with Carstairs 1987. An inward direction for a phenomenon means that it cares about material that is *more embedded* than some reference point; an outward direction for a phenomenon means that it cares about material that is *less embedded* than some reference point. As should be clear, these notions are relative to a particular position in a structure. Thus, in (10), we could say that when y looks outward, it sees z, and when it looks inward, it sees x. When z looks inward, it can see both x and y, and when x looks outward, it can see both y and z.

There are a variety of types of empirical motivations for bottom-up insertion, including (i) the constrained directionality of phonologically-conditioned suppletive allomorphy (§3.1), (ii) where infixes can (and can't) look to satisfy their phonological placement requirements (§3.2), (iii) the timing of infixation with respect to exponent choice for inner morphemes (§3.3), (iv) typological differences between the direction of replacive and additive grammatical tone (§3.4), and (v) apparently non-local phonological interactions among morphemes (§3.5). The theme that we will see emerge is that, when a morphological phenomenon is phonologically-constrained/determined, it displays an inward/outward asymmetry. These asymmetries can all naturally be understood through bottom-up insertion.

We therefore put forward bottom-up insertion as a second universal aspect of natural language morphology.

3.1 Phonologically-conditioned suppletive allomorphy is inwardly-sensitive

Perhaps the best-known argument for bottom-up insertion is an asymmetry in phonologically-conditioned suppletive allomorphy (PCSA), brought to the attention of morphological theorists in a series of works by Carstairs-McCarthy (Carstairs 1987, 1988, 1990, Carstairs-McCarthy 1998). He argued that, in general, the conditioning environment for PCSA is to be found inwardly relative to the morpheme in question. As an example, Carstairs (1990:17) cites the Seri passive prefix, realized as *p-* before vowel-initial roots and *a?:-* before consonant-initial roots (Marlett and Stemberger 1983). This displays inward-sensitivity because the choice of exponent for this affix is sensitive to the phonological form of the affix's stem (in this case, the root). Over the years, this generalization has been strengthened, perhaps most extensively by Paster 2005, 2006, 2009, but also by Dolbey 1997, Bobaljik 2000, Embick 2010, Kalin 2020, To Appear, among others.

A natural way to capture the generalization that PCSA is inward-looking is for exponence to proceed from the most embedded morphosyntactic node upward. This bottom-up insertion

guarantees that, at the point of exponence at a particular terminal, all and only the terminals that are more embedded than that terminal will have a phonological form. It is therefore predicted to be impossible for PCSA to look (be sensitive) outward.

There is, however, a fair bit of controversy about whether outwardly-sensitive PCSA exists, either as generally allowed, or allowed in certain special circumstances (e.g. Carstairs 1990, Hannahs and Tallerman 2006, Anderson 2008, Svenonius 2012, Deal and Wolf 2017 (cf. Kiparsky to appear); Rolle and Bickmore 2020). If true outward-looking PCSA does exist, this would support the need for simultaneous and/or top-down insertion, at least as an option in addition to bottom-up insertion. While this is to some extent still an open empirical question, it is (to our knowledge) not disputed that the overwhelming *majority* of cases of PCSA are inward-looking, which calls out for some kind of explanation.

If PCSA stood alone as the only evidence for bottom-up insertion, it would not be a knock-down argument, especially in light of potential counterexamples. But there is converging evidence for bottom-up insertion from other phenomena, as well, which the following sections turn to.

3.2 Infixation is inward-looking and inward-moving

Infixes are affixes that are different from garden-variety prefixes and suffixes in that they must occupy a particular position with respect to a phonological pivot (e.g., Yu 2007). In Leti (Malayo-Polynesian; Indonesia), for example, the nominalizer *-ni-* appears towards the left edge of its stem and must appear before a vowel, e.g., (11) (Blevins 1999:386).

- (11) -ni- (NOM) + kasi (dig) → k<**ni**>asi ‘act of digging’

It is clear that an infix can “move” (at least metaphorically, perhaps not literally) inwards—an infix can be realized inside phonological material that is more embedded than the morpheme exponed by the infix (i.e., relative to its morphosyntactic position), as in (11).

It is also well-known and well-attested that, when an infix is able to satisfy its positional needs at the stem edge (due to the phonological nature of this edge), it can surface right there, thereby looking like a prefix/suffix rather than an infix. Continuing with Leti, we can see that when *-ni-* combines with a vowel-initial stem, it will surface at the leftmost edge of this stem (Blevins 1999:384), as in (12).

- (12) -ni- (NOM) + atu (know) → <**ni**>atu ‘knowledge’

Thus in addition to an infix being able to “move” inwards in the sense described above, it can also “look” inwards at the edge of its stem, and stay at the stem edge.

The natural question, in the current context, is as follows: can infixes move and/or look *outwards*, into/at *less* embedded phonological material? Kalin To Appear, in considering 51 case studies of infixation (that also involve allomorphy, though this is not relevant here), reports that infixes can in fact *only* “move” and “look” inwards—never outwards. Empirically speaking, when an infix appears in a morphologically complex word, where it could hypothetically look/move “outward” to satisfy its positional needs, it never does. Both sub-types of inward-only constraint will be exemplified below.

Let’s continue with Leti. In Leti, inflected verbs take a subject-marking prefix, realized

as the outermost morpheme at the left edge of the word. When a verb root is nominalized (as in (11)/(12)), it can be re-verbalized (by zero derivation) and thereby take a subject-marking prefix. The relevant set of inflectional subject-marking prefixes in this context all have a V or CV shape (Blevins 1999:388). We might expect, then, that the nominalizing infix could move outwardly into one of these inflectional prefixes in order to satisfy its need to precede a vowel. But, the infix cannot move outward, as seen in (13).²⁷

- (13) A re-verbalized nominalized verb in Leti (Blevins 1999:389-390)

| | |
|--|----------------------------|
| ta-s< ni >òi 1PL.INCL.I-<NOM>shift ‘we (incl.) inherit’ | (cf. *t< ni >a-sòi) |
|--|----------------------------|

Despite the fact that the infix would have to displace over the same number of segments in either direction in order to satisfy its pivot/placement, it only has the option of displacing inwardly, into its stem; it cannot “move” outward (*t<ni>a-soi). Note that there is nothing wrong with an infix surfacing inside an affix, so long as that affix is inward relative to the nominalizer; for example, when -ni- combines with a complex stem like *va-kini* (RECIP-kiss), the resulting nominalization is *v<ni>a-kini* ‘reciprocal kissing’ (Blevins 1999:400).

While (13) shows that infixes “move” only in an inward direction, it is also the case that infixes only “look” inwardly as well. Consider the verbal plural infix -á- in Hunzib (Northeast Caucasian), with various surface allomorphs. This infix is positioned relative to the right edge of its stem, and has as its positional requirement that it must precede a consonant, e.g., (14) (van den Berg 1995).

- (14) a. áhu (take) + -á- (VPL) → a<**á**>hu (van den Berg 1995:284)
 b. ék (fall) + -á- (VPL) → e<**yá**>k (van den Berg 1995:295)
 c. šoše (bandage) + -á- (VPL) → šo<**wá**>še (van den Berg 1995:334)
 d. čáx (write) + -á- (VPL) → ča<**á**>x (van den Berg 1995:292)
 e. íx-lø (warm-VBLZ) + -á- (VPL) → ix<**á**>-le²⁸ (van den Berg 1995:308)

As can be seen in (14), the verbal plural combines with verbal roots/stems, and the infix surfaces inside of its verbal stem, before the consonant closest to the right edge of the stem. Many suffixes can pile up at the right edge of the verb in Hunzib, so we might expect to find a parallel to Leti <ni>atu from (12), where—just in case there is a consonant-initial suffix—the verbal plural infix could surface at the edge of its stem, satisfying its pivot/placement in that spot by looking outward. However, this is not possible:

- (15) The verbal plural with outer tense marking (van den Berg 1995:82)

| | |
|---|--|
| r-i< yá >λe-n PL.CLASS-kill<V.PL>-PRET.GER ‘killed (iterative, plural object)’ | (cf. *r-iλe< yá >-n, *r-iλ< á >-n) |
|---|--|

²⁷Note that the problem cannot be the creation of a *tn* onset sequence, as this is permitted, e.g., *t<ni>eti*, ‘chopping’ (Blevins 1999:390).

²⁸There is often neutralization of stem-final vowels in Hunzib. In the verbal plural, stem-final [o, u, ə] typically neutralize to [e] (van den Berg 1995:26,81).

Despite the presence of the consonantal preterite suffix *-n*, it is not possible for the verbal plural to be realized at the rightmost edge of its stem. Rather, the infix must find its pivot/placement in an inward direction, which requires “moving” into its stem, *iðe*.

Both of the inward-looking/moving observations above are systematic crosslinguistically, and we are not aware of any counterexamples: an infix can surface at the edge of its stem just in case it can find its pivot/placement by looking inwardly in that position; and (when no edgemost pivot is forthcoming) an infix must move inwardly into its stem to satisfy its positional needs. Bottom-up insertion provides a natural explanation for this inwardness of infixation—at the point where an infix is looking to satisfy its pivot/placement (namely, when the relevant morpheme is exponed), the only visible phonological material is material more embedded than the morpheme being exponed. If exponence were simultaneous across a structure or could go outward-in, then this result is completely unexpected—fixation should be able to look and move in an outward direction. In other words, without bottom-up insertion, there would need to be an arbitrary stipulation to account for the uniform inwardness of infixation.

The argument here—that bottom-up insertion is needed to explain the inwardness of infixation—holds no matter what specific account of infixation is assumed, e.g., whether infixes are taken to be placed in the phonology (e.g., McCarthy and Prince 1993b) or in the morphology (e.g., Yu 2007), and whether infixes do (e.g., Kalin To Appear) or don’t (e.g., Yu 2007) start out life as a prefix/suffix. Under any sort of account, to explain this directionality asymmetry naturally, it must be that at the point when an infix takes its surface position, there is no phonologically-contentful outer material.

3.3 Infixes are transparent for insertion of inner morphemes

There is yet another argument from infixation for bottom-up insertion. Building on observations about Palauan (Embick 2010:104-108), Turoyo (Kalin 2020), and Nancowry (Kalin 2021), Kalin (2022) shows that, systematically, infixes that happen to surface at a morpheme boundary (in the process of satisfying their positional requirements) are invisible to allomorphic relationships that happen across that boundary. Notably, this is true even for phonologically- and prosodically-conditioned allomorphic relationships.

In Nancowry (Radhakrishnan 1981, Kalin 2021), there is a productive causative morpheme that has two prosodically-conditioned suppletive forms (one of which is itself an infix), determined by the size of its stem; *ha-* appears with monosyllabic stems and *-um-* with disyllabic stems:

- | | | |
|------|--|--------------------------|
| (16) | a. CAUS ↔ ha- / monosyllabic stems | (17a) |
| | b. CAUS ↔ -um- / disyllabic stems | (17b) |
| (17) | a. CAUS + pin ‘thick’ → ha-pin ‘to thicken’ | (Radhakrishnan 1981:111) |
| | b. CAUS + palo? ‘loose’ → p<um>lo? ‘to loosen’ | (Radhakrishnan 1981:150) |

Causativized verbs can undergo further derivation into a nominal with the addition of a nominalizing affix. One such nominalizer is the infix *-in-*, which combines with (disyllabic) verbs and derives instrument nouns. Its baseline behavior with a monomorphemic, non-causativized verb is shown in (18) (Radhakrishnan 1981:146).

- (18) -in- (INOM) + caluak (swallow) → c<in>luak ‘a throat’

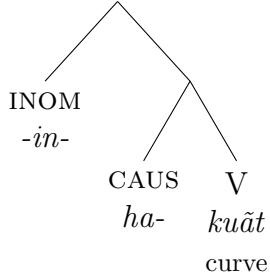
As a phonological sidenote: For both infixes above, (nominalizing *-in-* and causative *-um-*), Kalin (2021) proposes that the pivot/placement of these infixes is that they follow the first vowel of the stem; the resulting vowel hiatus leads to deletion of the stem vowel, with a derivation like that in (19) for (18) (and a comparable one for (17b)):

- (19) -in- + caluak → ca<in>luak → c<in>luak

The relevant question is what happens when nominalizing *-in-* combines with a causativized verb. The answer is that *-in-* does not disrupt the relationship between the stem of the causative and prosodically-conditioned allomorphy of the causative. In (20a), we see that the choice of causative *ha-* with a monosyllabic root survives the linear interruption of *-in-* between the monosyllabic root and causative *ha-*; (20b) shows the underlying morphosyntactic structure for clarity (causative inside nominalizer).

- (20) a. -in- (INOM) + ha-kuāt (CAUS-curve) → h-<in>kuāt ‘a hook’ (R:96)

b.



If the causative morpheme is exponed prior to the exponence/infixation of the instrumental nominalizer, then it is natural that the instrumental nominalizer will not interrupt the more-embedded prosodically-conditioned allomorphy of the causative.

Assuming that inner suppletive allomorphy always survives infixation of an outer morpheme, as borne out by the five other case studies considered by (Kalin 2022), then this furnishes further evidence in favor of bottom-up insertion. This pattern is not predicted under simultaneous or top-down insertion, where infixation would be expected to (at least be able to) bleed such allomorphic relationships.

3.4 Tonal overlays are inwards

Another inward phonological phenomenon is replacive grammatical tone. Grammatical tone is “a tonological operation that is not general across the phonological grammar, and is restricted to the context of a specific morpheme or construction, or a natural class of morphemes or constructions” (Rolle 2018:19). Grammatical tone is called *replacive* when it wipes out the otherwise-expected tone of an item; it is called *concatenative* when it coexists with the otherwise-expected tone of an item.

For example, consider the difference between the following two suffixes in Hausa, (21) (Rolle 2018:9, who cites Newman 1986:252,257). The plural suffix in (21a) introduces a replacive L tone, completely overwriting the underlying tonal pattern of the stem and making

it all L. The referential suffix in (21b), on the other hand, introduces a concatenative low tone, that adds onto the pre-existing low-high tonal pattern of the stem, docking on just the stem-final vowel.

- (21) a. jìmínáá (ostrich) + -Lúú (PL) → jìmìn-úú ‘ostriches’
 b. jààkíí (donkey) + -Ln (REF) → jààkñ-n ‘the donkey’

Both the replacive tone and the concatenative tone in (21) are inward, going from an affix to a stem.

Rolle (2018:Ch. 3) observes a typological restriction: replacive grammatical tone is only ever inwards, while concatenative grammatical tone can be inwards (as in (21b)) or outwards. Concatenative grammatical tone docking outwardly is seen in Kabiye (Rolle 2018:95, citing Roberts 2016), where a toneless class/number suffix gets a floating L tone from the right edge of the root, (22).

- (22) /púlóL + -ne/ → /púló + -nè/ ‘drinking trough’

However, there is no language Kabiye-prime, where tone is outward and replacive, i.e., overwriting the underlying tone of a lexical item that is less embedded. This typological finding of a replacive/concatenative asymmetry is consistent with previous work on grammatical tone (Inkelas 1998, 2014, Alderete et al. 1999, McPherson 2014, i.a.).

Under a bottom-up insertion model, this observation is easy to account for: grammatical tone imposed inwardly can change the tone of inner material (overwriting it) because that more-embedded tone is already present (to be able to be modified/overwritten). But grammatical tone cannot be replacive outwardly, because outer phonological material has not yet been exponed, and so there is no tone there to overwrite; rather, outwardly-imposed grammatical tone can only be additive, co-existing alongside outer tonal patterns. Simultaneous insertion models (like Rolle’s) and those that allow for top-down insertion can capture this observation through imposed constraints on tone association, but it does not fall out automatically from such models.

3.5 Non-local phonological effects

A final empirical domain where we can see the pay-off of bottom-up insertion is in explaining non-local phonological interactions among exponents. It has been observed (by at least Hyman 2000, 2003, Kiparsky 2011, Myler 2013) that “anti-scopal, Mirror-Principle-violating morpheme orders often give rise to non-local morphophonological effects” (Myler 2017:101). And while this has sometimes been used as an argument against (post-)syntactic approaches to morphology, Myler 2017 shows that such effects are actually predicted by bottom-up insertion operating on structures built by phrasal movement.

We will briefly discuss one of Myler’s case studies here, that of the Bantu language Nyakusa (data from Hyman 2000, 2003). In Nyakusa, verbs conforming to the well-known CARP template (V-CAUS-APPL-RECIP-PASS) may display non-local phonological interactions just in case the CARP morphological ordering does not correspond to the syntactico-semantic ordering. The phonological interaction of interest is one where the “superhigh” causative suffix *-j* triggers spirantization of an eligible preceding consonant, e.g., *b* changing to *f*. Now

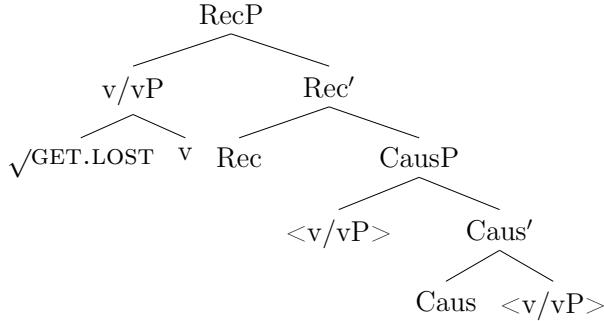
consider the contrast between the meanings and forms of (23a) and (23b), based around the verb root *sob* ('get lost').

- (23) a. sob-an-*j* (get.lost-REC-CAUS) 'get each other lost' = CAUS > REC
 b. sof-an-*j* (get.lost-REC-CAUS) 'lose each other' = REC > CAUS

The morpheme order in (23a) respects the Mirror Principle: CAUS scopes over REC semantically and correspondingly is linearly further from the verb root. The morpheme order in (23b) appears to violate the Mirror Principle, with REC scoping over CAUS semantically. In the MP-obeying order, (23a), the root-final consonant of *sob* is not spirantized; in the MP-violating order in (23b), the root-final consonant *is* spirantized (to *f*), despite not being linearly adjacent to the presumed trigger of spirantization, the causative suffix.

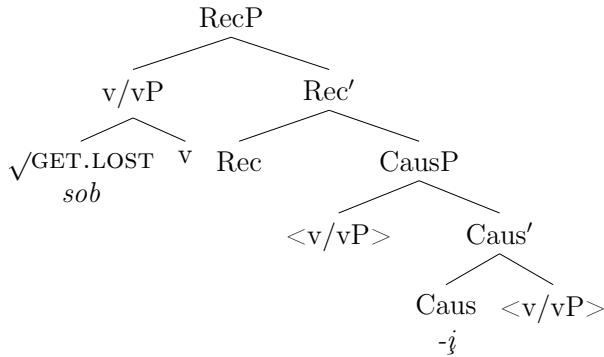
Myler argues for deriving the MP-violating order through phrasal movement of the vP (containing the root) through spec-Caus and into spec-Rec, as shown in (24).

(24)



In this structure, applying the embedding calculus described at the outset of §3, both Caus and the verb root count as the most deeply embedded node in their respective sub-structures, and thus both will be ordered as exponed before Rec. (Caus and the verb root are not ordered with respect to each other because neither projection contains the other.) Thus, Caus and the verb root will undergo insertion before the less-embedded Rec node; this early step of insertion is shown in (25), with only Rec awaiting insertion.

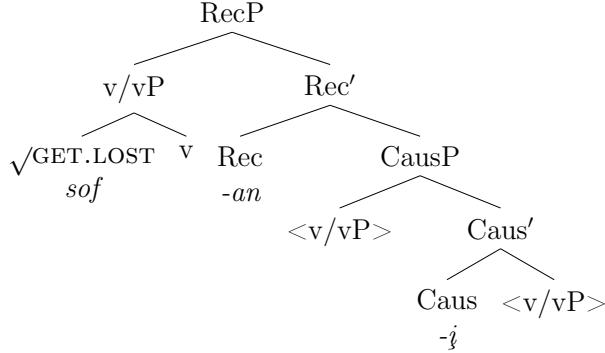
(25)



It is at the derivational stage represented in (25) that it is possible for Caus and the verb root to interact phonologically, with Caus triggering spirantization of the root-final consonant (*sob* to *sof*, not shown in (25)). When Rec is exponed, (26), it linearly intervenes between Caus

and the root; but crucially, the exponent is inserted too late to have blocked spirantization.

(26)



In the MP-obeying order, on the other hand, (23a), no such separate substructures are derived, and so the order of insertion is the expected one, where first the root is inserted, then Rec, then Caus; hence, there is no opportunity for spirantization of the root-final consonant.

While bottom-up insertion provides the tools to understand non-local phonological effects in MP-violating morphological orders, simultaneous insertion and top-down insertion afford no such analytical possibilities. The interested reader is referred to Myler 2017 for more detail and further case studies. (See also Gleim et al. to appear for some case studies about non-local phonological effects which illustrate the use of bottom-up insertion in a pre-syntactic framework.)

3.6 Interim comments

A number of phenomena support the need for bottom-up insertion of exponents. In addition to the types of empirical evidence discussed above, we'd like to draw the reader's attention to recent work on portmanteaus and ellipsis by Banerjee (to appear), who shows that ellipsis also seems to have a bottom-up nature, interspersed with exponent choice. This finding goes naturally hand-in-hand with those discussed here. See also the large body of work on bottom-up cyclicity effects in phonology, including Chomsky and Halle 1968, Kiparsky 1982, and many subsequent works.

Bottom-up insertion is orthogonal to late insertion (§2): a model could have late insertion but simultaneous exponence across the structure being realized (see, e.g., Rolle 2018); or a model could have bottom-up insertion operating over structures formed in the lexicon (see, e.g., Müller 2021); bottom-up insertion is also compatible with (really, built into) incremental theories of morphology. Bottom-up insertion, in a realizational model, has a sort of redundant flavor to it, which Marantz (2010) refers to as “recycling”: the morphosyntactic structure is built from the bottom up, and then exponence starts back down at the bottom of the already-built structure. Note, though, that the “bottom” of the structure may be different at the point of realization than the order of syntactic merger, e.g., due to phrasal movement or other pre-insertion morphosyntactic structural changes (see, e.g., Myler 2017, Kalin 2020). We have no deep explanation for why “recycling” is required, but we'd like to suggest that perhaps there is something about how phonological/prosodic words/structure are built that

can explain it.²⁹ The only models that lack recycling (but have bottom-up insertion) are incremental models, but those have other empirical issues, as discussed in §2, including requiring a sort of inverse of recycling—anticipation of the syntactic derivation (lookahead).

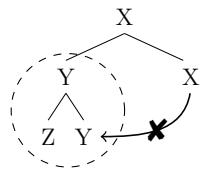
Finally, we want to note that bottom-up insertion of phonological exponents might have other consequences—in particular, it has been proposed by Bobaljik (2000) that exponent insertion overwrites/erases morphosyntactic features, and so inward sensitivity should *only* be to phonological form and other non-syntactic, exponent-specific information, like class membership. For discussion of and potential counterexamples to this proposal, see Carstairs-McCarthy 2001, Adger et al. 2003 and Gribanova and Harizanov 2017.

4 Cycles and domains

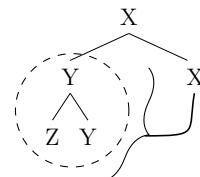
The literature has unearthed a number of robust empirical generalizations that illustrate the utility of cycles and locality domains in constraining morphological realization and processes. So, to wrap up this chapter, we put forward cycles and domains as a candidate for a universal of natural language morphology. (For related topics, see Ch. 15 of this volume, on phases, and Ch. 45, on cyclicity.)

The strictest possible locality condition on morphological processes is immediate adjacency. In this section, we focus on the question of whether morphological processes can be restricted in ways that can't be explained simply with adjacency, but rather require reference to locality domains. Abstractly speaking, arguments for locality domains generally involve the apparent *underapplication* or *misapplication* of processes (see e.g. Kiparsky 1973, 2000, Baković 2011), and domains/cycles in morphology are not different in this respect. The two abstract pictures below illustrate the patterns, with a dashed circle surrounding a locality domain:

(27)



(28)



In (27), we see an abstract underapplication pattern where the node X fails to trigger some process on a head node Y, even though they're adjacent, since they are inside two distinct domains. In (28), we see a misapplication pattern, where a process triggered by X does not only affect its immediately adjacent sister node Y (as we might expect it to) but rather a larger domain that Y is a part of; unlike with an underapplication pattern, with misapplication the process in question actually applies but its target is somewhat different from what might be expected under simple adjacency.

Patterns of underapplication and misapplication can be crosslinguistically systematic (visible at the typological level) and/or language specific (visible within a single language). For example, in the case of underapplication, we might observe that elements of a given

²⁹We are grateful to Alec Marantz for a very helpful conversation about recycling, and the suggestion that it may have a phonological explanation.

type *never* trigger a certain process crosslinguistically, which may lead us to believe that there is a system-inherent factor that enforces this. Or, we might find that, in a given language, a certain type of element generally triggers a certain process but, in a specific set of configurations, fails to do so. We discuss underapplication in the domains of allomorphy (§4.1) and allosemy (§4.2), and misapplication in the domain of clitic displacement (§4.3). We also consider briefly the connection between word-internal and word-external domains (§4.4). As the uses of cycles and locality domains in morphology are just as manifold as their specific implementations, we can do little more than highlight some examples here to illustrate the general line of argumentation from an abstract perspective.

4.1 Domains of allomorphy

It is generally agreed that there is *some* sort of locality condition on suppletive allomorphy (see §2.3.1), in the sense that the trigger and the target of allomorphy cannot be arbitrarily far away from each other. At a first pass, allomorphy often seems restricted to being conditioned by an immediately adjacent morpheme, with allomorphy blocked under intervention (discussed in works as far back as Aronoff 1976, Siegel 1978, Allen 1979, Carstairs 1987). One prominent set of questions that arises in morphological theories with hierarchically structured words is whether linear adjacency or structural adjacency (or some combination of the two) is the correct adjacency-based locality condition, and, whether there are additional domain-based restrictions as well, e.g., the word or even domains within the word. (For an excellent overview, we refer the reader to Gouskova and Bobaljik to appear.)

Recently, a fruitful way to explore locality conditions on suppletive allomorphy has been found in containment structures. This approach was pioneered by Bobaljik (2012), who showed that (i) the superlative contains the comparative, which in turn contains the adjectival root, (ii) while an adjectival root can supplete in *both* the comparative and the superlative, it can't supplete in *just* the superlative, and (iii) suppletion of the adjectival root can only be triggered by a morpheme within the same word domain as the root. These findings together argue for a particular locality domain (the word) *and* some sort of further structural adjacency requirement on allomorphy.

Bobaljik's work is part of (and inspired much of) a lively and ongoing debate about what exactly the right locality conditions are on allomorphy—see, e.g., Embick 2010, Moskal 2015, Merchant 2015, Bermúdez-Otero 2016, Bruening 2017, Deal 2018, Wu 2018, Lee and Amato 2018, Smith et al. 2018, Kalin and Atlamaz 2018, Božić 2019, Choi and Harley 2019, Harðarsson to appear, Middleton 2020, Paparounas 2021. To give one concrete example, Moskal (2015) derives the differences between case-driven suppletion of pronouns (which is common) and case-driven suppletion of lexical nouns (which is unattested with only very few tentative counterexamples) by means of so-called accessibility domains, which are calculated on the basis of category-defining heads (e.g. *n*). For pronouns, which do not need a *n*-head, the case node is inside the relevant accessibility domain, but for lexical nouns, which do have a *n* head, the case node is outside of the accessibility domain. The systematic absence of case-driven suppletion with lexical nouns instantiates the underapplication pattern in (27).

4.2 Domains of allosemy

A second major morphological phenomenon for which locality domains have been invoked is allosemy, which in many respects shows striking parallels with allomorphy. Allosemy can be defined as local polysemy resolution, i.e., where a polysemous root is fixed to one of its possible meanings depending on its context (Anagnostopoulou and Samioti 2014). Unlike with phrasal idioms (though the division is not always so clear), the resolution of (canonical cases of) allosemy is necessarily much more local. One well-known example is the root *globe*, which has several readings (e.g., a spherical object, or the earth), but only has one specific reading when the root undergoes derivational word formation with *-al*, as seen in complex words like *global* and *globalization*, which can only refer to the earth.

In the earliest discussions of allosemy (although not under that name), its existence was taken as evidence for lexicalism, since there seemed to be a special word-internal domain for this semantic narrowing (see, e.g., Wasow 1977, Dubinsky and Simango 1996, Horvath and Siloni 2008). However, as has been shown since then, allosemy can also be accounted for in a non-lexicalist model of morphology by means of locality domains similar to the ones we saw above. Building on earlier work (especially Siegel 1974, Allen 1979, Marantz 1997, 2001), Arad (2003, 2005), Borer (2013) and Anagnostopoulou and Samioti (2014) have all argued that contextually-dependent meaning of linguistic units is constrained by locality domains.

In reference to the two abstract patterns at the outset of this section, the constraints on allosemy instantiate an underapplication pattern, (27): an element X will not be able to trigger a context-specific reading of an element Y if X and Y are contained in two different locality domains. In Arad's (2003, 2005) proposal, it is category-defining heads that determine the upper bound for the assignment of a non-compositional reading of a root. In doing so, she derives the differences between two classes of verbs, which she calls root-derived and noun-derived, and which differ, amongst other things, with respect to semantic flexibility. While roots in root-derived verbs may have a range of different semantic readings, roots in noun-derived verbs are tied to a specific reading, namely the one they were assigned in a previous cycle (when they became a noun). In this theory, it is thus always the first category-assigning head that determines the specific reading of a root.

Borer (2013) criticizes several aspects of Arad's theory as overly restrictive, and argues instead that assignment of a reading may be optional within a cycle, thereby allowing for bigger domains for allosemy. To give a concrete example from Borer 2013: there are internally-complex words that have a very specialized meaning, such as *editorial*, which refers to a specific type of piece written by an editor (rather than anything an editor could write). Crucially, subsequent derivations building on *editorial*, such as *editorialize*, contain the fixed meaning of *editorial*. (See also Rasin et al. 2021 for arguments against Arad's generalizations.) While the precise definition of when, where, and how meanings are fixed (of roots or larger structures) is still up for debate, we are still dealing with an underapplication pattern, where a locality domain is used to constrain the ways in which outer elements can lead to new readings of a more deeply-embedded expression.

The relation between domains of allomorphy (§4.1) and domains of allosemy has been investigated by Borer (2013), Marantz (2013a) and Harðarsson (to appear), who arrive at the promising conclusion that the two domains can in many cases be identified with each other. Interestingly, a point made both by Borer (2013) and Harðarsson (to appear) is that

we often find mismatches between domains picked out by morphophonological processes on the one hand and allosemy and allomorphy on the other. It remains to be seen how exactly to put all the pieces together.

4.3 Clitic displacement

Critic displacement is another morphosyntactic domain where locality domains have proven to be extremely useful. As is well-known, the placement of clitics often seems to defy the typical syntactic rules of a given language, but is in itself completely regular. Thus, many theories of morphosyntax allow for at least a subset of clitics to be repositioned in some systematic way *after* the syntactic structure has been built. This is, of course, common in post-syntactic theories of morphology such as DM, but occasionally also invoked for some clitics in other theories (see e.g. Halpern 1995 or Bruening 2017). The general rules determining clitic placement are still poorly understood, and concrete proposals are often language-specific in scope (though there are some counterexamples—see Marantz 1988, Embick and Noyer 2001, 2007, Anderson 2005). As a result, we still don't know much at a typological level about how clitic placement interacts with morphosyntactic locality domains, though there have been a few case studies.

One relevant case study is found in Kramer 2010, which discusses the NP-internal placement of the definite determiner in Amharic. The determiner usually appears right-attached to the first word of the NP, (29a), but appears further rightward in some configurations where the NP-initial constituent is complex, as shown in (29b) (Kramer 2010:198-199):

- (29) a. t'ik'ur-**u** dimmät
black-DEF cat
'the black cat'
- b. [t̪inant̪inna yä-mät't'-a]-**w** tämari
yesterday C-come.PF-3MS-DEF student
'the student who came yesterday'

Kramer analyses this as a late post-syntactic dislocation process in which the determiner, which is base-generated NP-initially, is dislocated to a position to its right. Crucially, this dislocation process is subject to the Phrase Impenetrability Condition (Chomsky 2000, 2001) and, as a result, it has to skip phrases completed in an earlier phase (the bracketed constituent in (29b)). Thus, the determiner dislocates across an entire domain rather than across a simple word. This is an instance of the misapplication pattern in (28): we expect dislocation relative to just the closest word, but instead dislocation applies to a larger constituent because of a domain boundary.

4.4 Morphological and syntactic domains

Are word-internal (morphological) and word-external (syntactic) domains the same? One might assume that—given a syntax-based late insertion model—the answer would trivially be yes. But, recent years have seen a number of different formalizations of the idea that, even in a late insertion model, word formation has some properties that should not be

dealt with in the syntax proper, at least in some languages (see e.g. Marantz 1988, Embick and Noyer 2001, Compton and Pittman 2010, Harley 2011, Harizanov and Gribanova 2019, Arregi and Pietraszko 2018, Ershova 2020, Fenger 2020, Kalin 2020, Georgieva et al. 2021). If that is correct, then an interesting question concerning locality domains arises: are post-syntactic word-formation processes restricted by the same kind of locality domains as syntactic word-formation processes? A few works have engaged with this question—see Bobaljik and Wurmbrand 2013, Kilbourn-Ceron et al. 2016, Piggott and Travis 2017, Fenger 2020—but it is still an underexplored area.

We will briefly look at the discussion of phases as a relevant notion of word-internal locality domains in Fenger 2020. Fenger observes that several morphosyntactic and morphophonological diagnostics all point to the conclusion that complex verbs in the two head-final agglutinating languages Turkish and Japanese consist of several domains. On the syntactic side, she notes what looks like one complex verb in a simple case, (30a), consists of several parts that can be coordinated, (30b), separated by a question particle, (30c), or elided (not shown here). On the phonological side, she shows that stress, which usually falls on the last syllable of a word, can fall on an earlier syllable in precisely the types of words with this internally complex behavior, (30d).

- | | | |
|------|---|--|
| (30) | <p>a. kal-iyor-du stay-PROG-PST 'was staying'</p> <p>b. [gel-miṣ] ve [git-miṣ]-ti-m come-PRF and go-PRF-PST-1SG 'I had come and gone'</p> | <p>c. yakal-iyor=mu-y-du catch-PROG=Q-Y-PST 'Was s/he catching it?'</p> <p>d. kal-'iyor-du stay-PROG-PST 'was staying'</p> |
|------|---|--|

The most relevant observation for our purposes here is that the word-internal locality domains which Fenger 2020 identifies are exactly those which are evidenced in clausal phenomena (see Ch. 15 of this volume): while derivational, valency-related, and aspectual affixes are part of the inner domain, tense and agreement affixes are part of the outer domain. This shows a promising path for identifying the same locality domains both within and outside of words.

4.5 Interim comments

The discussion above focused mainly on morphological evidence for domains and cycles, but—as alluded to a number of times throughout this section—one goal of work on morphological locality domains (in particular in late insertion frameworks) is to tie morphological domains to the same notion of the phase as introduced in the MP in Chomsky 2000, 2001 (see Ch. 15 of this volume). It is important to note, though, that not all the accounts here presuppose the same notion of phase, and certainly more research will be required to see whether the different concepts labelled “phase”, “spell-out domain”, and “accessibility domain” can be made compatible with one another.

A related line of research in recent years investigates in which ways morphosyntactic domains are equivalent to (or at least related to) phonological and prosodic ones. A growing body of work takes a strong stance, that the notion of the syntactic phase is immediately relevant for phonological processes such as stress assignment, vowel harmony, grammatical

tone, etc. (see among many others Pak 2008, Newell 2008, Newell and Piggott 2014, Fenger 2020). The advantages of this approach, as well as its limits (see in particular the paper by D’Alessandro and Scheer 2015, and the response by Bonet et al. 2019), are continuing to be explored, and the findings will of course have a direct impact on the notion of domains and cycles in morphology as well.

On a final note: all of the discussion above ignored the traditional kind of morphological domain inspired by phonology, i.e., strata (see e.g. Siegel 1974, Allen 1979, Kiparsky 2000, Bermúdez-Otero forthcoming). We do not attempt here to explore whether a stratum-based approach would allow us to capture (all or a subset of) the above-mentioned diagnostics for morphological domains in a natural way, nor do we broach the possibility of equating phases and stratum, a challenge well outside the scope of this chapter.

5 Conclusion

The framework put forward in the Minimalist Program relies on one or more relatively powerful morphological components of the grammar to explain the form of words, outside of the purview of syntax. While MP, narrowly construed, makes few commitments in the area of morphology, nevertheless MP is compatible with a variety of morphological approaches. In this paper, we have evaluated such approaches in the face of a variety of empirical considerations, arguing for the possibility of three universals of morphological architecture: morphology is realizational and post-syntactic (§2), realization proceeds from the bottom up (§3), and realization is constrained by domains/cycles (§4).

To conclude the paper, we briefly mention some other potential universals of natural language morphology (§5.1), and we offer a short evaluation of what we have gained in the course of this discussion (§5.2).

5.1 Other potential universals

This chapter highlighted a few of the (we think) most prominent and empirically well-supported candidates for universals of morphology, but it is clear that these are not the only ones we could have discussed. Similar to the empirical and theoretical support for late insertion, §2, there are many benefits of adopting late linearization, i.e., the assumption that syntactic structures are underdetermined with respect to linear order, and that linear order is only calculated after some/all of the syntactic derivation is complete (e.g., Kayne 1994, Chomsky 2007, Idsardi and Raimy 2013; see also Ch. 42-44 of this volume). This direction of inquiry has, in our view, been particularly fruitful in conjunction with late insertion, as many morphological and morphophonological processes make reference to linear order (see Fox and Pesetsky 2005, Marušić et al. 2007, 2015, Bhatt and Walkow 2013, Arregi and Nevins 2012, Smith to appear, *i.a.*).

Another potential area to dig for universals is with respect to potential submodules of morphology, as famously advocated in Arregi and Nevins 2012 (see also Embick and Noyer 2007, Embick 2007, 2010). The argument in these works is that the externalization of syntactic structures (consisting of roots and abstract features) as linearized strings of phonetic elements proceeds in small discrete steps, and that different morphological operations

have fixed positions in that step-wise derivation. A related question is whether (aspects of) morphology and phonology are in a fixed sequential order (either wholesale, or within smaller interleaved cycles), or alternatively whether morphology and phonology are (at least partially) simultaneous; for differing views and discussion, see, e.g., McCarthy and Prince 1993a,b, Paster 2006, Yu 2007, Wolf 2008, Bermúdez-Otero 2012, Bye and Svenonius 2012, de Belder 2020, Kalin 2020, To Appear, Rolle 2020, Stanton 2020.

Crosslinguistic universals might also be found concerning the featural makeup of morphological categories, as well as the concomitant markedness asymmetries. We find strong tendencies and potentially even exceptionless generalizations as to how languages divide the logical space of grammatical categories, but views differ as to whether this classifies as a universal in the sense used throughout this chapter. On morphological markedness in general, see Moravcsik and Wirth 1986, Battistella 1990, Haspelmath 2006; on morphological markedness in the context of morphological theory see Harley and Ritter 2002, Nevins 2011, Weisser to appear.

Lastly, much of the discussion in this chapter has assumed a morpheme-based approach to morphology, as opposed to a lexeme/stem-based approach; for the latter type of approach, see amongst many others Anderson 1992, Aronoff 1994, Beard 1995, Stump 2001. And for recent discussions of some of the issues at stake, see Marantz 2013b and Leu 2020.

We are sure there are many other areas for potential exploration of universals, but we leave our discussion here.

5.2 What have we gained?

Early Minimalism posited a largely unconstrained morphology, with words able to be formed pre-syntactically, syntactically, and post-syntactically, and the morphological module as a sort of black box, converting simple syntactic structures into complex morphological representations. Alongside developments in theories of morphology, especially in DM, later Minimalism has moved towards a late insertion approach, though still largely stays away from committing to a particular model of the morphological module.

DM’s toolbox—i.e., what lurks inside the black box—is rich and not without controversy, including a variety of post-syntactic operations beyond Vocabulary Insertion, commonly the following: Lowering, Local Dislocation, Impoverishment, Morphological Merger, Fusion, and Fission. To the extent that this toolbox can serve to model and constrain “irregularities” in natural language morphology, it relieves the narrow syntax of this burden, facilitating a highly Minimalist syntax indeed.

On a late insertion approach, feeding into syntax is the narrow lexicon, which has itself also been streamlined in recent years. This pre-syntactic lexicon consists of roots and functional morphemes (features and/or feature bundles), without any phonological content. It has also been proposed that semantic content should be divorced from the narrow lexicon and subject to late insertion, leaving us in the end with a truly Minimalist lexicon; see especially Borer 2005, who takes her approach to follow in the footsteps of Harley 1995, van Hout 1996, Kratzer 1996, Marantz 1997, and see also Pietroski 2006, Lohndal 2014, Wood and Marantz 2017, Wood 2020, Preminger in prep.

In this chapter, we have defended three potential universals of the morphological engine of natural languages—insertion of phonological forms is late and proceeds from the bottom

up; and morphological processes are constrained by locality and domains. Each of these universals of the grammatical architecture has a variety of convergent evidence in its favor, and thus goes a long way in explaining crosslinguistic morphological facts. We have not, in this chapter, discussed what these universals might stem from—whether they must be attributed to UG, or are attributable to the acquisition process or to third factors, including communicative and (non-linguistic) cognitive pressures. Late insertion might be best seen as a by-product of a pared-down narrow lexicon (the latter constrained by UG, perhaps?). Bottom-up insertion seems non-optimal, in that it requires “recycling”, though perhaps it has a phonology-based explanation (see discussion in §3.6). Locality, domains, and the existence of cycles all have potential cognitive explanations, and so may belong more properly to the domain of third factors. But these are mere speculations, and we leave this for future work to investigate.

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