Minimalism, morphology, and the lexicon: Then and now

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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 theoretical and empirical burden onto morphology: morphology in a pre-syntactic 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 is responsible for all "complexity and variety" (Chomsky 2014:xi) in how a syntactic structure is externalized, via a post-syntactic "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 very little serious consideration to developing a theory of the lexicon or of the phonological component.

On the lexicon, MP makes few commitments. The lexicon is taken to include unitary collections (lexical items) built from features that are made available by 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 (to be interpreted at LF), 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 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).

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

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[1]Chomsky on the Borer conjecture, which MP largely adopts: "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).

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 there are true universals of morphology, quoting Jespersen, who famously said "no one ever dreamed of a universal morphology."[2] The implication is clear: UG is for syntax, while morphology is a grab bag of exceptions, arbitrariness, and relatively unconstrained variation.

Prior to the rise of Minimalism, work in morphology typically assumed that words were the atoms of syntax, and that the morphological module stood on its own, without any meaningful interaction with syntax; 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.[3] Coinciding with the early days of Minimalist theorizing, Distributed Morphology (DM) was born (Halle and Marantz 1993, 1994), which takes morphology to be "syntax all the way down". 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 sort of 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 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 and the lexicon has changed substantially. The empirical and theoretical picture has become much more nuanced, and we now ask much more fine-grained questions about the nature of lexical items and interactions between morphology and syntax, as well as interactions among phenomena that sit at their interface. Some of these changes are reflected in later MP, including moving away from a lexicalist model (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) the adoption of valuation (via Agree) as opposed to checking (via a spec-head relationship) in MP, allowing for dynamic feature valuation and feature interactions during the course of the syntactic (and post-syntactic) derivation; (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

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[2]Though Chomsky does occasionally concede that "there are doubtless constraints on how externalization takes place" (Chomsky 2014:xi).

[3]There are two notable (types of) exceptions to this generalization. First is the morphological theory proposed by Lieber 1992, which locates word formation in the syntax; note, though, that words are always X^0s, and there is no substantial interaction between syntactic elements above and below the X^0 level. Second are morphological theories that adopt what is known as the Split Morphology Hypothesis, where derivational morphology and inflectional morphology belong to different parts of the grammar, with the latter being syntactic in nature (see, e.g., Anderson 1982, 1992).

of morphosyntactic diversity in the world's languages; and (c) an explosion of empirical research into morphosyntactic phenomena, which have provided a fruitful testing ground for morphological theory, including DM but also others—see, e.g., Nanosyntax (Starke 2009, Caha 2009, 2020) 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 of natural 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 universals of morphology. We consider and defend three specific candidates for universals: late insertion (§2), bottom-up insertion (§3), and domains/cycles (§4). Finally, we step back and consider what we've gained through these developments, and where the field goes from here (§5).

2 Late insertion

Late insertion, stated as generally as possible, is the proposal that the atoms of syntax do not have a phonological form, but rather that phonological realization is separate from and after (at least some) syntactic structure building. Late insertion in the broadest possible sense is a hallmark of a number of otherwise very diverse morphological theories, including DM (Halle and Marantz 1993, 1994), Nanosyntax (Starke 2009, Caha 2009), Consolidated Morphology (Bruening 2017), A-morphous/Affixless Morphology (Anderson 1992, Aronoff 1994, Beard 1995), and Paradigm Function Morphology (Stump 2001, 2016). We use the term late insertion in a more specific way, which we take to be consistent with its conventional use, to refer to theories that (in addition to taking phonological realization to be post-syntactic) are morpheme-based and form words in (and potentially after) the syntax, as exemplified most prominently by DM and Nanosyntax.

In The Minimalist Program, Chomsky positions himself as open to late insertion, on the basis of phonologically-suppletive forms like the English copula, 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[exical] 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).

Apart from the fact that the Minimalist early-and-late insertion model involves a complexification of the grammar, it's crucial to note that it is not just the existence of suppletive allomorphy that supports the need for late insertion. There are a diverse array of motivations for late insertion, and it is these motivations that this section turns to. In particular, we will discuss support for late insertion from (i) the role of the syntactic derivation and syntactic structure in word formation and exponence (§2.2), (ii) the nature of exponents/exponence

(§2.3), and (iii) the lack of phonological effects in syntax (§2.4). 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 aspect of natural language morphology. Before turning to arguments for late insertion, we first briefly lay out a (we hope) helpful 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 e.g. Stewart 2016 for an attempt to list and discuss the most prominent ones), we want to define some important 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: (i) where in the grammar words are built, and (ii) whether word forms *introduce* meaning/features or *reflect* meaning/features.[4]

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 (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). Theories taking the (a) position are known as "lexicalist", in that words are formed in one or more components of the grammar (including at least the lexicon) that are wholly separate from the syntax;[5] such theories may be morpheme-based or process-based. With respect to (ii), we are referring to a 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).

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

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[4]This classification is of course not exhaustive. See e.g. Stump 2001, Stewart 2016 for other important dimensions along which theories differ. The classification discussed here is only intended as a reference point for the discussion throughout this chapter. Stump (2001) for example also classifies theories as to whether they assume the independent existence of affixal morphemes in the lexicon or not, an issue we do not address directly in this chapter.

[5]This term comes from the Lexicalist Hypothesis (Chomsky 1970), which states that the syntax manipulates 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.

	Lexicalist	Non-lexicalist	
	Non-syntactic word formation	*Syntactic word formation*	*(Post-)syntactic word formation*
Incremental	Wunderlich 1996; Stiebels 2002	Lieber 1992; Collins & Kayne 2021	*(unattested?)*
Realizational	Anderson 1992, 2005; Beard 1995; Stump 2001, 2015; Müller 2021	Starke 2009; Caha 2009, 2020; Bruening 2017	Noyer 1992; Halle & Marantz 1993, 1994

Table 1: A typology of morphological theories

We take the term "late insertion" in its conventional use to delineate a realizational model where word formation is primarily syntactic (and potentially also post-syntactic). In other words, this term picks out the second and third cells in the bottom row of Table 1, thereby including Distributed Morphology, Nanosyntax, and Consolidated Morphology.

In the remainder of this section, we will present a variety of arguments for late insertion, as defined above. 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), triangulates to what in our view is the most adequate model, namely the bottom rightmost cell, which includes Distributed Morphology. We want to note however that the adjacent cell (syntactic word formation-only models) can also account for many of these facts, and so more work is required to investigate in detail which arguments distinguish those two types of models/cells.

2.2   Arguments for non-lexicalist models

In this section, we present a series of arguments for non-lexicalist models, i.e., models that deny that words are formed/stored in the lexicon (potentially in addition to another non-syntactic component of the grammar), and instead take words to be formed in the syntax and/or post-syntax; see Table 1.

2.2.1   The role of syntax in word formation

The most basic argument against lexicalism 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) (Baker 1985:374f). Along similar lines, the relative closeness of tense, aspect, and mood morphemes to the root correlate with their proposed syntactic hierarchy (see, e.g., Demirdache and Uribe-Etxebarria 2000, Julien 2002). Such Mirror Principle obeying orders are found across

morphosyntactic domains. Perhaps the simplest way to account for this observation is to have the morphological structure of words fall out 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 Minimalism) a complex "checking" procedure.

The potential wrinkle, of course, comes from cases where the Mirror Principle seems to be violated—when morphological structure 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 2020b). 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 structure 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.

A particularly striking example of syntax-morphology misalignment comes from 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, there is a copy of the embedded verb, e.g. (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, which he analyzes 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 embedded verb—cannot be pied piped, (2) (copied material 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 into head noun position, but past tense marking cannot be copied, even though (in the relative clause) tense is suffixal on the verb. These data are difficult to explain if the verb is "born" inflected in the VP, 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 joins with the verb either syntactically or post-syntactically.

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 and predict unattested ways a word's form/structure might deviate from the syntax. In other words, word formation must primarily be an issue of syntax (plus potential additional operations in the post-syntax).[6]

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": the root GOOD can supplete 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. Beyond simply being in the same word domain, there appear to be further restrictions on what can influence exponent choice, though exactly what those restrictions are is much debated. See §4.1 for some additional discussion.

Further cases of syntax and word formation feeding exponence are taken in up §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.

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 beyond specific frameworks (see Tallmann 2020 for a recent overview), many theories 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,

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[6]Though Lieber's 1992 model of morphology locates word formation in the syntax, the facts discussed in this section also argue against her particular approach, where word formation happens below the X^0 level.

negation behaves like a bound morpheme with respect to word order and morphophono-logical processes. Thus, even a very specific notion such as 'morphosyntactic word' does not yield coherent results and cannot be maintained. Another case is discussed in Fenger (2020), where certain restructuring verbs in Japanese behave like they are part of the same morphosyntactic word as their complement verb for word order and morphophonological properties, but behave like a separate morphosyntactic word for processes like conjunction.

In late insertion models, such facts can be accommodated fairly straightforwardly since the notion of 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 another 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 Clyded" and "know-it-all" (Bruening 2018:4-5; see Bruening 2018 as well as Carnie 2000 for many more). And consider A-N-N compounds in German and Dutch (Ackema and Neeleman 2004, Barnickel 2014, de Belder and van Koppen 2014), like those in (3).

(3) a. Ein-e   Rot-es   + Kreuz   + Schwester
         A-FEM red-NEUT + cross.NEUT + nurse.FEM
         'a red-cross nurse'
     b. Ein-e   Rot-e   + Kreuz   + Schwester
         A-FEM red-FEM + cross.NEUT + nurse.FEM
         'a red-cross nurse'   Barnickel 2014

The agreement borne by the adjectival element in the compound (*rot*) is underdetermined—it can agree with either noun in the compound. This seems to indicate that agreement can either apply before or after compounding, deriving (in turn) the difference between agreeing with the closest noun, (3a), and the head noun, (3b).

We contend that only syntactic (and post-syntactic) word formation provides the flexibility needed 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, Crysmann 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 Crysmann (2000), who meticulously applies all the relevant clitic vs. affix diagnostics to weak pronouns and some non-argumental elements in European Portuguese. Crysmann 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 "infixed" in between the verb and tense/mood markers in future or conditional contexts, (4). Importantly, Crysmann independently identifies the tense and mood morphemes as affixes.

(4) Monstrar-no-los-á.
      Show-us-them-FUT
      'He will show them to us.'   Spencer 1991:366

On the other hand, however, these items show a certain amount of word order freedom, as they can appear pre- or post-verbally, (5a,b), a choice which depends not only on the features of the element itself but also of the syntactic context. Further, these elements can take wide scope over coordinated constituents, (5c), a diagnostic that has been claimed as a strong argument in favor of a clitic status (see Miller 1992).

(5) a. Os alunos   telefonaram-**lhe** todos.
         The students phoned-him   all.
         'All the students phoned him.'
     b. Os alunos   todos **lhe**-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.' Barbosa 1996

Against the background of this data, Crysmann concludes that "transitional types do indeed occur" (2000:121). The modeling 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 an the morphological component can contain independent morphs, which may, at least potentially, be linearized discontinuously by the syntax. Finally, Crysmann 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 are not necessary in a framework in which the difference between affixes and clitics is less important. As discussed in the previous section, it is in fact expected to find mismatches, for example of the sort observed in European Portuguese (depending in part on what one assumes about the inventory of possible post-syntactic operations) 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, Georgieva et al. 2021, Fenger 2020).

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, we would like to note that cases of this sort may also very well be problematic for certain non-lexicalist theories, such as that of Bruening (2017), where affixes are base-generated as adjoined to their host and then licensed by functional heads via Agree throughout the derivation.

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. (See Ch. 28 for more on features.) 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.

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 Ch. 20). 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 (6) (bracketed constituent elided).

(6) 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 esteve aqui e   a   Maria também vai [estar aqui].
         the João was   here and the Maria also   goes be.INF here

         Intended: 'João was here and Maria will [be here] too.'

Under a model where adjectives and verbs are fully inflected upon entering the syntax, there needs to be a story about why the type of inflectional mismatch in (6a) is tolerated under ellipsis, but not the type in (6b). 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, (6a).

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 the vignette on phi-agreement in this volume).[7] The appearance of some affixes is thus negatively defined. Lopez gives the following simple example from Icelandic (Sigurðsson 1996), where the verb and the participle inflect for default values (3SG.NEUT) when there is no accessible nominative subject to agree with.[8]

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[7]For similar findings in the domain of case, see Schütze 1997.

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

(7) Stelpunum   var   hjálpað
    girls.DAT.PL.DEF be.PST.3SG helped.3SG.NEUT
    'The girls were helped.'   Sigurðsson 1996:9 (gloss adapted)

This pattern is easy to describe in a valuation-based model of Agree, where default agreement is the result of the probe having tried to find an accessible argument to agree with 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 (7) 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, to appear) argues that differences between languages which do exhibit the Anaphor-Agreement-Effect (Rizzi 1990, Woolford 1999) and those which do not can be attributed to whether the anaphor already has its phi-features (via valuation by its binder) at the point when it is targeted for agreement. If the anaphor has not yet agreed with its binder, it has no phi-features itself and thus cannot control agreement on the verb. But if the anaphor has already agreed with its binder at the point when it is probed, then it *can* control agreement. Such asymmetries are straightforwardly captured in a valuation model—a head simply cannot participate in agreement if it has no valued features (yet). In checking models, where the items in question already have their features from the outset, such asymmetries are not predicted.[9]

All of the above arguments in favor of a valuation model over a checking model are also arguments against pre-syntactic lexicalism (where fully-formed words are the input to syntax)—the syntax plays a central role in determining the features present in words. A valuation model also necessitates a *realizational* theory of morphology (see Table 1), because—by definition—the elements that enter the syntax lack (certain) feature values, and so it is not possible to know (yet) what morphemes/phonological forms these elements should correspond to. Note that realizational, lexicalist theories that have a matching procedure between words and the output of syntax, like Paradigm Function Morphology (Stump 2001, 2016), are also compatible with a valuation model. And conversely, non-lexicalist models that employ checking as opposed to valuation (like Bruening's 2017 Consolidated Morphology), face the same problems as lexicalist and incremental models with respect to the arguments in this section.

We now turn to further arguments for realizational theories.

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[9]In 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).

2.3   Arguments for realizational models

The previous section focused on arguments that primarily speak against a syntactically-independent morphological module (i.e., arguments against lexicalist models). This section turns to arguments 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. These arguments thus focus on the nature of exponents/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

Suppletive allomorphy describes a situation where there are multiple replacive (i.e., non-phonologically-derived) realizations for a morpheme. In such cases, there is obviously a deviation from the idealized lexical item of early Minimalism, which was taken to be a triplet of (i) a phonological form, (ii) semantic features, and (iii) formal features. In the face of suppletive allomorphy, e.g., of the English copula (*be, is, am, are, were, was*) Chomsky admitted the possibility of late insertion for certain items (as discussed in the introduction to this chapter). Suppletive allomorphy is found throughout the languages of the world, especially commonly for inflectional affixes, 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, Kalin 2020a).

Suppletion is challenging for incremental models because the contextual environments that condition suppletion may be "outward" relative to the exponent at hand. Root suppletion, for example, is always outwardly-sensitive, as seen in the famous case of the adjective *good* being realized as *bett* in the context of the comparative suffix, *-er.* If exponents are introduced "incrementally", from the root outward, then there should be no accessible outer material for the form of an exponent to be sensitive to. To achieve this, an incremental model would either need to deny the existence of suppletive allomorphy altogether (as Collins and Kayne 2021 do) or build in significant checking/look-ahead. Some suppletive allomorphy is similarly challenging for pre-syntactic lexicalist models: an exponent's conditioning environment can depend on the syntactic context, even a *derived* syntactic context (see §2.3.3.).

2.3.2   Underspecification and elsewhere

Exponents are commonly underspecified for feature contrasts and can have "elsewhere" (negatively-defined) environments. Consider "L" agreement marking in Turoyo (Neo-Aramaic; Turkey; Jastrow 1993, Kalin 2020b): *li* (1sg), *lan* (1pl), *lǝx* (2m.sg), *lax* (2f.sg), *lxu* (2pl), *le* (3m.pl), *la* (3f.sg), *lle* (3pl).[10] 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

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[10]These 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.

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]. 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 (either as a metasyncretism, or as a property of lexical items), it is not plausible to make the same move for *first person*, as first person nominals do trigger gender agreement in the adjectival system. (This example/argument is similar to those offered by Bobaljik 2017, using Russian and Stump 2001:8, using Bulgarian.)

The Turoyo example above shows how underspecification can be used in a late insertion framework to model syncretism across a natural class of feature bundles (e.g., the first person feminine/masculine syncretism), which we call "shared feature syncretism", adopting a term from Kramer (2016). Relative featural underspecification can also be used to model "nonshared feature syncretism"—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 realizations, one specific to singular feminine, (8a), and the other for all other definite determiners (which don't otherwise form a natural class separate from feminine singulars), (8).

(8)   a.   [D, DEF, +F, -PL] ↔ -wa
       b.   [D, DEF] ↔ -u

Nonshared feature syncretisms can be modeled naturally via a realizational model with the Elsewhere Principle (also called the Paninian Principle). In the Amharic case, 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-singular and non-feminine determiners display a syncretism of the nonshared feature type.

Finally, an elsewhere distribution may result from differences in specificity across the *contextual environment* for insertion of different exponents for the same morpheme. For example, see the nominalizer in Bahnar (Banker et al. 1979, Kalin 2020a), which has three suppletive realizations:

(9)   a.   NOM ↔ a- / TIE.UP
       b.   NOM ↔ bɔ- / *m*-initial stems
       c.   NOM ↔ -ɔn- / elsewhere

Here, all of the exponents realize the same feature/terminal. Whereas the distribution of *a-* and *bɔ-* can 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, 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. This kind of indirect relation can be modeled with various tools, in particular with the Elsewhere Principle and Subset Principle (as in Stump's Paradigm Function Morphology, Müller's Harmonic Serialism Morphology, and Distributed Morphology) or with the Superset Principle (as in Nanosyntax), but the crucial point here is that some sort of indirect relation is necessary (see Anderson 1992, Marantz 1997, Stump 2001 for the same point). This, in turn, shows that a realizational framework is empirically more adequate than an incremental model. In an incremental model (such as Wunderlich 1996 or Collins and Kayne 2021), where the morphemes in question contribute the morphosyntactic features themselves directly, such indirect relations are difficult to model. To give a concrete example, if the Turoyo first person singular agreement morpheme *li* (see above) really does not contribute gender (rather than being underspecified for it), then it would remain a mystery as to how it can control gender agreement on adjectives.

2.3.3 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) that can be understood as a retreat to the unmarked in a marked environment.

To illustrate, we draw on 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, (10b).

(10) 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 (10b), 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 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, a.o.

Instances of a retreat to the unmarked in a marked environment shows again that it is crucial to have exponence follow the syntactic derivation, as is true for realizational, non-pre-syntactic theories of morphology. Other types of models are forced to have significant lookahead and 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 poignantly in the Principle in (11):

(11) 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)

While we do not have the space to discuss the concrete empirical implications of the PPFS as well as the potential counterexamples here, we want to note that it is our impression that the vast majority of current frameworks adopt it in one way or another (for discussion see e.g., Zwicky 1969, Hetzron 1972, Zwicky and Pullum 1986, Miller et al. 1997).[11]

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):

(12) 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 (11) and (12) 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.[12]

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

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[11]For 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.

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

the lexical items that constitute the atoms of syntax, and the latter because realization is intra-syntactic.[13] 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.

2.5   Interim comments

The preponderance of empirical evidence seems to us to point 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.

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). 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 "morphomic" 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, we refer the reader to Kramer 2016, and to Trommer 2016 on ways to reconcile late insertion with morphomic distributions.

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 Distributed Morphology under the term "cyclicity"). Bottom-up insertion

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[13]Note 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.

is found in some form across many different types of morphological frameworks, both incremental and realizational (e.g., Anderson 1982, 1992, Kiparsky 1982, 2000, Wunderlich 1996, Bobaljik 2000, Paster 2006, Embick 2010). 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, Rolle 2018) 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 (13) below, x is the most embedded, followed by y, followed by z.

(13)
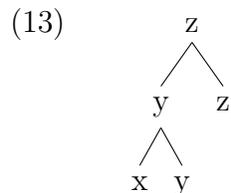
According to bottom-up insertion, then, node x would be exponed before node y, and node y before node z. To see how this definition would order exponence in more complex structures generated by phrasal movement, the reader is referred to §3.5 below, and to Myler 2017.

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 (1), 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 insertion 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 morphological universal.

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:ʔ-* 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, most notably by Paster 2005, 2006, 2009, but also by Dolbey 1997, Bobaljik 2000, Embick 2010, Kalin 2020a,b, 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 not to our knowledge 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., (14) (Blevins 1999:386).

(14)   -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 (14).

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 (15).

(15)   -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 2020a, in considering 49 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.

Consider Leti again. 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 (14)/(15)), it can be re-verbalized (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, it can't, as seen in (16).[14]

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

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

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, e.g. 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 (16) 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 (NE 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., (17) (van den Berg 1995).

(17)   a.   áhu (take) + -á- (VPL) → ɑ<**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)

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[14]Note 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).

e. íx-lə (warm-VBLZ) + -á- (VPL) → ix<**á**>-le[15] (van den Berg 1995:308)

As can be seen in (17), 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 (15), 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:

(18) The verbal plural with outer tense marking (van den Berg 1995:82)
      r-i<**yá**>ƛe-n (cf. *r-iƛe<**yá**>-n or *r-iƛ<**á**>-n)
      PL.CLASS-kill<V.PL>-PRET.GER
      'killed (iterative, plural object)'

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, *iƛe*.

    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—infixation should be able to look and move in an outward direction.

    A final note here is that this result holds no matter what specific account of infixation is assumed—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 2020a) or don't (e.g., Yu 2007) start out life as a prefix/suffix. Under any sort of account, to explain this directionality asymmetry, 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 2020b), and Nancowry (Kalin 2021b), Kalin (2021a) 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.

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[15]There 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).

In Nancowry (Radhakrishnan 1981, Kalin 2021b), 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:

(19) a. CAUS ↔ **ha-** / monosyllabic stems   (20a)

      b. CAUS ↔ **-um-** / disyllabic stems   (20b)

(20) a. CAUS + pin 'thick' → **ha-**pin 'to thicken something' (Radhakrishnan 1981:111)

      b. CAUS + paloʔ 'loose' → p<**um**>loʔ '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 (21).

(21) a. **-in-** (INOM) + calɯak (swallow) → c<**in**>lɯak 'a throat'

                                                                    (Radhakrishnan 1981:146)

      b. **-in-** (INOM) + tikoʔ (prod) → t<**in**>koʔ 'a prod'   (Radhakrishnan 1981:97)

Note that for both nominalizing *-in-* and causative *-um-* above, Kalin (2021b) 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 (22) for (21a) (and a comparable one for (20b)):

(22)   **-in-** + calɯak → ca<**in**>lɯak → c<**in**>lɯak

Of course, the relevant question now 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.[16] In (23a), 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-*; (23b) shows the underlying morphosyntactic structure for clarity (causative inside nominalizer).

(23) a. **-in-** (INOM) + <u>ha</u>-kuãt (CAUS-curve) → <u>h</u>-<**in**>kuãt 'a hook'   (R:96)

      b.

─────────────────────
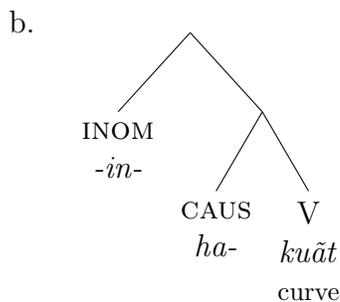
[16]I do not show the *-um-* allomorph surviving infixation of the nominalizer because infixation of *-um-* followed by infixation of *-in-* actually results in the surface-disappearance of *-um-*; this can be explained by completely predictable phonological/phonotactic repairs within the language, but would take us too far afield here. See Kalin 2021b:13-14.

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 seven other case studies considered by (Kalin 2021a), 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 (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, (24) (Rolle 2018:9, who cites Newman 1986:252,257). The plural suffix in (24a) introduces a replacive L tone, completely overwriting the underlying tonal pattern of the stem and making it all L. The referential suffix in (24b), 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.

(24)   a.   jìmínáá (ostrich) + -Lúú → jìmìn-úú 'ostriches'
        b.   jààkíí (donkey) + -Ln → jààkî-n 'the donkey'

Both replacive tone and concatenative tone in (24) 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 (24b)) 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, (25).

(25)   /púlóL + -ne/ → /púló + -nè/ 'drinking trough'

However, there is no language Kabiye-prime, where an outwardly imposed tone can overwrite the underlying tone of a lexical item. 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. Simulta-

neous 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. (Myler 2017) observes that "anti-scopal, Mirror-Principle-violating morpheme orders often give rise to non-local morphophonological effects", and shows that this is 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 -*į* triggers spirantization on an eligible preceding consonant. Now consider the contrast between (26a) and (26b), based around the verb root *sob* ('get lost').

(26)   a.   sob-an-į (get.lost-REC-CAUS) 'get each other lost' = CAUS > REC
        b.   sof-an-į (get.lost-REC-CAUS) 'lose each other' = REC > CAUS

In the Mirror-Principle-obeying order in (26a), the root-final consonant of *sob* is not spirantized; in the Mirror-Principle-violating order in (26b), 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 Mirror-Principle-violating order through phrasal movement of the vP (containing the root) through spec-Caus and into spec-Rec, as shown in (27).

(27)
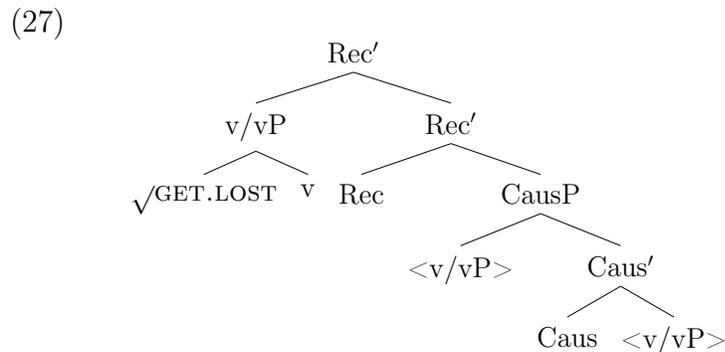
In this structure, applying the embedding calculus described at the outset of §3, both Caus and the verb root count as the most deeply embedded node in their respective sub-structures, and thus both will be ordered as exponed before Rec. (Caus and the verb root are not ordered with respect to each other 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 (28), with only Rec awaiting insertion.

(28)

```
                              Rec′
                    ┌──────────┴──────────┐
                  v/vP                    Rec′
              ┌─────┴─────┐         ┌───────┴───────┐
          √GET.LOST    v         Rec            CausP
            sob                          ┌────────┴────────┐
                                     <v/vP>             Caus′
                                                      ┌────┴────┐
                                                    Caus    <v/vP>
                                                     -i̧
```

It is at the derivational stage represented in (28) 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 (28)). When Rec is exponed, (29), it linearly intervenes between Caus and the root; but crucially, it is inserted too late to have blocked spirantization.

(29)

```
                              Rec′
                    ┌──────────┴──────────┐
                  v/vP                    Rec′
              ┌─────┴─────┐         ┌───────┴───────┐
          √GET.LOST    v         Rec            CausP
            sof                   -an      ┌────────┴────────┐
                                       <v/vP>             Caus′
                                                        ┌────┴────┐
                                                      Caus    <v/vP>
                                                       -i̧
```

In the Mirror-Principle-obeying order, on the other hand, (26a), 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 Mirror-Principle violating morphological structures, simultaneous insertion and top-down insertion afford no such flexibility. The interested reader is referred to Myler 2017 for more detail and further case studies; see also Gleim et al. 2021 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 (2021), 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.

Bottom-up insertion is orthogonal to late insertion: 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 realization 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 2020b). 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.[17] The only models that lack recycling (but have bottom-up insertion) are incremental models, but those have myriad other issues, as discussed in §2, including requiring a sort of inverse of recycling—anticipation of the syntactic derivation (a kind of 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 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 necessity of cycles and locality domains that impact morphological realization and processes. So as the final candidate for a universal of morphology that we will discuss, we put forward the existence of cycles and domains.

The strictest sort of locality condition involves adjacency. Allomorphy, for example, often seems restricted to being conditioned by only an immediately adjacent morpheme, with the allomorphy being bled under intervention (see, e.g., Siegel 1978, Allen 1979, Embick 2010, Paparounas 2021). Frameworks allow for and implement adjacency restrictions on morphological processes in various ways, and so different sorts of questions arise, such as whether linear adjacency or structural adjacency (or some combination of the two) is the correct locality condition for these processes (e.g., Embick 2010, Moskal 2015, Kalin and Atlamaz 2018, Smith et al. 2018, Choi and Harley 2019, Gouskova and Bobaljik to appear).

In this section, we focus on the question of whether morphological processes can be restricted by locality domains which are at least potentially bigger than one morpheme/one terminal node. Abstractly speaking, arguments for locality domains typically involve 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:

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

(30)

X
Y   X
Z Y ✗

(31)

X
Y   X
Z Y
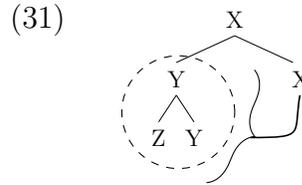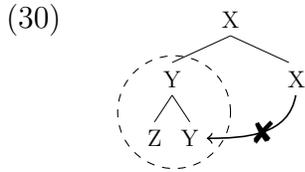
In (30), we see an abstract underapplication pattern where the node X fails to trigger some process on a head node Y, even though they're adjacent, since they are inside two distinct domains. In (31), we see a misapplication pattern, where a process triggered by X does not only affect its immediately 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.

Patterns of underapplication and misapplication can be systematic (i.e., visible at the typological level) or case-specific (visible within a language). For example, in the case of underapplication, we might observe that elements of a given 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 and allosemy, and misapplication in the domain of clitic displacement.

The uses of domains and cycles in morphology are just as manifold as the their specific implementations, and so 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

Allomorphy is often invoked as an argument for a domain-based notion of locality. It is generally agreed upon that there is some sort of locality condition on allomorphy in the sense that the trigger and the target of allomorphy cannot be arbitrarily far away from each other. Clear instances of this pattern are, for example, the striking absence of AAB-patterns with adjectival suppletion (Bobaljik 2012) and with case-driven suppletion of nominal stems (Moskal 2015). Both Embick (2010) and Bobaljik (2012) argue that allomorphic relations require structural or linear adjacency. However, a number of case studies prompted by these earlier works have since shown that an account in terms of strict (linear or structural) adjacency might be too restrictive (see e.g. Moskal 2015, Merchant 2015, Bermúdez-Otero 2016, Bruening 2017, Deal 2018, Wu 2018, Lee and Amato 2018, Smith et al. 2018, Choi and Harley 2019, Harðarsson 2020 *i.a.*).

As a response to (a subset of) these case studies, several attempts have been made to define restrictions on allomorphy and suppletion in terms of locality domains (see Moskal 2015, Smith et al. 2018, Božič 2019). The idea is that there is some structurally defined locality domain in which both the trigger and the target of must be contained in order for allomorphy to be possible.[18] Moskal (2015) for example derives the differences between

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[18]Note though, that these approaches are usually still forced to assume that, in addition to being inside the same domain, some instances of allomorphy also require linear or structural adjacency. See Smith et al.

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 accessibility domain, but for lexical nouns, which do have a n head, the case node is outside of the locality domain. Thus the systematic absence of case-driven suppletion with lexical nouns instantiates the underapplication pattern in (30).

4.2   Domains of allosemy

The second major empirical phenomenon for which locality domains have been invoked is allosemy, which in many respects shows striking parallels with allomorphy. Building on earlier work (especially Siegel 1974, Allen 1979, Marantz 2001), Arad (2003, 2005) and Borer (2013) have 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, (30): 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 domains.

In Arad's (2003, 2005) proposal for example, 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 thus argues that assignment of a reading may be optional within a cycle, thereby allowing for bigger domains for allosemy. To give a concrete example taken from Borer (2013): there are internally-complex words that have a very specialized meaning, such as [[[[edit]or]y]al], which refers to a specific type of piece written by an editor (rather than anything an editor could write). Crucially, subsequent derivations building on [[[[edit]or]y]al] such as [[[[[edit]or]y]al]ize] 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 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 of the domains of allomorphy and allosemy has been investigated by Borer (2013), Marantz (2013a) and Harðarsson (2020), 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 (2020) is that we often find mismatches between domains picked out by morphophonological processes on the one hand and allosemy and allomorphy on the other.

2018, Gouskova and Bobaljik to appear for discussion.

4.3 Clitic displacement

Another morphosyntactic phenomenon where locality domains have proven helpful is in understanding clitic displacement. 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 after the syntactic structure is complete. This is, of course, common in post-syntactic theories of morphology such as Distributed Morphology, 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 the actual proposals are often language-specific in scope (though see Marantz 1988, Embick and Noyer 2001, 2007, Anderson 2005). Thus, studies of how rules of clitic placement interact with morphosyntactic domains in general are still missing, but in some cases, a combination of the rules of clitic placement with morphological or morphosyntactic domains has led to interesting results.

Kramer (2010), for example, discusses the NP-internal placement of the definite determiner in Amharic. The determiner usually appears right-attached to the first word of the NP, but appears further rightward in some configurations where the NP-initial constituent is complex, as shown in (32):

(32) a. t'ɨk'ur-**u** dɨmmät
          black-DEF cat
          'the black cat'
      b. [tɨnantɨnna yä-mät't'-a]-**w**   tämari
          yesterday   C-come.PF-3MS-DEF student
          'the student who came yesterday'   Amharic, Kramer (2010)

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 (32b)). Thus, the determiner dislocates across an entire domain rather than across a simple word. This is an instance of the misapplication pattern in (31): we expect dislocation relative to just the closest word, but instead dislocation applies to a larger constituent because of a domain boundary.

4.4 Word formation

The final morphological process that we want to discuss briefly is word formation. Recent years have seen a number of different formalizations of the idea that, even in a late insertion model, word formation has 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, Georgieva et al. 2021). And, building on that assumption, interesting questions concerning locality domains arise, e.g., are post-syntactic word-formation processes restricted by the same kind of locality domains as syntactic word-formation processes? So far, very few works have actually engaged with these questions.

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 (33a) consists of several parts that can be coordinated, (33b), separated by a question particle, (33c), or elided. 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 exactly these configurations, (33d).

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

The interesting observation for our purposes is that the word-internal locality domains which Fenger (2020) identifies are exactly those which are evidenced in clausal phenomena: while derivational, valency-related, and aspectual affixes are part of the inner domain, tense and agreement affixes are part of the outer domain.

4.5   Interim comments

The discussion above focused specifically on morphological evidence for domains and cycles, but research in recent years has made substantial progress in unifying the notion of domains across modules of core grammar. As has been alluded to several times in the discussion above, the standard notion of locality domain invoked by works on the morphology-syntax interface is the same notion of the phase as introduced by Chomsky (2000, 2001). It must be noted 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" or "spell-out domain" can be made to fit a coherent definition. While Moskal's (2015) accessibility domains used for allomorphy (and to a certain extent also for allosemy in Harðarsson 2020) are certainly related to the notion of the phase, phases and accessibility domains are still different.

Another promising 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), will have to be evaluated in future work, and will have a direct impact on the notion of domains and cycles in the morphological component.

A final point that must be mentioned is that 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 have the space to discuss here whether a stratum-based approach would allow us to capture (a subset of) the above-mentioned diagnostics for morphological domains in a satisfying way. It strikes us as conceptually preferable to use the identical (or at least as similar as possible) notion of a domain across different grammatical modules. But, it is not clear to us to what extent the two notions of locality domains/cycles (phases vs. strata) are similar or even identical if we abstract away from the many additional assumptions in which the two types of approaches typically differ.

5   Outlook

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). 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, Marušič 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 whether morphological processes can be governed by phonological considerations of optimization; 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 2020a, 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, as noted in §2.1, 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. But of course such a decision must be justified, and we have not had the space for that here. For recent discussions of some of the issues at stake, see Marantz 2013b, Leu 2020.

We are sure there are many other areas for potential exploration of universals, but we leave our exploration 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 Distributed Morphology), 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.

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 Minimal 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 which has been pursued in more recent work as well, e.g., 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 (§2) and proceeds from the bottom up (§3); and morphological processes are constrained by locality and domains (§4). 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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