Non-concatenative morphology as epiphenomenon*

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1 Introduction

1.1 Goals

Somewhere between the system of syntax-semantics and the system of phonology, there is an interface in which representations legible to the one system are mapped to representations legible to the other. Just how much goes on at that interface is a matter of contention. Syntax determines the linear order of certain combinations of elements, and phonology determines the pronunciation of certain combinations of elements, so it has been proposed that syntax can linearize morphemes as well as phrases, and that phonology is responsible for whatever phonological alternations appear. This reduces the need for a morphology component or lexical rules, as argued in Lieber (1992).

However, the observed variation goes beyond what is independently necessary for syntax and phonology; some morphemes appear in places that a constrained syntax cannot place them, and some allomorphs show forms that phonology couldn't provide.

One response is to posit a powerful morphological component, allowing a wide variety of rules to impose alterations on base forms, as with the readjustment rules of Halle and Marantz (1993), the word formation rules of Anderson (1992), and similar assumptions in Stump (2001). The latter two subscribe to a 'realization-based view', to use the term of Koenig (1999), which holds that roots belonging to major classes (such as N, A, and V) and affixes are fundamentally different kinds of thing. In this view, affixes are merely the excrescences of realization rules, which spell out the form of lexemes in different morphosyntactic or morphological environments. Because morphological exponence relies on *processes* on this view, we should expect to find languages that express morphological categories through nonconcatenative means such as deletion, feature change, and metathesis. Indeed, we do observe phenomena which, on the surface at least, seem consistent with this expectation.

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We attempt instead to rely as fully as possible on the independently motivated components of syntax and phonology to do the work necessary for morphology; thus we pursue a 'morpheme-based' program like Lieber (1992), but with the benefit of eighteen years of further progress in syntactic and phonological theory.[1][2] Morphology, we argue, may be reduced entirely to the function that spells out the syntactic tree by choosing and inserting phonologically contentful lexical items. Assuming late insertion, we make use of several devices which have been argued for elsewhere in different ways: contextual allomorphy, affixation of autosegments and/or featurally deficient root nodes, and the affixation of prosodic units, figure centrally. Non-concatenative effects arise from (i) the way the phonology deals with roots/stems and affixes that are deficient segmentally (they consist solely of prosodic information) or featurally (they are composed of underspecified root nodes), and (ii) the way the phonology handles affixes whose relation to higher level prosodic units such as the word and phrase is prespecified. We propose that these devices taken together are sufficient to account for the panoply of non-concatenative effects.

1.2 Background

Our approach to phonology may be similarly described as radically conservative. We assume an optimality-theoretic approach to the phonology module of the grammar, but in contrast to much actual analytical practice, we rigorously uphold the view that lexical, morphological and syntactic information is unavailable to the phonological component (see also Kager 2008 and Bermúdez-Otero 2011 for similar views). There is a unique phonological grammar for the language, and the constraints in CON are restricted to evaluating phonological structure. This assumption rules out approaches such as Cophonology Theory (Inkelas 1998; Inkelas et al. 1997; Inkelas and Zoll 2005; Orgun 1996, 1999; Orgun and Inkelas 2002; Yu 2000), lexically indexed faithfulness constraints (Itô and Mester 1995, 1999; Fukazawa 1997; Fukazawa et al. 1998), lexically indexed markedness constraints (Pater 2010), morpheme-specific alignment constraints (McCarthy and Prince 1993; Yu 2007), morpheme realization constraints like MORPHREAL (McCarthy and Prince 1995; Kurisu 2001), explicitly represented transderivational relations such as OO-FAITH (Benua 1998), ANTI-FAITHFULNESS (Alderete 1999; Horwood 2001) and paradigmatic faithfulness (McCarthy 2005; Rice 2004).

We focus in this work entirely on productive inflectional morphology and not opting to

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[1]

[2] Over the years these two opposing theoretical styles have been known under a variety of different names. Hockett (1954) distinguished between Item-and-Process and Item-and-Arrangement, earlier generative morphologists distinguished between Phrase Structure Morphology (Selkirk 1982; Di Sciullo and Williams 1987) and Transformational Morphology (Matthews 1972; Aronoff 1976; Anderson 1982, 1984, 1986; Martin 1988; Zwicky 1991; bea ????), while more recently the debate has been between realization-based A-Morphous morphology (Anderson 1992) and Distributed Morphology (Halle and Marantz 1993), which is essentially morpheme-based but also admits of powerful 'readjustment rules', which Bermúdez-Otero (2011) shows "utterly destroy the empirical content of morphological and phonological hypotheses". This fundamental division carries over into work couched in OT. Proponents of the morpheme-based view here include Archangeli and Pulleyblank (1994), Akinlabi (1996), Rose (1997), Zoll (1998), and Wolf (2005), all of whom espouse an autosegmental approach to morphological processes, while the realization-based view is found in Transderivational Anti-Faithfulness Theory (Alderete 1999, 2001) and Realizational Morphology Theory (Kurisu 2001). Aronoff (1994) argues both of these views have precursors in the ancient and mediaeval grammarians.

treat problem cases such as English strong verbs and hence taking no stand on whether or how regularities across small sets of forms should be captured (see Bermúdez-Otero 2011 for discussion of this matter).

Our account differs from most previous accounts both in our assumptions about syntax and about phonology. We assume a finer-grained decomposition of the syntactic structure than is usually considered in morphological studies. This eliminates some of the need for morphology-specific entities such as agreement features and theme vowels, since we locate them in the syntax. Along with this, we assume that Spell-Out is cyclic, its domain being a phase, a somewhat larger target than the terminal node usually assumed (drawing here on Nanosyntax, phase theory, and nonstandard versions of Distributed Morphology, as discussed below).

Our focus from the outset of this research has been 'non-concatenative morphology', but our central claim is that there really is no such thing — there are only non-concatenative effects, which are result from purely phonological responses to parsing lexical entries that are underspecified or prespecified in some way. Non-concatenative effects thus entail violation of primitive faithfulness constraints such as LINEARITY, UNIFORMITY, INTEGRITY and CONTIGUITY. To date, these constraints are generally little invoked in phonological analyses.

The structure of this chapter is as follows. Section 2 sets out the theory of exponence. Section 3 applies the model to morphemes whose phonological representation is underspecified in crucial ways, and section 4 applies the model to morphemes with prespecification of the affix's place in word- and higher-level structure. Section 5 discusses subtractive morphology, and section 6 presents our main conclusions and proposes directions for future research.

1.3 The Concatenative Ideal

Non-concatenative morphology does not refer to a natural class of phenomena. The class of non-concatenative patterns is defined negatively as anything that falls short of the concatenative ideal, which we may define under the six headings in (1). These are not to be interpreted as constraints in the grammar.

(1) *The Concatenative Ideal*

a. *Proper Precedence*
Morphemes are linearly ordered (i.e. no overlapping)

b. *Contiguity*
Morphemes are contiguous (i.e. no discontinuity)

c. *Additivity*
Morphemes are additive (i.e. no subtraction)

d. *Morpheme preservation*
Morphemes are preserved when additional morphemes are added to them (i.e. no overwriting)

e. *Segmental Autonomy*
The segmental content of a morpheme is context-free (i.e. morphemes should not have segmental content determined by the lexical entry of another morpheme)

f. *Disjointness*
Morphemes are disjoint from each other (i.e. no haplology)

Points (1-a) and (1-b) concern relations of linear precedence between segments of different morphemes. Points (1-a) through (1-d) have in common that their violation involves various kinds of destructive alterations of underlying information (precedence relations or segments).

Surface violations of these principles may, we argue, only arise as a result of phonological processes. For example, coalescence and metathesis may introduce temporal overlap between morphemes and disrupt relations of contiguity and proper precedence. Violations of the concatenative ideal accordingly fall into six categories in (2). In this chapter, we deal with the first five of these. Morphological haplology will be the topic of a future paper.

(2) *Non-concatenative phenomena*

a. Autosegmental affixation/affixation of underspecified root node
/blurk+[spread glottis]/,/blurk+$C_{[\mathrm{spr\ gl}]}$/→[$\mathrm{p^h}$lurk]
Edge association determined by syntax. Affix may be phonologically displaced in output.

b. Infixation
/blurk+in/→[bl-in-urk]
Edge association determined by lexical specification of affix.

c. Subtraction
/blurk−C#/→[blur]
A special case of autosegmental affixation. Segmental host of autosegmental affix deleted for phonological reasons.

d. Ablaut
/blurk+a/→[bl-a-rk]
Combines properties of both autosegmental affixation and infixation with prespecification of affix's integration into word.

e. Template satisfaction, copying
/blurk+$\sigma_\mu\sigma_{\mu\mu}$/→[bəlurk]
Affix is segmentally un(der)specified prosodic node. Material supplied through epenthesis or copying in phonological component.

f. Haplology
/blurk_i+urk_j/→[bl$\{\mathrm{urk}\}_{ij}$]

Finally, mention must be made of nonconcatenative morphological processes that never seem to play a role in spelling out morphosyntactic features. These would appear to have formally different properties in that they do not seem to be subject to the restriction of additivity we argue is essential to Spell-Out. These are templatic subtraction (truncation), blending, cross-anchoring metathesis of the kind found in argot or language games and, probably transfixation. Truncation is commonly observed in hypocoristics, vocative formation and, occasionally, compounding (Alber and Arndt-Lappe 2011: c.f.). Blending is illustrated in Spanish (Piñeros 2004), e.g. /xéta+fòtografía/ 'animal's face + photograph' → *xètografía* 'poor quality photograph of someone's face, mugshot'. Cross-anchoring is exemplified by Zuuja-go, a professional argot used by Japanese jazz musicians (Ito et al. 1996), e.g. /batsuguɴ-no fumeɴ/ 'fantastic score' → *guɴbatsu-no meɴfu*. Transfixation involves an alternation at multiple sites throughout the domain (e.g. all vowels, all eligible consonants) and is commonly recruited for signalling expressive and affective meanings. In Basque, for example, there is an affective diminutive marked by palatalizing all coronals in the word (excluding /r/), e.g. *polita* vs. *poʎica* 'pretty (DIM)' (Hualde 1991; Hualde and de Urbina 2003). These processes are what Dressler (2000) terms 'extragrammatical morphology'. For this reason, these phenomena are excluded from further consideration here. We leave it to future research to explore formal differences between morphological exponence and extragrammatical morphology in more detail.

2 The model

In this section we lay out the interface architecture we are proposing. We draw on previous work here, in particular Mirror Theory (Brody 2000a,b; Brody and Szabolcsi 2003; Adger et al. 2009; Adger 2010), Distributed Morphology (DM; Halle and Marantz 1993, 1994; Harley and Noyer 1999; Embick and Noyer 2007 and references there) and its phase-based extensions in Marantz (2001), Marantz (2007), Marvin (2002), Newell (2008), and also on ongoing research being conducted at the CASTL group in Tromsø under the rubric of Nanosyntax, including Starke (2009a), Caha (2009b), Svenonius et al. (2009), and Taraldsen (2010).[3] Since DM is the most well-established similar model, we note at relevant points where our assumptions are similar and where they diverge.

The main idea is to get as much out of syntax as possible; syntax provides structures which can be linearized and translated into different kinds of constituents, so we derive much of the constituency and linearization of morphological structures from syntax. By use of an independently needed organization of syntactic structure, we hope to eliminate morphological subcategorization, morpheme-specific alignment constraints, and other such mechanisms.

In the mapping from syntactic structures to phonologically legible representations, we can distinguish between defaults and marked options. A default will be an aspect of the mapping that does not require positive evidence to be learned, and so all else being equal should be cross-linguistically more common. A marked option will be learnable on the basis of positive evidence, and will correspond to the presence of information of a certain kind in an underlying representation (e.g. a syntactic instruction for marked linearization with respect to heads, or a phonological feature for marked linearization with respect to prosodic structure).

2.1 Morphemes and constituency

We assume that each language has a set of features (T, V, etc.) which are visible to syntax. We follow most frameworks in adopting a basic distinction between categorial projections and nonprojecting features: categories form headed dependencies and projections (by the operation Merge, Chomsky 1995), but features do not. A category has a feature as its label, and so a symbol like D is ambiguously a feature or a category with the label D. Features are organized in dependency relations, which give feature "geometries" and also the functional hierarchy of categories. Following Brody (2000b), we can use a branch sloping down to the right to represent a complement dependency between categories (e.g. Pl[ural]

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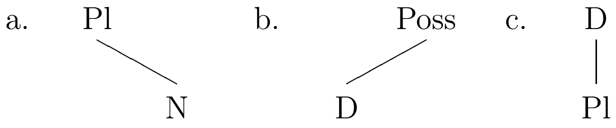
[3] The material in this section has benefitted from collaborative work at CASTL over the past few years, including the seminars of Michal Starke; discussions with David Adger have also been especially valuable.

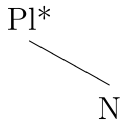
takes a category N complement in (3-a)), and a branch sloping down to the left to represent a specifier dependency between categories (e.g. Poss[essive] takes a category D specifier in (3-b)). We can then use a vertical branch to represent a (nonprojecting) feature dependency (for example, in (3-c), D has the feature Pl).

(3)



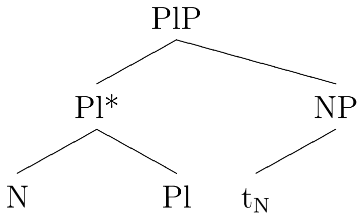
Certain important aspects of word structure are determined by properties of syntactic categories, rather than by lexical entries. This is captured in DM through the syntactic operation of head-movement, which combines categories to create syntactic words prior to lexical insertion (Halle and Marantz 1993: 113). However, head-movement differs from phrasal movement, for example in locality, scope, and reconstruction (Mahajan 2000). We therefore adopt an interpretation of head-movement which draws from Brody's (2000a; 2000b) Mirror Theory. Though head-movement is triggered in the syntax, its primary effect in on Spell-Out. We use the symbol * to mark the trigger of head-movement, so that in (4), N is understood to incorporate into Pl (we will assume that in the absence of the feature, as in (3-a), Pl and N are not incorporated).

(4)



As detailed in the next subsection, we assume that the incorporated constituent [$_{\text{Pl}}$N-Pl] in (4) spells out as a phonological word; following Brody (2000a), head movement is unlike phrasal movement, in that it does not add syntactic dominance relations. However, in order to represent linearization graphically it will sometimes be useful to draw traditional head-movement trees with multiple segments for heads which host incorporation, as in (5).

(5)



In this paper, a diagram like (5) will be used strictly for the graphic convenience of linearly representing the surface order of morphemes; Brodian structures like that in (4) more accurately reflect the properties of syntactic representations (i.e. the syntax recognizes two objects Pl and N, one with the incorporating property (*), standing in a relation 'complement'; the additional symbols in (5) play no role in the syntax).

Where DM requires lexical entries to be inserted under a single terminal node and uses a mechanism of fusion to combine terminal nodes, we assume what Williams (2003) calls 'spanning', i.e. we assume that a morpheme may spell out any number of heads in a complement sequence (cf. also Ramchand 2008, Son and Svenonius 2008, Caha 2009b, Starke 2009b and other work in Nanosyntax).

Thus, in DM the assumption is that each morpheme tends to represent a single category in the syntax, and vice versa; exceptions arise when heads undergo fusion or receive phonologically null spell-outs, in which case there can be fewer morphemes than heads, or when feature bundles are added postsyntactically or undergo fission, in which case there may be more morphemes than syntactic heads.

The austere alternative (pursued in Nanosyntax) is that there is no feature–category distinction, so that any morpheme which spells out multiple features spells out a complex structure, possibly a branching one. Here we preserve the distinction between (projecting) categories and (nonprojecting) features as in DM, which makes it possible to let morphemes spell out multiple categories, as in Nanosyntax, without forcing us to assume that morphemes spell out branching syntactic structures; complex internal structure in a lexical item is restricted to nonprojecting features, on our assumptions.[4]

2.2 Order and the functional sequence

Mirror effects (Baker 1985, 1988; Cinque 1999; Brody 2000a,b) suggest that morphology mirrors syntax, in the default case: dominance relations in unincorporated structures, and their specifiers, translate into left-to-right linearization, while incorporated heads linearize right-to-left.

We follow work in cartography (Cinque 1999; Rizzi 1997, inter alia) in positing distinct extended projections for the various categorial features, for example something like (6-a) for the extended projection of V,[5] and something like (6-b) for the extended projection of N.[6]

(6) a. Force $\succ$ Int $\succ$ Fin $\succ$ $\mathrm{Mod_{Epist}}$ $\succ$ $\mathrm{T_{Fut}}$ $\succ$ $\mathrm{T_{Past}}$ $\succ$ $\mathrm{Mod_{Aleth}}$ $\succ$ $\mathrm{Asp_{Hab}}$ $\succ$ $\mathrm{Asp_{Perf}}$ $\succ$ $\mathrm{Asp_{Prog}}$ $\succ$ $\mathrm{Mod_{Abil}}$ $\succ$ Voice $\succ$ Cause $\succ$ Init $\succ$ Rev $\succ$ V $\succ$ Res
b. Path $\succ$ Place $\succ$ K $\succ$ Q $\succ$ π $\succ$ D $\succ$ Num $\succ$ α $\succ$ Unit $\succ$ Pl $\succ$ Cl $\succ$ N

Following Noyer (1992), the same hierarchical structure is relevant for nonprojecting features and for projecting categories; for example, if Person dominates Number in the "geometry" of agreement features, then Person must dominate Number in the functional hierarchy of categories (here represented by π dominating Unit and Pl).[7]

The degree to which the functional sequence is universal or allows cross-linguistic variation

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[4] In this we follow Brody (2000a,b) and are compatible with the assumptions of e.g. Williams (2003); Ramchand (2008); Son and Svenonius (2008); Adger et al. (2009).

[5] On Force, Int[errogative], and Fin[iteness], see Rizzi (1997); on the highly complex area which we abbreviate here using Mod[ality], T[ense] and Asp[ect] (and Epist[emic], Aleth[ic], Fut[ure], Hab[itual], Perf[ect], Prog[ressive], Abil[itative]), see Cinque (1999); on Rev[ersive], see Muriungi (2008); and on Init[iation] and Res[ult] in the verb phrase see Ramchand (2008).

[6] Path and Place here are prepositional components, while K stands in for a class of oblique cases and functional prepositions, cf. Svenonius (2010); for π, see har (????); for (strong) Q[uantifier], D[eterminer], Num[ber], Unit, and Pl[ural], see Svenonius (2004, 2008); α introduces adjectives, following Julien (2005); for Cl[assifier] see Borer (2005).

[7] Features further distinguishing persons and numbers, such as Participant and Augmented, are not shown in (6). We assume that all category features are strictly ordered, but if a feature like Participant is not a category feature then it might be ordered only with respect to π and its other dependent nonprojecting features.

is an unsettled issue, for example Topic or Focus or Negation or Possession may have variable placement in the sequence. Furthermore, languages may allow different parts to be skipped in an extended projection. What is important is that for each language, there is a functional sequence, on which extended projections can be defined. An extended projection is a structure in which categories take complements which are lower in the same functional sequence. The structures in (7) are extended projections (using > to represent the complement-taking relationship) licensed by the functional sequences in (6).

(7)
a. Voice > V
b. T$_{\text{Past}}$ > Asp$_{\text{Prog}}$ > Init > V
c. Q > D > α > Unit > N
d. Pl > Cl > N

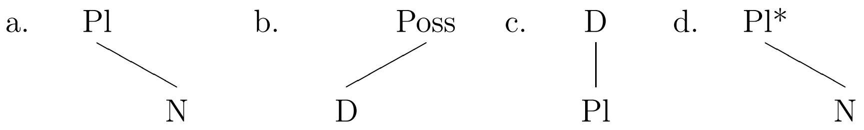
The structures in (8), however, are not extended projections nor subparts of extended projections, as can be seen by comparing them to (6). Rather, they involve embeddings. Something like (8-a) has been proposed by Son and Svenonius (2008) as a possible representation for directed motion verbs (consider *arrive*, which takes a locative complement but entails motion), and (8-b) could be a representation for a deverbal noun like *breakability*.[8]

(8)
a. V > Path
b. N > Pos > A > Mod$_{\text{Abil}}$ > Voice > V

Since morphemes spell out complement sequences, morphemes will normally only spell out spans of a functional sequence, like those in (7), but may also spell out some embedding structures, like those in (8).[9]

The tree representations from (3) are repeated in (9). Here, on our assumptions, a morpheme spells out categories in complement sequences. Therefore, a morpheme could spell out all of (9-a) (as in English *women*), or two morphemes could spell out each part separately (as in Hawaiian *mau wāhine* 'plural woman').[10] In (9-b), two morphemes would be necessary, and in (9-c), only one morpheme would be possible. In (9-d), repeated from (4), either one or two morphemes would be possible but if two, then because of the * they would be incorporated into a single word (as in English *girls*).

(9)



While complements are licensed by the functional hierarchy, which is largely invariant across languages, specifiers are licensed by features the distribution of which varies from language to language. We call them Spec features for convenience; because they are features of features, they are second-order features, following Adger and Svenonius (2011). For example,

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[8] Based on a proposal by Michal Starke, EGG summer school lectures, Novi Sad, 2002, and taking Pos[itive] $\succ$ A to be part of a functional sequence for adjectives, cf. Kennedy (1999).

[9] I.e. the monomorphemic *arrive* could spell out V > Path, and a suffix like *-able*, on something like Starke's proposal, could spell out A > Mod$_{\text{Abil}}$ > Voice.

[10] Elbert and Pukui (1979: 162f); the plural word *mau* is normally preceded by a demonstrative or possessor in Hawaiian.

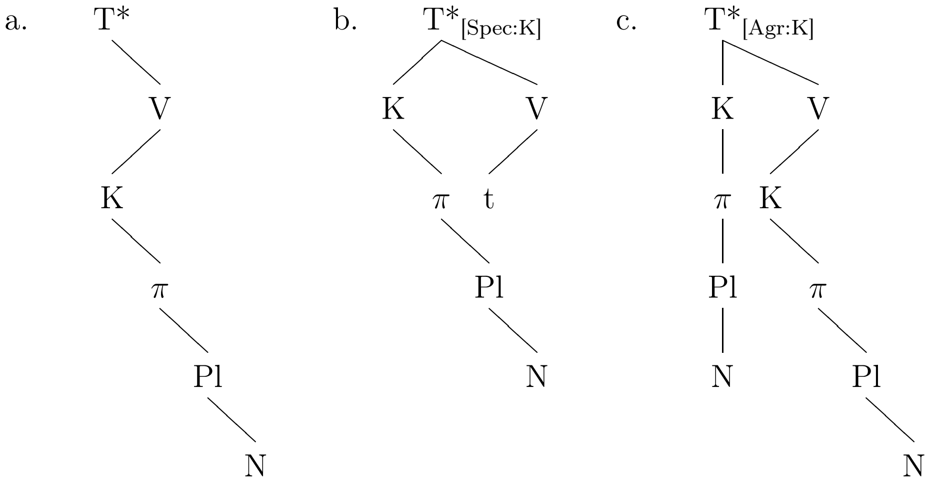
a language which has KP subjects in the specifier of TP has a second-order Spec:K feature on T, and a language which moves operators (wh-expressions) to the specifier of IntP has a second-order feature, perhaps Spec:Op, on Int. The Poss node in (9-b) must have a Spec:D feature. A Spec feature is an instruction to Merge to create a dependency to a category of the specified type in the search domain.

Following Kayne (1994) and Brody (2000a), specifiers normally linearize to the left of the heads on which they are dependent, with higher projections' specifiers linearizing to the left of those of lower projections. However, head-movement may cause a head to be linearized elsewhere. Head-movement here is a syntactic feature which affects the way the linearization algorithm orders the exponents associated with the tree structure (and little else; cf. Chomsky's 2001: 37f observations about the relative syntactic inertness of head-movement). The feature * which we use to represent (Brodian) head-movement is a second-order feature in our terms, because it is a feature of a feature, assigned e.g. to T in French, but not in English (it cannot be a property of lexical items).

We make use of one other second-order feature, namely Agr features, which like Spec features create dependencies but only among first-order features, not among categories. That is, the dependency they create is a feature dependency, which ignores the category-feature distinction. The distribution of Agr features, like the distribution of Spec and *, is also language-specific. A language which shows number agreement on participles has Agr:Pl on Asp, and a language with person agreement on tense has Agr:π on T.[11]

So, to illustrate second-order features, (10-a) would be a tense-inflected verb followed by a KP specifier [K–π–Pl–N] of V. If π without additional features is third person, then this is a third person plural noun phrase of some kind; if D is definiteness, then this KP is not definite. (10-b) would be the same specifier moved to T, in a language with a Spec:K feature on T (the classic 'EPP'), hence preceding the tense-inflected verb, while (10-c) is the case of an agreement probe without movement (cf. Chomsky 1995; Béjar 2004 on feature movement or copying). The third person plural features are then available for the spell-out of T, for example in a language like Spanish with fused tense and agreement morphology, but V-T still precedes the unmoved KP.

(10)



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[11] If we assume that Spec only licenses external Merge, then the combination of Spec and Agr could yield internal Merge, i.e. Spec+Agr would be necessary to cause movement.

Agreement features are important for morpheme insertion, but agreement features are usually semantically uninterpretable (see Svenonius 2007 for discussion). In this paper, we will assume that all and only nonprojecting instances of features are uninterpretable; that is, all and only categories receive semantic interpretations (cf. Kayne's 2005 conjecture that a syntactic object contains at most one interpretable feature; however, we assume that holds only of categories, not of the lexical entries which lexicalize them).

2.3 Phases, Phrases, and Words

We have already mentioned that the syntactic feature * identifies syntactic words, which are mapped to phonological words in the input to phonology. A second major aspect of phonological organization which is read off the syntax is the prosodic phrase. We follow Kratzer and Selkirk (2007); Adger (2007); Kahnemuyipour (2009) in taking the phase of Chomsky (2001, 2008), inter alia to determine the prosodic phrase in the input to the phonology (just as with the word, language-specific phonological constraints may distort the equivalence). Certain syntactic heads are designated as phase heads. The complement of a phase head is processed by Spell-Out as soon as all of the instructions induced by second-order features (Agr, Spec, and *) on the phase head have been carried out.

Processing by Spell-Out occurs in two stages, which we call L-Match and Insert.[12] L-Match is the stage of Spell-Out which matches features in the syntactic representation to syntactic features in lexical entries. L-Match is essentially syntactic and is not sensitive to phonological information, in keeping with the observed strict modular distinction between syntax and phonology (Zwicky and Pullum 1986; Pullum and Zwicky 1988). Insert, on the other hand, sees only the phonological aspects of lexical entries, and is crucial for example for choosing among allomorphs which are sensitive to the phonological environment.

The most discussed phases are C and *v*, which have phase complements TP and VP.[13] Thus TP and VP, roughly, should determine the edges of prosodic phrases, and the literature cited at the beginning of this subsection argues that this is borne out, once all factors are taken into consideration. The surface prosody is the output of phonology, and phonological constraints need not respect syntactic boundaries; the argument is that specific syntactic boundaries (the complex head and the phase complement) deliver prosodic categories (the phonological word and the phonological phrase) to the input for the phonology. Language-specific syntactic properties (distribution of the second-order features) and phonological properties (realignment of prosodic word and phonological phrase boundaries) will result in adjustments to this picture, but such high-level prosodic structure is not a topic for this paper. What is important here is that the phase defines the domain of Spell-Out, which includes lexical access and the association of morphemic exponents to syntactic structure.

We will assume that the extended projection of N, just like the extended projection of V, typically contains two phases (Svenonius 2004), in an argumental DP; thus the phrasal prosody of *[$_\phi$the long petition] against [$_\phi$the new road]* can be derived in the same way

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[12] L-Match for 'lexical entry match' to distinguish it from the Match which is part of the Agree operation since Chomsky (2000).

[13] In a fine-grained cartographic representation, the phase heads might be Force and Voice, and the phase complements are whatever category they combine with in a given tree (e.g. Cause or Init might not be obligatory).

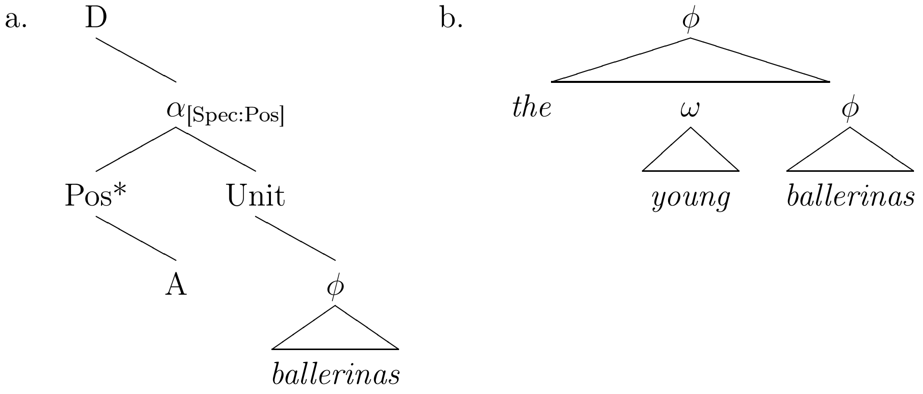
as the phrasal prosody of *[$_{\phi}$The young ballerinas] detest [$_{\phi}$the new laws]* (on which see Kratzer and Selkirk 2007). Roughly, an unembedded phase complement will correspond to what Selkirk (1995) (inter alia) calls a ‘minor phrase’, and an embedded phase complement will correspond to a ‘major phrase’, as prosodic prominence builds up cyclically. The phonology of a given language may combine short prosodic phrases (to satisfy minimality constraints) or split up long ones (maximality).

A phase complement may contain up to three different kinds of material: head material from the extended projection, specifier material from a distinct extended projection, and previously spelled-out material belonging to a distinct phase.

All three can be illustrated with a noun phrase like *the young ballerinas*, as in (11).

In (11-a), the structure Pl* > N is spelled out as *ballerinas* in a first phase cycle, as represented by replacing the syntactic structure with a triangle and the syntactic label (Pl*) with a phonological one (ϕ). In (11-b), the material in the D-domain is also spelled out: The extended projection of the adjective is a word, because of Pos*, and the entire DP is a phase, hence a prosodic phrase ϕ.

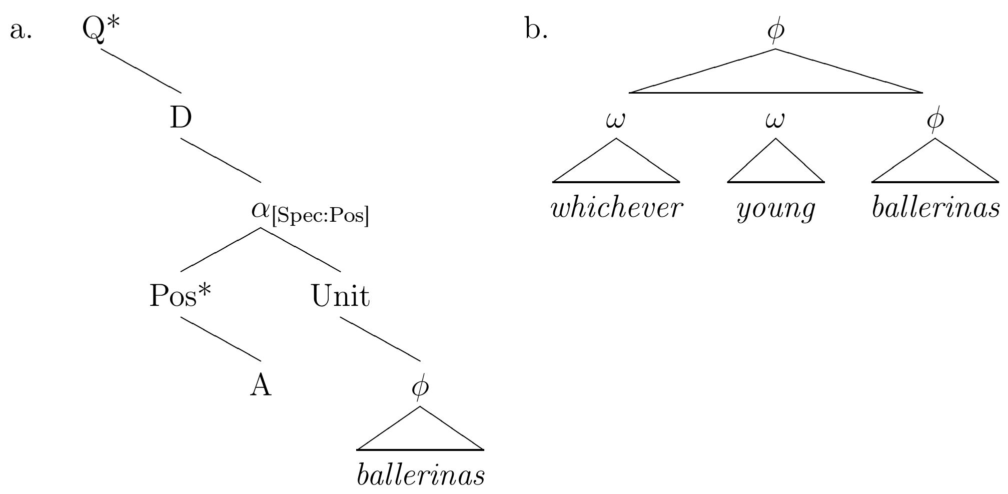
(11)



A phonological word is built on the extended projection of the adjective, a distinct extended projection; but no prosodic phrase is built directly on the adjective, because it is not directly dominated by a phase head. Any non-phasal specifiers containing a category marked * will spell out as a phonological word, while non-incorporated head material will spell out as function words (cf. Selkirk 1996 on the lack of secondary stresses in sequences of function words in English), though language-specific phonological processes may build word or phrase structure or cause other effects.

This assumption makes a prediction, namely that head-moved complex functional heads should be phonological words; for example, if *whichever* is a combination of Q and D (and perhaps additional heads), then it would be a word, as illustrated in (12).

(12)



Since a single morpheme can replace a complement sequence, a word like *both* with complex semantics will also spell out multiple categories, and also map onto a phonological word.

2.4 Lexical insertion

We will represent lexical entries in the usual format, e.g. {-z} ⇔ <Pl> means that phonological content /z/ spells out the syntactic category Pl, with the hyphen being simply a convenient indication to the reader that it will be realized as a suffix due to independent factors.

A detail which comes up frequently is that of phonological conditioning of allomorphs. We have nothing new to add to this phenomenon but note it explicitly here because it plays an important role in so many languages. As an example, we can cite Axininca Campa, an Arawakan language of Peru (Payne 1981; Bye 2007). Whenever an alienable noun bears a personal possessive prefix, it must also have a 'genitive' suffix, whose form varies between {-ni} or {-ti}. The {-ni} allomorph attaches to any stem containing two nuclear moras; {-ti} attaches elsewhere. Thus *i-çaa-ni* 'his anteater', *a-sari-ni* 'our macaw', but *a-yaarato-ti* 'our black bee'. Spell-Out may specify a phonological context, as shown in (13), which provides the relevant lexical entry. The first disjunct has precedence by the Elsewhere Principle. See Paster (2006) and Bye (2007) for more cases of this type.

(13) *Axeninca Campa genitive*

$$\left.\begin{array}{l}\{\text{-ni}\}\ /[\mu\mu]\_\_ \\ \{\text{-ti}\}\end{array}\right\} \Leftrightarrow \ <\text{Gen}>$$

We have suggested, following Williams (2003) and others, that morphemes replace 'spans' or sequences of heads in a complement line, normally a part of an extended projection. When a single morpheme spells out multiple features, we represent these as an ordered n-tuple, so that e.g. if *arrive* spells out <V,Path> it will spell out a structure in which V immediately dominates Path, but not vice-versa. The n-tuple represents dominance relations only and contains no information about projections or second-order features. This means that the same affix can be used for interpretable and uninterpretable features, as when an interpretable local case in e.g. Hungarian is copied by an agreement process onto nominal dependents (e.g. in *azok mellett a házak mellett* 'those next.to DEF houses next.to', "next to those houses", Dékány 2009).

The term 'suppletion' is often used for special allomorphs of a root, but a more general term for a morpheme which spells out two or more categories is 'portmanteau', suggested by Hockett (1947). The clearest examples are those in which a morpheme A spells out one category, and morpheme B spells out another, but where the combination A-B is expected, one instead finds a third morpheme, C. This is the case with irregular suppletive forms; if {-z} ⇔ <Pl> is the entry for the plural and if (14-a) is the lexical entry for *mouse*, then there must be a third entry like (14-b) for the irregular plural.

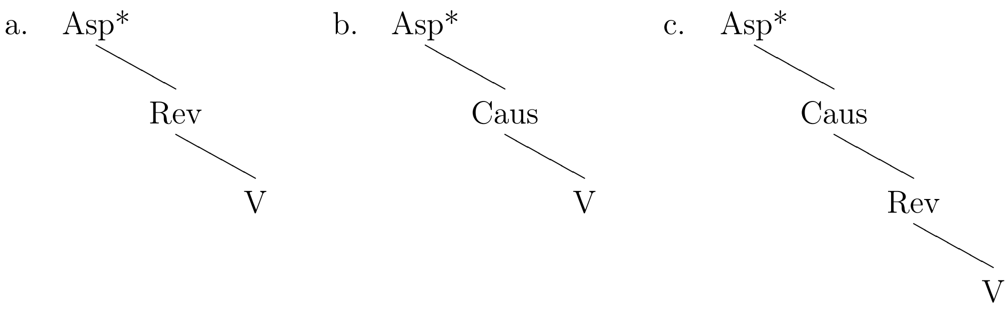
(14) a. {maʊs} ⇔ <N>
b. {maɪs} ⇔ <Pl,N>

Muriungi (2009) discusses a portmanteau morph in Kĩĩtharaka: there is a reversive *-ûk* and a causative *-i* but a causative reversive is spelled out with a single morpheme, *-ûr*.

(15) a. kuam-ûk-a
bend-REV-FV
'unbend'
b. kuam-i-a
bend-CAUS-FV
'bend' (transitive)
c. *kuam-ûk-i-a
bend-REV-CAUS-FV
d. kuam-ûr-a
bend-REV.CAUS-FV
'unbend' (transitive)

The three grammatical examples in (15) can be represented by the three following trees (letting 'Asp' stand in for the FV 'final vowel' inflectional morpheme, though its semantic contribution is unclear).

(16)

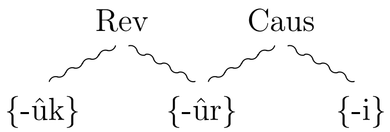


Muriungi suggests that the blocking of a sequence of morphemes by a single portmanteau is a general principle, which he calls the 'Union Spell-Out mechanism'. The principle is also discussed in Caha (2009a), Starke (2009b), and Taraldsen (2010), where it is called 'Biggest Wins' (see also Pantcheva (to appear) for discussion). Siddiqi (2009) names the principle

Minimize Exponence, i.e. use the smallest number of morphemes possible.[14]

We can represent such portmanteaux as branching lexical entries. We use squiggly lines to represent the connection between the syntactic feature specifications in a lexical entry and the phonological content.

(17)

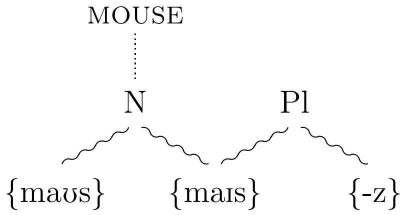


The branching entry graphically captures the fact that the reversive features in (15-a) and (15-d) are the same, and likewise for the causative features expressed in (15-b) and (15-d); if the lexical entries were not linked, there would be no guarantee that *ûk* and *ûr* both denoted the same kinds of reversal.

Lexical insertion must occur in two stages; on the syntactic side, the syntactic features are visible and so the whole doubly-linked entry in (17) is associated with trees like those in (16) (and so is the verb root). On the phonological side, allomorphs are chosen. The competition between portmanteaux and separate affixes appears to interact with phonologically sensitive allomorph selection, so we assume that Minimize Exponence is the result of a preference by the phonological side of the Spell-Out procedure for multiply-linked exponents; this may be overridden by phonological specifications.[15]

This allows us to represent the fact that the conceptual content is the same for the singular and the plural forms of a word like *mouse-mice*; we add conceptual content with a dotted line in (18).

(18)



The fact that the entries are interlinked allows us to suitably constrain the competition without having to assume that the encyclopedic content associated with the concept MOUSE is listed twice in the lexicon (the computer mouse must have a separate lexical entry for those who do not use the suppletive plural there). The link to a conceptual content makes the entry in (18) more accurate than the more compact representation in (14) above, the format we will usually use for talking about syntax and morphology.

Because the concept is doubly-linked, there is competition, unlike the case of paraphrase.[16]

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[14] Siddiqi (2009) treats the matter of suppletion at length. Siddiqi's treatment relies on Fusion to combine heads before lexical insertion, which forces him to posit systematic insertion of negative feature specifications to prevent Fusion when there are regular suffixes. By allowing a portmanteau whenever there is a morpheme with multiple category specifications, we can dispense with both Fusion and the stipulated features which block it.

[15] Thus, for example, in French, before a vowel *à l'eau* 'to the-water' is used rather than the portmanteau **au eau* ('to.the water'), cf. Zwicky 1987.

[16] E.g. *pink* does not block the paraphrase *pale red* (to use an example discussed by Poser 1992) because the lexical entries of the different words are not interlinked. Part of learning suppletive morphology is learning

Here, again, Minimize Exponence will favor the insertion of the plural form whenever the Pl node is present in the syntax. There is no need for a zero plural suffix in this word, in contrast to DM.

2.5 Non-concatenativity as an epiphenomenon of phonology

We have now outlined the Spell-Out model in which we propose to derive the putative nonconcatenative effects outlined in section 1. We will argue in the following sections that deviations from the concatenative ideal, when found, are the result of purely phonological processes, when the structural effects of the requirements of exponence are repaired in the phonology. Non-concatenative effects may also arise in the ordinary course of things, in the absence of lexical underspecification or prespecification. Here we briefly consider a couple of examples.

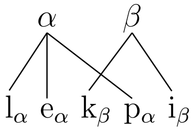
An example of repair which disrupts linearization is metathesis in the Dravidian language Kui (Winfield 1928; Hume 2001). In this language, the past is marked by the suffix {-pi}, e.g. /gas+pi/→gas-pi 'to hang oneself PAST'. Following a stem ending in a velar consonant, the /p/ of the suffix and the final velar of the stem metathesize under compulsion of a high-ranking sequential markedness constraint *DORS⌒LAB, e.g. /lek+pi/→lep-ki 'to break PAST'.

(19)

/lekpi/	*DORS⌒LAB	LINEARITY
a. lekpi	*!	
b. ☞ lepki		*

Naturally, this introduces a discontinuity, in violation of the concatenative ideal, as illustrated in (20).

(20)



Using data from Costello (1998), Horwood (2008) describes the case of Katu, a Mon-Khmer language spoken in Laos. In this language, the nominalizer affix, underlyingly {ar-}, may surface as a prefix or infix, with appropriate phonological modifications. The variation is governed by a disyllabic maximum on word size. If the root is a single syllable, the nominalizer is prefixed, e.g. *ɔɔp* 'to wrap' *ar-ɔɔp* 'wrapping'. If the root is disyllabic, on the other hand, the nominalizer is infixed, and adjusted so as to satisfy syllabic well-formedness requirements, e.g. *ka.tʃʰiit* 'to be shy' *ka-r-tʃʰiit* 'shyness'; *k.lɔɔs* 'to exchange' *k-a-lɔɔs* 'an exchange'. The prefix-infix alternation in this language would appear to be purely phonological (in section 4 we discuss examples of infixes which cannot be explained in this way and which require a marked specification for the position attribute in the morpheme's lexical entry).

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that a lexical entry is complex in the way illustrated in (18).

3 Segmental and featural deficiency in lexical entries

In the default case, a morpheme consists of a string of segments. It is also widely accepted that certain morphemes may be 'larger' or 'smaller' than the segment. Some morphemes are argued to contain only prosodic information, being specified for example as a mora (μ), syllable (σ), foot (Ft), or prosodic word (ω). Others are argued to contain only featural information. Such morphemes are phonologically 'deficient' since they cannot be phonetically interpreted without full segmental content. In Section 3.1 we will examine morphemes containing featurally underspecified root nodes. Section 3.2 will address segmentally underspecified prosodic affixes.

3.1 Affixation of features and underspecified root nodes

Affixation of a root node,[17] possibly specified as a consonant or vowel, can in principle be distinguished from the affixation of a prosodic node such as a mora. A featurally deficient segmental root node would be expected to be associated with the edge of the domain where it is introduced by the syntax, either by epenthesizing featural content or coalescing with the nearest available compatible root node in the stem, resulting in 'mutation'. A mora, on the other hand, would be expected to 'float' to a larger degree, for example skipping non-weight-bearing segments that often inhabit the right edges of words of many languages that otherwise treat codas as weight-bearing. A possible example of affixation of an empty root node may be taken from Qafar (*Ethnologue*: Afar), a Cushitic language of Ethiopia (Hayward 1998). In this language the indefinite genitive form of feminine nouns is marked by a C suffix that is made phonetically interpretable either by copying the featural content of a following consonant or, in the absence of such, by a default /h/, e.g. (p. 630) *saga* 'cow', *sagág gaysa* 'cow's horn', *sagáɗ daylo* 'cow's offspring', *sagáh iba* 'cow's legs'. It is unlikely that the suffix is a mora, since this specification would be just as consistent with lengthening of the stem-final vowel. Since the property of being consonantal seems to be a part of the lexical specification of the suffix, we conclude that it is represented as an underspecified consonantal root node. The affixation of bare consonants and vowels seems to be rare and may in practice often be difficult to distinguish from mora affixation. We believe it is far more common to find affixation of featurally deficient root nodes which have some place or manner information. Such affixation, we argue, typically results in the kind of alternations known as 'mutation'.

It is a widespread perception that mutation is essentially an additive process involving the affixation of a featural autosegment, although mutation may also entail destructive alterations, as we shall see in Section 4.3 on ablaut. Nevertheless, the perception persists since a number of influential publications addressing mutation in the context of autosegmental phonology restrict their focus to purely additive mutations (Lieber 1983, 1984, 1987; Akinlabi 1996).[18] Work on mutation carried out within the OT framework has tended to adopt au-

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[17] In this paper, we use two distinct senses of the word ROOT: descriptively in the morphological sense that lexical words have roots, and technically in the phonological sense that a V or C node to which phonological features attach is a root. We believe that context makes clear in each case which sense of root we mean.

[18] The conception of mutation as autosegmental affixation should be seen in the broader theoretical context in which it evolved. Concerns about the generative power of feature-changing rules motivated the development

tosegmentalized representations of distinctive features, developing constraints to handle featural autosegments that are 'floating' in the input (Zoll 1998; Myers 1997; McLaughlin 2000; Wolf 2007). Floating features are problematic with respect to getting linearization to come out right in privative feature theories, however, and we therefore follow De Lacy (2006, 2011) in assuming that there are no floating features. In cases of mutation, the affix contains a root node that lacks a primary Place specification. Mutation may then be understood as a purely phonological response to the requirement that root nodes have a specification for primary Place, a requirement that is satisfied by allowing the affix to parasitize the Place specification of an adjacent or nearby segment. We hold the constraint responsible to be HavePlace (Padgett 1995; Parker 2001; Smith 2002; McCarthy 2008). The formulation in (21) is from McCarthy (2008: 279).

(21) HavePlace
Assign one violation mark for every segment that has no Place specification.

The requirements of HavePlace drive coalescence, which entails violation of the faithfulness constraint Uniformity, defined in (22) following McCarthy and Prince (1995: 123).

(22) Uniformity ('No coalescence')
Let input segments = $i_1, i_2, i_3, \ldots, i_m$ and output segments = $o_1, o_2, o_3, \ldots, o_n$.
Assign one violation mark for every triple (i_x, i_y, o_z), where
i_x and i_y are in correspondence with o_z, and
i_x and i_y are distinct.

3.1.1 Mutation in Aka

An uncomplicated example of initial mutation is supplied by Aka, a Zone C Bantu language spoken in the Central African Republic as described by Akinlabi (1996: A3).[19] Aka evinces morphological voicing of the root-initial consonant in one of its nominal classes, Class 5. Classes 5 and 6 respectively mark the singular and plural of one group of nouns. Our own approach contrasts with that of Wolf (2007), which assumes floating features in the input; see also Kurisu (2001: 40f.). The data is taken from Akinlabi (1996: 285f.), who cites unpublished field notes by Kosseke and Sitamon (1993) and Roberts (1994).[20]

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in the mid 1970s and 1980s of non-linear approaches. SPE-style feature-changing rules were criticized because they failed to distinguish between natural assimilations and unnatural feature changes (e.g. Odden 1987). The shift to autosegmental representations allowed dispensing with feature-changing rules, making the grammar more restrictive. The first step was the development of radical underspecification approaches (Kiparsky 1982; Archangeli 1984, 1988; Pulleyblank 1988; Steriade 1995). As in SPE, features were still generally held to be binary, but only one feature value was assumed to be present in lexical entries, and the complementary feature value was filled in by later redundancy rules. Assimilation rules were modelled as feature-filling spreading. The work of Lieber and Akinlabi represents an extension to morphology of the idea that autosegmental rules are limited to feature-filling.

[19] The language is entered in *Ethnologue* (`http://www.ethnologue.com/`) as 'Yaka', with 'Aka' as one of the name variants.

[20] An anonymous reviewer has brought to our attention the existence of an encyclopaedia of Aka culture and language currently running to 13 volumes Thomas et al. (1983–2008), not cited in Akinlabi (1996). Regrettably we have not had the opportunity to consult this work, but the reviewer kindly made available to us correspondence with the first author of the encyclopaedia, Jacqueline Thomas, on the data used here

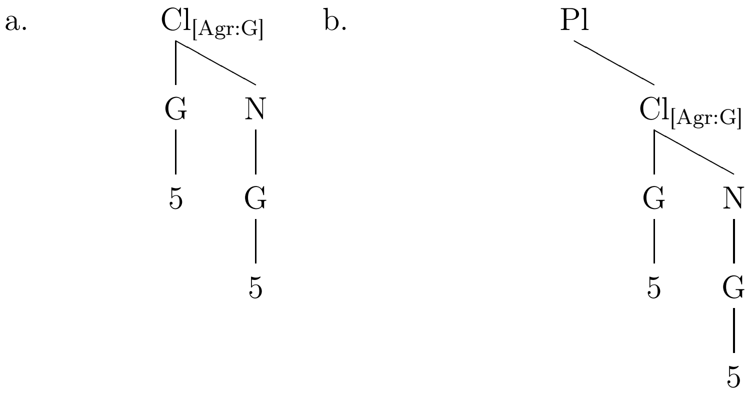
(23) *Morphological voicing in Aka* (Akinlabi 1996: 285f.)

a.	*Alternating*			
	Class 5 sg (UR)	Class 5 sg (SR)	Class 6 pl	
	/C$_{\text{[voice]}}$, tèŋgé/	dèŋgé	mà-tèŋgé	'piercing tool'
	/C$_{\text{[voice]}}$, kásá/	gásá	mà-kásá	'palm branch'
	/C$_{\text{[voice]}}$, pàpùlàkà/	bàpùlàkà	mà-pàpùlàkà	'lung'
	/C$_{\text{[voice]}}$, ɸókó/	βókó	mà-ɸókó	'hole'
b.	*Non-alternating*			
	/C$_{\text{[voice]}}$, gɔ̀àlà/	gɔ̀àlà	mà-gɔ̀àlà	game of imitation
	/C$_{\text{[voice]}}$, bèlèlè/	bèlèlè	mà-bèlèlè	'sound of a waterfall'
	/C$_{\text{[voice]}}$, ʤámbà/	ʤámbà	mà-ʤámbà	'mud'

As in other Bantu languages, nouns in Aka are typically prefixed in both the singular and the plural. We assume that the prefix is the exponent of a functional feature, Cl for Classifier, along the lines of Borer (2005), and we will assume that the Plural projects an additional head, Pl.

In general, there are two alternatives for prefixes: Either Cl and Pl incorporate their complements in the syntax, but are lexically specified as prefixes, or else they do not syntactically form a complex X* with the following noun and so are linearized head-initially (cf. Julien 2002). In this case, there is a sizable class of noun class markers which are consistently prefixal, so we assume the latter. We add a nonprojecting feature 'G[ender]' on the noun, and assume that this is copied onto the Cl node by agreement. The relevant gender feature is '5' for classes 5 and 6.[21]

(24)



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and their interpretation. She points out that the class nomenclature used in our description is now deemed antiquated in work on Aka, where the classical Bantu classes 5 and 6 apparently used in Akinlabi's description respectively correspond to 7 and 8 used by scholars of Aka. The general marker of Class 7 (Classical Bantu Class 5) is {dì-}, but in the western parts of the Aka speaking area, this has been replaced by initial voicing in many lexical items. However, it appears that the choice of {dì-} or voicing in Class 7 still has to be listed for each stem, and she expresses skepticism to voicing as a regular marker of the relevant class.

[21] Recall that we are assuming that all and only semantically interpretable instances of features project, which raises the question of whether there is a semantic interpretation for class five. If there is, then it would project, as a category; a class five noun root would be a portmanteau which lexicalizes 5 as well as N. The copying of 5 onto Cl and other agreeing elements in the DP would be more or less the same.

The lexical entry for a Class 5 prefix is specified for insertion in <Cl,G,5> (25), and the lexical entry for a Class 6 prefix is <Pl,Cl,G,5> (26). We assume in line with most recent work that voicing is a privative feature (Iverson and Salmons 1995, 2003; Jessen 2001; Rooy and Wissing 2001; Wetzels and Mascaró 2001; Petrova et al. 2006) (though see Wolf (2007) for an analysis of Aka assuming [voice] is a binary feature).

(25) *Aka Class 5*

C ⇔ <Cl,G,5>
|
[voice]

(26) *Aka Class 6*

/mà/ ⇔ <Pl,Cl,G,5>

Now let us address how morphological voicing in Class 5 is handled by the phonological component. First let us examine more closely the reasons why floating features are problematic. Suppose that the exponent of Class 5 was simply a floating feature [voice]. In a privative framework, sonorants cannot contrastively bear [voice], and voiceless obstruents are characterized by the absence of [voice]. The [voice] feature is introduced by the syntax to the left of N, but the phonology cannot parse it in that position because it lacks a root node. The erroneous prediction in a privative feature theory is that, given an input with more than one obstruent in the root, the [voice] feature should be free to dock on any one of them. Consider the tableau in (31). For the purposes of this tableau, we assume that floating features are subject to a constraint *Float, which militates against floating features in the output. Since features on this theory are autosegments, they are subject to Max and Dep constraints. Max[voi] requires that an underlying [voice] feature surface faithfully in the output. When Max[voi] and *Float are ranked high, they will force an underlying floating [voice] feature to be parsed. Candidate (a) deletes [voice] in violation of top-ranked Max[voice]. In candidate (b), the [voice] feature remains floating in the output, which falls foul of a constraint *Float. Candidates (c) and (d) faithfully parse [voice], but the contest between them remains undecided since both violate Ident[voi] and *VcdObs equally. For Max, Dep, and Ident[F] see McCarthy and Prince (1995: 122).

(27) Max
Let input segments = $i_1, i_2, i_3, \ldots, i_m$ and output segments = $o_1, o_2, o_3, \ldots, o_n$.
Assign one violation mark for every i_x that has no correspondent o_y.

(28) Dep
Let input segments = $i_1, i_2, i_3, \ldots, i_m$ and output segments = $o_1, o_2, o_3, \ldots, o_n$.
Assign one violation mark for every o_x that has no correspondent i_y.

(29) *VcdObs
Voiced obstruents are disallowed.

(30) Ident[F]
Let input segments = $i_1, i_2, i_3, \ldots, i_m$ and output segments = $o_1, o_2, o_3, \ldots, o_n$.
Assign one violation mark for every pair (i_x, o_y), where

i_x is in correspondence with o_y, and
i_x and o_y have different specifications for [F].

(31)

[voi], k$_1$as$_2$a	Max[voi]	*Float	Ident[voi]	*VcdObs
a. k$_1$as$_2$a	*!			
b. [voi] k$_1$as$_2$a		*!		
c. ☞,☹ k$_1$az$_2$a			*	*
d. ☞ g$_1$as$_2$a			*	*

Once we redefine the elements responsible for mutation as featurally deficient root nodes rather than floating features, we can leverage Linearity (McCarthy and Prince 1995: 123) to prevent the free floating of mutation-inducing features.

(32) Linearity
Let input segments $= i_1, i_2, i_3, \ldots, i_m$ and output segments $= o_1, o_2, o_3, \ldots, o_n$.
Assign one violation mark for every quadruple (i_w, i_x, o_y, o_z), where
i_w is in correspondence with o_y, and
i_x is in correspondence with o_z, and
i_w precedes i_x, and
o_y does not precede o_z.

In tableaux, we will generally show violations of Linearity in tabular format where linearization of affixal with respect to root material is at issue. Coindices for elements in the affix are shown in the first column, coindices for elements in the root in the first row. Where the affix is introduced on the left and affixal material therefore precedes root material in the input, the table will contain a precedence sign ($\prec$) in the top lefthand corner. Marks are assigned to a cell (affix element$_A$,root element$_B$) if it is not the case that $A \prec B$. Conversely, where the affix is introduced on the right, and the affixal material succeeds root material in the input, the top lefthand corner of the table will show a 'succeeds' sign ($\succ$). In this case, marks are assigned to a cell (affix element$_A$,root element$_B$) if it is not the case that $A \succ B$. Coindices of root material are generally shown as integers, affixal coindices as letters of the Roman alphabet. Epenthetic material will be assigned Greek-letter indices.

Since we are assuming that the affix marking Class 5 is introduced from the left in the syntax, minimal violation of Linearity will entail coalescence of the affixal root node with the initial consonant of the stem. The tableau in (33) deploys equivalent candidates to those in (31). Candidates (c) and (d) again fare equally on Ident[voi] and *VcdObs, as well as falling foul of Uniformity from (22), which is also ranked low. Candidate (c), however, has all of the marks of (d) plus an additional violation of Linearity (an instance of harmonic bounding), allowing (d) to beat (c).

(33)

C$_x$+k$_1$as$_2$a | [voice]	MAX	HAVEPL	IDENT[voi]	*VCDOBS	LINEARITY	UNIFORMITY
a. k$_2$as$_3$a	*!					
b. C$_x$ k$_2$as$_3$a | [voice]		*$_x$!				
c. k$_1$az$_{2,x}$a | [voice]			*$_2$	*	$\prec$ 1 2 x * *!	*
d. ☞ g$_{1,x}$as$_2$a | [voice]			*$_1$	*	$\prec$ 1 2 x *	*
e. ☞,☹ k$_{1,x}$as$_2$a			*$_x$	*	$\prec$ 1 2 x *	*

However there is a fifth candidate (e), which fares as well as the desired winner: (e) has a violation profile that is identical to that of the desired winner (d), but for the locus of its one violation of IDENT[voi]. While the desired winner (d) assesses a mark to IDENT[voi]@1, the equally competitive candidate (e) assesses a mark to IDENT[voi]@x. What is required to ensure the desired winner's actual supremacy is some way of penalizing *loss* of featural information without incurring penalties for the addition of featural information. We therefore invoke an alternative view of featural faithfulness, MAX-feature Theory, that is much used in accounts relying on privative features. Important literature on this approach includes and Lamontagne and Rice (1995), Causley (1997), Zoll (1998) and McCarthy (2008). In (34) we identify the replacement of IDENT[voi] as MAX[Lar].

(34) MAX[Lar]
Let input Laryngeal tier = $l_1 l_2 l_3 \ldots l_m$ and output Laryngeal tier = $L_1 L_2 L_3 \ldots L_n$.
Assign one violation mark for every l_x that has no correspondent L_y.

The tableau in (35) re-presents the analysis integrating all elements of the discussion.

(35)

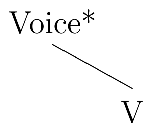
C_x+k_1as_2a | [voice]	Max	HavePl	Max[Lar]	*VcdObs	Linearity	Uniformity
a. k_2as_3a	*!					
b. C_x k_2as_3a | [voice]		$*_x$!				
c. $k_1az_{2,x}a$ | [voice]				*	$\prec$ 1 2 x * *!	*
d. ☞ $g_{1,x}as_2a$ | [voice]				*	$\prec$ 1 2 x *	*
e. $k_{1,x}as_2a$			$*_x$!	*	$\prec$ 1 2 x *	*

3.1.2 Heterotropic autosegmental affixation in Inor

Mutation does not always manifest itself at the edge at which the affix is introduced by the syntax. An advantage of the deficient root node theory is that Linearity will ensure minimal displacement within the space defined by other phonological constraints. The need to assume featural Alignment constraints is rendered unnecessary by this assumption, along with the idea that the edge orientation of each affix is determined by the syntax, and therefore in the input to the phonological component.

In Inor (Chamora and Hetzron 2000), there is an 'impersonal' form of the verb, which we represent simply as V incorporating into a head Voice, setting aside irrelevant details.[22]

(36)



The morphological manifestation of the impersonal includes an *-i* suffix and labialization of the rightmost non-coronal consonant in the root. Examples are given in (37).[23]

(37) *Inor impersonal labialization*

ROOT	PERF	PERF.IMPERS	
$\sqrt{\text{nfg}}$	nəfəg	nəfəg^w-i	'to be greedy'
$\sqrt{\text{sbr}}$	səbər	səb^{w}ər-i	'to break'

---

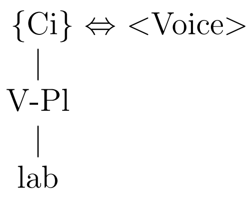
[22] See also Piggott (2000) for an account that similarly eschews the use of Alignment to describe the edge orientation of the labialization.

[23] The palatalization of /s/ to [ʃ] in $\sqrt{\text{drs}}$ is due to the front vowel context.

$\sqrt{\text{bsr}}$	bəsər	b^{w}əsər-i	‘to cook’
$\sqrt{\text{drs}}$	dənəs	dənəʃ-i	‘to break off the edge’

Since the position in which labialization is realized varies, we analyze it as a featurally deficient consonantal root node with a specification for V-Place but not C-Place, as shown in (38). (For the concepts V-Place and C-Place, see for example Clements and Hume 1995 and Morén 2003.) In the tableaux, we represent this underspecified consonant as a superscript /^{w}/.

(38) *Inor Impersonal*



The variability in the realization of the impersonal is driven by HAVEPLACE, introduced above. If epenthesis is ruled out, the underspecified /^{w}/ must coalesce with a neighboring consonant so as not to fall afoul of this constraint. Coronal consonants do not have labialized counterparts and, in the event that the root lacks a non-coronal consonant, labialization simply fails to surface. The constraint *CORLAB (39) must therefore dominate MAX as in in (40). MAX must also dominate LINEARITY, since moving /^{w}/ possibly far from its underlying position is preferable to outright deletion. To simplify the exposition, we abstract away from the role of (highly ranked) HAVEPLACE and (low-ranked) UNIFORMITY.

(39) *CORLAB
Labial coronals are disallowed.

(40)

d$_1$ən$_2$əs$_3$+$^{w}{}_{x}$i	*CORLAB	MAX	LINEARITY
a. d$^{w}{}_{1,4}$ən$_2$əʃ$_3$i	*!		≻ 1 2 3 x * * *
b. d$_1$ən$^{w}{}_{2,4}$əʃ$_3$i	*!		≻ 1 2 3 x * *
c. d$_1$ən$_2$əs$^{w}{}_{3,4}$i	*!		≻ 1 2 3 x *
d. ☞ d$_1$ən$_2$əʃ$_3$i		*	

If there is only one labializable consonant in the root, then that undergoes labialization regardless of its position in the root. This falls out from the ranking we have already established, as shown in (41) and (42).

(41)

s$_1$əb$_2$ər$_3$+$^{w}{}_{x}$i	*CorLab	Max	Linearity
a. s$^{w}{}_{1,4}$əb$_2$ər$_3$i	*!		≻ 1 2 3 x * * *
b. ☞ s$_1$əb$^{w}{}_{2,4}$ər$_3$i			≻ 1 2 3 x * *
c. s$_1$əb$_2$ər$^{w}{}_{3,4}$i	*!		≻ 1 2 3 x *
d. s$_1$əb$_2$ər$_3$i		*!	

(42)

b$_1$əs$_2$ər+$^{w}{}_{x}$i	*CorLab	Max	Linearity
a. ☞ b$^{w}{}_{1,4}$əs$_2$ər$_3$i			≻ 1 2 3 x * * *
b. b$_1$əs$^{w}{}_{2,4}$ər$_3$i	*!		≻ 1 2 3 x * *
c. b$_1$əs$_2$ər$^{w}{}_{3,4}$i	*!		≻ 1 2 3 x *
d. b$_1$əs$_2$ər$_3$i		*!	

Where there is more than one labializable consonant in the root, the rightward orientation is a result of the low ranked constraint Linearity. In (43) below, both (b) and (c) fare equally well on *CorLab and Max. Linearity, however, favours (c) with its one violation mark against (b)'s two.

(43)

n$_1$əf$_2$əg$_3$+$^{w}{}_{x}$i	*CorLab	Max	Linearity
a. n$^{w}{}_{1,4}$əf$_2$əg$_3$i	*!		≻ 1 2 3 x * * *
b. n$_1$əf$^{w}{}_{2,4}$əg$_3$i			≻ 1 2 3 x * *!
c. ☞ n$_1$əf$_2$əg$^{w}{}_{3,4}$i			≻ 1 2 3 x *
d. n$_1$əf$_2$əg$_3$i		*!	

Chamora and Hetzron (2000) do not provide any examples with roots in which only the first and second radicals are labializable, e.g. hypothetical $\sqrt{\text{bgd}}$, although both their descriptive generalization and the present analysis would predict that it is always the second radical that undergoes labialization in such cases. See Zoll (1997) for a case from Japanese that works in a similar way that uses featural Alignment constraints.

3.2 Segmental deficiency: Prosodic nodes as affixes

There are differing opinions on what affixes in prosodic morphology represent. The first non-linear approaches to reduplication in the late 1970s and early 1980s defined templates in terms of skeletal units, C and V (McCarthy 1979, 1981; Marantz 1982; Yip 1982; Broselow and McCarthy 1983; Archangeli 1983, 1984). It became clear that there were a number of problems with defining templates in terms of C and V (or X) slots. One issue was that skeletal templates violate counting norms (phonological rules do not count segments). A second is overgeneration: skeletal templates entail it should be possible to find languages in which templates are defined as any arbitrary string of C and V slots, e.g. VCCV. Such shapes do not seem to occur.

Finally, there may be considerable variation in the shape of the reduplicant considered as a string of Cs and Vs. In the Philippine language Ilokano, for example, the reduplicant may be CVC, VC, or CCVC, depending on the initial substring of the base. Skeletal accounts must therefore specify reduplicant shape maximally, including the 'excess' positions that do not get filled with material when conditions in the base are not met.

The Prosodic Morphology Hypothesis of McCarthy and Prince (1986) marks the beginning of a second phase, where the affixes were defined as 'authentic units of prosody' — essentially the minimalist view taken in this chapter. With the advent of Optimality Theory, however, the Prosodic Morphology Hypothesis gave way to Generalized Template Theory or GTT (see McCarthy and Prince 1994, 1995, 1999 and Urbanczyk 1996). Originally the GTT was a hypothesis about the lack of need for templates in reduplication. Reduplicants may roughly be syllable or word-sized. According to GTT, though, this difference need not be stipulated in the template but follows from phonological constraint interaction and whether the reduplicant is specified underlyingly as a ROOT or an AFFIX. Constraints on the mapping between morphology and phonology preferentially interpret affixal reduplicants as monosyllabic, and stem reduplicants as prosodic words (minimally consisting of a single foot). Interestingly, McCarthy (2000a) proposes that a bare foot node may serve as an affix in Cupeño (see below, Section 3.2.2), at a time when he was simultaneously pursuing the Generalized Template Theory. A recent dissertation by Saba Kirchner (2010) entitled 'Minimal Reduplication' has argued for a return to the view that syllables may be affixes. We find Saba Kirchner's approach to be eminently compatible with the one we develop here. In this section, we discuss segmental root node affixation, distinguishing it from affixation of morae, and also autosegmental affixation.

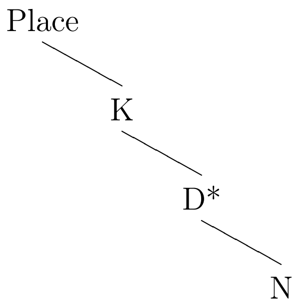
The use of tones and moras occurs reasonably frequently in the literature. A simple example is the tonal locative in Jamsay, a Niger-Congo language in the Dogon group spoken in Mali (Heath 2008). The formation of the locative takes the form of the addition of a L tone at the right edge of the tonal tier of the lexical stem (p. 107).

(44) *Tonal locative in Jamsay*

Bare stem			Locative		
/kaː, H/	káː	'mouth'	/kaː, H, L/	kâː	'in the mouth'
/uro, H/	úró	'house'	/uro, H, L/	úrò	'in the house'
/gɔː, LH/	gɔ̌ː	'granary'	/gɔː, LH, L/	gɔ̌ː̀	'in the granary'
/numo, LH/	nùmó	'hand'	/numo, LH, L/	nùmôː	'in the hand'

We can assume that the locative is a Place head, perhaps with some additional functional structure such as K. Judging from the distribution of nominal morphology and syntax as described by Heath (2008) (e.g. plural suffix, noun precedes numerals, various locative elements precede N), we assume that the N raises to D, but not higher.

(45)



The lexical entry for the locative tone is then as in (46).

(46) {L} ⇔ <Place,K>

3.2.1 The syllable as affix

Saba Kirchner (2010) argues that the copying of input material may serve a variety of phonological ends; it is not restricted to reduplicative morphology. Drawing on a proposal by Kitto and de Lacy (1999), he argues that in Hocąk (Siouan; Wisconsin and Nebraska; a.k.a. Winnebago), vowel copying is preferred to straight epenthesis as a strategy for circumventing consonant clusters in the output, e.g. /ʃ+wa$_1$pox/ 'you stab' and /ʃ+ru$_1$xuk/ 'you earn' become respectively [ʃ$\underline{a_1}$wa$_1$pox] and [ʃ$\underline{u_1}$ru$_1$xuk] (copied elements shown underlined), rather than [ʃəwa$_1$pox] or [ʃəru$_1$xuk]. This process is the famous 'Dorsey's Law'. The result is obtained by ranking *Complex and Dep above the faithfulness constraint Integrity (McCarthy and Prince 1995: 124), defined in (47).

(47) Integrity ('No diphthongization/split')
Let input segments = $i_1, i_2, i_3, \ldots, i_m$ and output segments = $o_1, o_2, o_3, \ldots, o_n$.
Assign one violation mark for every triple (i_x, o_y, o_z), where
o_y and o_z are in correspondence with i_x, and
o_y and o_z are distinct.

The constraint interaction is shown in (48).

(48)

/ʃ+wa$_1$pox/	*Complex	Dep	Integrity
a. ʃwapox	*!		
b. ʃəwa$_1$pox		*!	
c. ☞ ʃ$\underline{a_1}$wa$_1$pox			*

In a similar way, reduplication may be understood as a *phonological response* to the segmental deficiency of an affix consisting of a bare prosodic node such as a mora, syllable or foot. Cross-linguistically, Saba Kirchner (2010) argues there is a case to be made that reduplication and epenthesis are alternative strategies for satisfying the same structural requirements. Thus we find languages where the requirement that syllables have onsets is achieved through copying a consonant in the vicinity, as in the Salishan languages Spokane (Bates and Carlson 1998). Similarly, we find languages like Mono (Niger-Congo; Congo; Olson 2005) where word minimality requirements are satisfied through the insertion of a syllable whose content is supplied by copying a neighboring vowel, e.g. /ʒī/→[īʒī] 'tooth'; /ngú/→[úngú] 'water'. If all reduplication should turn out to be describable in this way, reduplication would be eliminated as a morphological process and recourse to primitives like 'base' and 'reduplicant' would be unnecessary. See Inkelas (2011) for an overview of reduplication phenomena.

Kaingang

An apparently simple example of syllable affixation comes from Kaingang, a Macro-Ge language of Brazil originally described by Henry (1948) and Wiesemann (1972) (see also Poser 1982, McCarthy and Prince 1986, and Steriade 1988 for earlier treatments). The verbal plural in this language is marked by suffixing a complete copy of the final syllable of the base, as shown in the examples in (49).

(49) *Verbal plural in Kaingang*

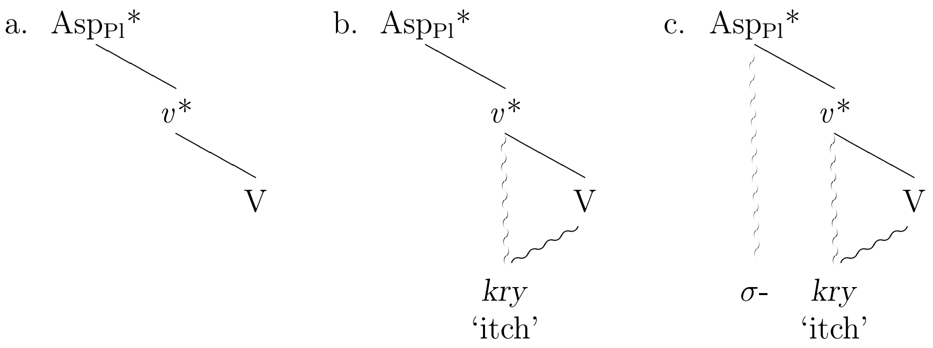
vã	vã$\underline{\text{vã}}$	'throw away'
kry	kry$\underline{\text{kry}}$	'itch'
mrãn	mrãn$\underline{\text{mrãn}}$	'strike'
jẽmĩ	jẽmĩ$\underline{\text{mĩ}}$	'grasp'
vãsãn	vãsãn$\underline{\text{sãn}}$	'exert, fatigue'

In order to maintain the hypothesis that reduplication in a language like Kaingang essentially consists in the suffixation of a syllable, we have to ensure that the input to the process must already be fully syllabified. Affixation of a syllable to a prosodically underspecified input would have no visible effect since the syllable contributed by the affix would simply be used as raw material by the prosodic structure-building operations that ordinarily apply. One possible way around this problem would be to posit lexically represented syllable structure. However, this is not usually a starting point in phonological analysis since, to the best of our knowledge, syllable structure is universally non-contrastive. We offer a different solution based on having syntax triggering a round of syllabification before the affix is lexicalized.

Kaingang has a basic morphological alternation in the verb at a very low level, where one form, which we can call 'nominal', combines with a copula-like element, and another form, which we can call 'verbal', combines with a distinct auxiliary element (Henry 1948). Focusing on the verbal form, we represent the basic verbal structure as $v* > \text{V}$, i.e. an incorporating verbal functional projection (possibly Voice) dominating the verbal root; $v*$ must be at or above the verbal phase head, since additional morphology occurs outside it. In particular, an aspectual head which can express repeated action, which we will call $\text{Asp}_{\text{Pl}}*$, shows up as a reduplicant suffix.

Since $v*$ attracts V out of the phase complement, the phase complement VP spells out without any verb in it. In the next phase, $\text{Asp}_{\text{Pl}}*$ attracts the V-$v*$ complex. When the higher phase spells out, L-Match finds lexical items suitable for insertion, working outward from the innermost word. Thus V-v^* is lexicalized first, and word structure is built on it. Then the $\mathrm{Asp}_{\mathrm{Pl}}{}^*$ layer is lexicalized, by finding an L-Match for $\mathrm{Asp}_{\mathrm{Pl}}$ and Inserting it. These two steps are illustrated in (50-b-c), using squiggly lines for L-Matched and Inserted lexical entries. Although we cannot work this out in detail here, we note this account entails an interesting prediction regarding the kinds of categories syllable affixes and, by extension, higher prosodic nodes, which may be recruited as exponents.

(50)



Once we have a fully syllabified input, we must also ensure that the affix syllable is prevented from simply coalescing with one of those of the stem. We assume this can be accomplished simply by ranking Uniformity(σ) high.

The core interaction is shown in (51). The syllable affix must be faithfully parsed, as demanded by highly ranked Max-σ. Since Dep outranks Integrity, the empty syllable is filled by duplicating material from elsewhere in the word (c) rather than through epenthesis (b). The coindices of duplicated material are shown with a superscript prime ($'$).

(51)

$[\mathrm{v}_1\mathrm{a}_2]_{\sigma_a}+\sigma_x$	Max-σ	Dep	Integrity
a. $\mathrm{v}_1\mathrm{a}_2$	$*_x!$		
b. $\mathrm{v}_1\mathrm{a}_2.\mathrm{t}_\alpha\mathrm{ə}_\beta$		$*_\alpha!*_\beta$	
c. ☞ $\mathrm{v}_1\mathrm{a}_2.\mathrm{v}_{1'}\mathrm{a}_{2'}$			$*_1*_2$

There must also be a constraint that ensures duplicate segments are as close as possible to their antecedents. We dub the relevant constraint LocalCopy (cf. Locality in Riggle 2004 and Yu 2005: 452).

(52) LocalCopy
Let input segments $= i_1, i_2, i_3, \ldots, i_m$ and output segments $= o_1, o_2, o_3, \ldots, o_n$.
Assign one violation mark for every quadruple $(i_x, o_y, o_{y'}, o_z)$ where
o_y and $o_{y'}$ is in correspondence with i_x, and
$o_y \prec o_z$ and $o_z \prec o_{y'}$, or $o_{y'} \prec o_z$ and $o_z \prec o_y$.

LocalCopy is able to produce the right result even if ranked low. In (53), LocalCopy ensures that locally duplicating candidate (d) wins over long-distance duplicating candidate (c). We give violations of LocalCopy in similar tabular format as for Linearity.

(53)

	$[j_1\tilde{e}_2]_{\sigma_a}[m_3\tilde{\imath}_4]_{\sigma_b}+\sigma_x$	MAX-σ	DEP	INTEGRITY	LOCALCOPY
a.	$j_1\tilde{e}_2m_3\tilde{\imath}_4$	$*_x!$			
b.	$j_1\tilde{e}_2m_3\tilde{\imath}_4.t_\alpha ɘ_\beta$		$*_\alpha!*_\beta$		
c.	$j_1\tilde{e}_2m_3\tilde{\imath}_4j_{1'}\tilde{e}_{2'}$			$*_1*_2$	$\begin{array}{lll} & 1' & 2' \\ 1 & {*}{*}{*}! & \\ 2 & & {*}{*}{*} \end{array}$
d. ☞	$j_1\tilde{e}_2m_3\tilde{\imath}_4m_{3'}\tilde{\imath}_{4'}$			$*_3*_4$	$\begin{array}{lll} & 3' & 4' \\ 3 & * & \\ 4 & & * \end{array}$

The second challenge of Kaingang reduplication is to account for the reduplication of the entire syllable intact. The naive description of the pattern as involving copying of the entire syllable cannot serve as the starting point for a theoretical treatment. This is necessary given our own assumptions as well as those standardly adopted in work on reduplication since Marantz (1982): prosodic nodes (considered as templates or affixes) are the targets of copied segmental material; they are not themselves copied. There is thus more to the Kaingang pattern than meets the eye. Still, the pattern is readily grasped and will serve as a convenient starting point for introducing several constraints that will play a central role throughout this chapter.

The first feature we address is the copying of complex onsets. In Kaingang, all complex onsets have /r/ as their second element. Explaining this phenomenon has to be broken down into two subproblems: (i) why $C_1C_2V_3$ does not map to C_1V_3, and (ii) why $C_1C_2V_3$ does not map to C_2V_3. The solution to the first subproblem may lie with the CONTIGUITY family of faithfulness constraints. McCarthy and Prince (1995: 123) posit two contiguity constraints, I-CONTIGUITY in (54-a), which prohibits skipping of material internal to the input string, and O-CONTIGUITY in (54-b), which prohibits intrusion of material.

(54) CONTIGUITY

Let $I = i_u \frown i_v \frown i_w$ be a contiguous substring of the input and $O = o_x \frown o_y \frown o_z$ a substring of the output, such that pairs (i_u,o_x), (i_v,o_y), and (i_w,o_z) correspond.

a. I-CONTIGUITY (“No skipping”)
Assign one violation mark for every pair (I,O) where
I and O correspond, and
i_v is zero and o_y is an contentful element.

b. O-CONTIGUITY (“No intrusion”)
Assign one violation mark for every pair (I,O) where
I and O correspond, and
i_v is a contentful element and o_y is zero.

By ranking I-CONTIGUITY over INTEGRITY in (55) we correctly eliminate candidate (d), with skipping of input material in the duplicated string. However, something is still missing from (55) since (c), indicated with a ‘frownie’ (☹), is more harmonic than the desired winner (e), which has an additional mark on INTEGRITY (marked ¡*!).

(55)

	$[k_1r_2y_3]_{\sigma_a}+\sigma_x$	Max-σ	Dep	I-Contiguity	Integrity
a.	$k_1r_2y_3$	$*_x!$			
b.	$k_1r_2y_3.t_\alpha ə_\beta$		$*_\alpha!*_\beta$		
c. ☹	$k_1r_2y_3.r_{2'}y_{3'}$				$*_2*_3$
d.	$k_1r_2y_3.k_{1'}y_{3'}$			$*_2!$	$*_1*_3$
e. ☞	$k_1r_2y_3.k_{1'}r_{2'}y_{3'}$				$*_1*_2$¡$*_3!$

In many languages, low-sonority onsets are preferred over onsets with higher sonority. This preference emerges in perfective CV reduplication in Sanskrit, e.g. *pa-prac^h-* ‘asked’, *si-ṣmi-* ‘smiled’ (Steriade 1982, 1988). In clusters with falling sonority, it is precisely the second consonant that is duplicated, e.g. *tu-stu-* ‘praised’. For simplicity, let us take this preference as based on a markedness constraint *SonOns, which militates against sonorous segments in onset position. Kaingang does permit sonorous onsets word-initially, as shown by the examples in (49). *SonOns must plainly be subordinated to Ident[F] constraints relevant for sonority and Max. Unmarked low sonority onsets will emerge precisely when there is an empty syllable in the input without prespecified segmental content (cf. McCarthy and Prince 1994). Ranked above Integrity it gets the right result, favouring the desired winner (e) over (c).

(56)

	$[k_1r_2y_3]_{\sigma_a}+\sigma_x$	Max-σ	Dep	I-Contiguity	*SonOns	Integrity
a.	$k_1r_2y_3$	$*_x!$				
b.	$k_1r_2y_3.t_\alpha ə_\beta$		$*_\alpha!*_\beta$			
c.	$k_1r_2y_3.r_{2'}y_{3'}$				*!	$*_2*_3$
d.	$k_1r_2y_3.k_{1'}y_{3'}$			$*_2!$		$*_1*_3$
e. ☞	$k_1r_2y_3.k_{1'}r_{2'}y_{3'}$					$*_1*_2*_3$

Three features of the data remain to be explained. First, we note that every element of the copied string is to the right of the base material. This reflects highly ranked O-Contiguity, which disallows intrusion of material, as shown in (57).

(57)

	$[m_1r_2\tilde{a}_3n_4]_{\sigma_a}+\sigma_x$	O-Contiguity
a.	$m_1r_2\tilde{a}_3.m_{1'}r_{2'}\tilde{a}_{3'}n_4$	*!
b. ☞	$m_1r_2\tilde{a}_3n_4.m_{1'}r_{2'}\tilde{a}_{3'}n_{4'}$	

In the original definition due to McCarthy and Prince (1995: 123), O-Contiguity required that “the portion of the output standing in correspondence forms a contiguous string”. It is not clear how this would apply to the kind of intrusion of duplicated material that we see here. Since Contiguity as reformulated in (54) assesses discrepancies between corresponding strings, each input string – output string pair is evaluated separately. In candidate (a), the input string /$m_1r_2\tilde{a}_3n_4$/ has two output strings in correspondence with it, [$m_{1'}r_{2'}\tilde{a}_{3'}n_4$] and [$m_1r_2\tilde{a}_3.m_{1'}r_{2'}\tilde{a}_{3'}n_4$], and so there are two string pairs to be assessed. The latter string violates O-Contiguity.

The final segment of the reduplicated output form is the same as the input string. The relevant constraint is {Right,Left}-Anchor (McCarthy and Prince 1995: 123), defined in (58).

(58) {Right,Left}-Anchor(S_1,S_2)
Any element at the designated periphery of S_1 has a correspondent at the designated periphery of S_2.

Let *Edge*(X,{L,R})=the element standing at the *Edge*=L,R of X.
Right-Anchor. If x=Edge(S_1,R) and y=Edge(S_2,R) then $x\Re y$.
Left-Anchor. Likewise, *mutatis mutandis*.

To ensure that a consonant at the right edge of the input string is duplicated, Integrity must be dominated by R-Anchor, as shown in (59).

(59)

$m_1r_2\tilde{a}_3n_4+\sigma_x$	R-Anchor	Integrity
a. $m_1r_2\tilde{a}_3n_4.m_{1'}r_{2'}\tilde{a}_{3'}$	*!	
b. ☞ $m_1r_2\tilde{a}_3n_4.m_{1'}r_{2'}\tilde{a}_{3'}n_{4'}$		*

Finally, we need to explain why onsets are copied at all when an equally sonorous coda in the base could simply be recruited for the purpose: why is *mrãn* not simply reduplicated as *mra.nan*? The counterfactual form contains two copies of /n/, but they have different 'syllabic roles' since the first occurrence represents an onset, the second a coda. Several scholars have proposed constraints requiring identity between corresponding segments in terms of their syllabic role, beginning with McCarthy and Prince (1993). (For additional examples, see Rose and Walker (2004: 511) and Kenstowicz (2005).) We dub ours Ident[σ-role] in (60) and adapt the content from Rose and Walker (2004: 511).

(60) Ident[σ-role]
Correspondent consonants (in the output) must have identical syllabic roles.

Ranking Ident[σ-role] above Integrity again achieves the correct result, as shown in (61).

(61)

$m_1r_2\tilde{a}_3n_4+\sigma_x$	Ident[σ-role]	Integrity
a. $m_1r_2\tilde{a}_3.n_4.\tilde{a}_{3'}$	*!	
b. ☞ $m_1r_2\tilde{a}_3n_4.m_{1'}r_{2'}\tilde{a}_{3'}n_{4'}$		*

Mangarayi

Mangarayi (Merlan 1982) is a Gunwingguan language spoken in Australia's Northern territory with a pattern of reduplication that may be analyzed as the prefixation of a syllable.

Reduplication functions in this language to express the meaning 'having lots of ...' with inanimate nouns, and also with a kind of plural quantificational force in certain animate nouns. We assume that it represents a Num* head outside the lowest word-forming node, as with the Kaingang Asp_{Pl}*.

Representative data from Merlan (1982: 215f.) is given in (62). Merlan (1982) identifies the reduplicated string as CVC, i.e. *waŋgiɟ* reduplicates as *waŋgaŋgiɟ*, with cross-anchoring of the reduplicant edges. However, in line with recent work (McCarthy and Prince 1986, 1993; Kurisu and Sanders 1999; Crowhurst 2004) we assume the reduplicated string is either VCC or VC. The reduplicated string takes the form VC with roots beginning with an open syllable (62-a), and VCC with roots beginning with a closed syllable (62-b).

(62) *Mangarayi*

a.	gamag	'digging stick'	gamamagɟi	'having digging sticks'
	waɭima	'young person'	waɭaɭima	'young persons'
	gabuɟi	'old person'	gababuɟi	'old persons'
b.	ɟalwaji	'mud'	ɟalwalwaji	'very muddy'
	waŋgiɟ	'child'	waŋgaŋgiɟ	'children'
	ɟimgan	'knowledgeable person'	ɟimgimgan	'knowledgeable persons'

We identify the affix as simply a syllable node, introduced on the left by the syntax. The lexical entry is shown in (63).

(63) *Mangarayi nominal reduplication*
$\sigma \Leftrightarrow$ <Num>

Although the affixal syllable is prefixed to the base, the string duplicated to fill that syllable with content does not coincide with the beginning of the segmental string, giving rise to a violation of O-CONTIGUITY. We hold the reason for this violation to be a highly ranked faithfulness constraint INITIAL INTEGRITY in (64), which penalizes the duplication of the initial segment of the word.[24] Ranking INITIAL INTEGRITY over O-CONTIGUITY derives the internal duplication pattern found in Mangarayi.

(64) INITIAL INTEGRITY
Let input segments $= i_1, i_2, i_3, \ldots, i_m$ and output segments $= o_1, o_2, o_3, \ldots, o_n$.
Assign one violation mark for every triple (i_x, o_y, o_z), where
o_y and o_z are in correspondence with i_x, and
o_y and o_z are distinct, and
i_x is initial in the input string.

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[24] The functional basis for such a constraint may have to do with the fact that the word-initial segment is known to be especially salient in word recognition. Duplicating the initial segment of the word may lead to errors in placing the word boundary, complicating the task of lexical recognition. Since internal reduplication kicks in later, the listener has comparatively more information about the identity of the lexical word.

(65)

σ_x + σ_a σ_b σ_c g$_1$ a$_2$ b$_3$ u$_4$ ɟ$_5$ i$_6$	ONSET	MAX-σ	DEP	INITIAL INTEGRITY	INTEGRITY	LOCALCOPY
a. σ_a σ_b σ_c g$_1$ a$_2$ b$_3$ u$_4$ ɟ$_5$ i$_6$		$*_x$!				
b. σ_x σ_a σ_b σ_c t$_\alpha$ ə$_\beta$ g$_1$ a$_2$ b$_3$ u$_4$ ɟ$_5$ i$_6$			$*_\alpha$!$*_\beta$			
c. σ_x σ_a σ_b σ_c g$_{1'}$ a$_{2'}$ g$_1$ a$_2$ b$_3$ u$_4$ ɟ$_5$ i$_6$				$*_1$!	$*_1*_2$	*,*
d. σ_x σ_a σ_b σ_c g$_1$ a$_{2'}$ a$_2$ b$_3$ u$_4$ ɟ$_5$ i$_6$	*!				$*_2$	
e. σ_x σ_a σ_b σ_c g$_1$ u$_{4'}$ ɟ$_{5'}$ a$_2$ b$_3$ u$_4$ ɟ$_5$ i$_6$					$*_4*_5$	***!,***
f. ☞ σ_x σ_a σ_b σ_c g$_1$ a$_{2'}$ b$_{3'}$ a$_2$ b$_3$ u$_4$ ɟ$_5$ i$_6$					$*_2*_3$	*,*

Moving on to the forms in (62-b), we see that the duplicated string also copies the coda. We assume this is an effect of IDENT[σ-role], introduced in the previous section.

(66)

σ_x + σ_a σ_b w$_1$ a$_2$ ŋ$_3$ g$_4$ i$_5$ ɟ$_6$	IDENT[σ-role]	I-CONTIGUITY	INTEGRITY
a. σ_x σ_a σ_b w$_1$ a$_{2'}$ ŋ$_{3'}$ a$_2$ ŋ$_3$ g$_4$ i$_5$ ɟ$_6$	$*_{3'}$!		$*_2*_3$
b. σ_x σ_a σ_b w$_1$ a$_{2'}$ g$_{4'}$ a$_2$ ŋ$_3$ g$_4$ i$_5$ ɟ$_6$		$*_{2',4'}$!	$*_2*_4$
c. ☞ σ_x σ_a σ_b w$_1$ a$_{2'}$ ŋ$_{3'}$ g$_{4'}$ a$_2$ ŋ$_3$ g$_4$ i$_5$ ɟ$_6$			$*_2*_3*_4$

In candidate (a), the duplicated /ŋ/ serves as both onset and coda in the second syllable, leading to a fatal violation of IDENT[σ-role]. In candidate (b) only the /g/ is duplicated and it serves as onset in each position. It satisfies IDENT[σ-role] but fails for another reason. All candidates violate O-CONTIGUITY at least once by virtue of infixing segmental material in the first place. This is forced by highly ranked INITIALINTEGRITY which penalizes the duplication of initial segments. However, candidate (b) also violates I-CONTIGUITY because the reduplicated portion of the string skips over material (the velar nasal) in the string with which it corresponds.

3.2.2 The foot as affix

Foot affixation and infixation effects in Cupeño

An example involving affixation of a foot is furnished by Cupeño, a Uto-Aztecan language of southern California (Hill 1970, 2005; McCarthy 1979, 1984, 2000a; McCarthy and Prince 1986, 1990; Crowhurst 1994). Earlier templatic analyses understood the formation of the habilitative form as mapping to a dactylic foot *template* [$\acute{\sigma}\sigma\sigma$] (McCarthy 1979, 1984; McCarthy and Prince

1986, 1990). Here we adapt and extend McCarthy's (2000a) analysis of the habilitative form as involving suffixation of a foot node. McCarthy (2000a) argues that habilitative formation (for most consonant-final stems) entails the suffixation of a foot to the head foot of the base. Examples with McCarthy's proposed footing are shown in (67).

(67) *Cupeño habilitative*

(ŋáŋ)	(ŋá)(ʔaʔaŋ)	'cry'
(kúʂ)	(kú)(ʔuʔuʂ)	'take'
(tʃál)	(tʃá)(ʔaʔal)	'husk'
(nəŋán)	(nəŋá)(ʔaʔan)	'hide *sth.*'
(həlʸə́p)	(həlʸə́)(ʔəʔəp)	'hiccup'
(kəláw)	(kəlá)(ʔaʔaw)	'gather wood'
(pá)tʃik	(pá)(tʃiʔik)	'leach acorns'
(yúy)muk	(yúy)(muʔuk)	'be cold'
(nə́)nəŋ	(nə́)(nəʔəŋ)	'play pion'
(tʃáŋ)nəw	(tʃáŋ)(nəʔəw)	'be angry'
(pí)(nəʔwəx)	(pí)(nəʔwəx)	'sing enemy songs'
(xá)(ləyəw)	(xá)(ləyəw)	'fall'

We assume the lexical entry for the habilitative in Cupeño is as in (68).

(68) *Cupeño habilitative*

$\text{Ft} \Leftrightarrow <\text{Mod}_{\text{Abil}}>$

McCarthy's proposed footing derives from Crowhurst (1994), who motivates an iambic analysis of Cupeño stress. Either of the first two syllables may bear lexical stress. This implies that the head syllable of the prosodic word must be represented underlyingly. McCarthy argues that there are faithfulness constraints that assess disparities in the position of underlying foot heads, whose general schema is as shown in (69).

(69) ANCHOR-POS(ITION) (Cat_1, Cat_2, P)
where P is one of {Initial, Final, Head}
If ς_1, $\text{Cat}_1 \in S_1$,
ς_2, $\text{Cat}_2 \in S_2$,
$\varsigma_1 \Re \varsigma_2$, and
ς_1 stands in position P of Cat_1,
then ς_2 stands in position P of Cat_2.

ANCHOR-POS (Ft,Ft,P) requires that the output preserve the position P within the foot of a corresponding segment in the input. ANCHOR(Ft,Ft,Head) therefore requires that the head of the foot be preserved. The tableau in (70) is a reworking of the corresponding tableau in McCarthy (2000a: 169). Candidate (c) is ruled out by an undominated constraint requiring identity of *heads* between correspondent head feet. The constraint FTBIN arbitrates the contest. The suffixed foot is disyllabic, an emergence of the unmarked effect (McCarthy and Prince 1994, 1995, 1999).

(70)

(k$_1$ə$_2$l$_3$á$_4$w$_5$)+Ft	Anchor(Ft,Ft,Head)	FtBin	Dep
a. ☞ (k$_1$ə$_2$l$_3$á$_4$)(ʔaʔaw$_5$)			ʔ,a,ʔ,a
b. (k$_1$ə$_2$l$_3$á$_4$)(ʔaw$_5$)		*!	ʔ,a
c. (k$_1$ə́$_2$)(l$_3$a$_4$ʔaw$_5$)	*!		ʔ,a

Notice that the position within the foot of the final consonant of the base in (70) is not preserved, i.e. the constraint Anchor-Pos (Ft,Ft,Final). Here we follow McCarthy in assuming that there is a competing positionally sensitive faithfulness constraint that outranks Anchor-Pos (Ft,Ft,Final). McCarthy identifies this constraint as Anchor(Stem,Word,Final), which requires identity of the last segment in the stem with the last segment in the derived habilitative form. Anchor(Stem,Word,Final) makes reference to morphological structure, which is precluded on our approach. For this reason, we recur to Anchor. The infixation effect derived by ranking R-Anchor above Anchor-Pos (Ft,Ft,Final) is shown in (71). In McCarthy's analysis, this result is obtained by ranking Anchor(Stem,Word,Final) above Anchor(Ft,Ft,Final) (McCarthy 2000a: 169).

(71)

(č$_1$á$_2$l$_3$)+Ft	R-Anchor	Anchor-Pos (Ft,Ft,Final)	FtBin
a. ☞ (č$_1$á$_2$)(ʔaʔal$_3$)		*$_3$	*
b. (č$_1$á$_2$)(ʔal$_3$)		*$_3$	**!
c. (č$_1$á$_2$l$_3$)(ʔaʔa)	*!		

For completeness, tableaux for *páčiʔik* and *pínəʔwəx* are added below, since these do not receive discussion in McCarthy (2000a). Low-ranked Dep serves the purpose of reining in the amount of epenthesized material.

(72)

(p$_1$á$_2$)č$_3$i$_4$k$_5$+Ft	R-Anchor	Anchor-Pos (Ft,Ft,Final)	FtBin	Dep
a. ☞ (p$_1$á$_2$)(č$_3$i$_4$ʔik$_5$)				ʔ,i
b. (p$_1$á$_2$)(č$_3$i$_4$k$_5$)			*!	
c. (p$_1$á$_2$)(č$_3$i$_4$ʔiʔik$_5$)				ʔ,i,ʔ!,i
d. (p$_1$á$_2$)(č$_3$i$_4$k$_5$ʔi)	*!			ʔ,i

(73)

(p$_1$í$_2$)nəʔwəx+Ft	R-Anchor	Anchor-Pos (Ft,Ft,Final)	FtBin	Dep
a. ☞ (p$_1$í$_2$)(nəʔwəx)				
b. (p$_1$í$_2$)(nəʔwəʔəx)				ʔ!,ə

3.2.3 Mora as affix

Moraic affixes are also reasonably common. Samek-Lodovici (1992), for example, discusses examples from Keley-I (Malayo-Polynesian) and Alabama (Muskogean). Drawing on data from Molina et al. (1999), Haugen (2008: 46,54) proposes that the habitual in Yaqui (Yoeme) is marked through the affixation of a mora to the first syllable.

(74) *Yaqui (Yoeme) habitual*

a.	b^{w}atania	b^{w}attania	'burn (food)'
	etapo	ettapo	'open up'
	hovoa	hovvoa	'get full'
	maveta	mavveta	'receive'
b.	yepsa	yeepsa	'arrive'

By default, the habitual is realized by geminating the onset of the second syllable, as shown in the examples in (74-a). When the first syllable is closed, the vowel is lengthened instead.

Mora affixation, epenthesis, reduplication and metathesis in Saanich

In both of the preceding sections we have seen that certain nonconcatenative effects, such as medial duplication, may arise as part of the phonological system's response to affixes deficient in segmental content. Morphologically, there is nothing that marks these cases out as special. Importantly, they do not make it necessary to postulate morphological processes that do violence to underlying specifications without improving markedness. Another candidate morphological process is morphological metathesis. The claim that metathesis may be a morphological process in some languages was first made by Thompson and Thompson (1969) on the basis of data from Rotuman (Malayo-Polynesian; Fiji) and Clallam (Salishan; Washington State). Similar claims for the existence of morphological metathesis have been put forward for other Salish languages Saanich and Halkomelem, the Yok-Utian languages Ohlone (a.k.a. Mutsun Okrand 1979), and Sierra Miwok (Freeland 1951),[25] and Tunisian Arabic (Kilani-Schoch and Dressler 1986). Like subtraction, metathesis has been used to argue for realization-based approaches to morphology (see e.g. Anderson 1992: 66–7, 390). Here we argue that metathesis is a purely phonological strategy for remaining faithful to some morphological exponent in line with the general morpheme-based approach adopted here. We already briefly discussed one such case, that of Kui, in section 2. In this section we detail our approach with a more complex case.

Montler (1986, 1989) describes the formation of the actual in Saanich, a dialect of North Straits Salish spoken on Vancouver Island, British Columbia. The language is a close relative of Clallam. Anderson (1992: 66–7) uses Montler's (1986) treatment of Saanich to argue for an approach to morphology based on realization rules. In his 1989 analysis, however, Montler argues that the metathesis is one possible effect of mapping to a CVCC template.[26] The idea that metathesis is a phonological effect rather than an exponent is further developed in work by Stonham (1994, 2007), Davis and Ueda (2006), and Zimmermann (2009), who argue that

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[25] See Bye and Svenonius (2011) for a comprehensive reanalysis of this system.

[26] Not addressed in Anderson (1992).

the allomorphy results, not from a template, but from the affixation of a mora. We follow the gist of their treatment here, going one step further by supplying a full OT analysis.

The variation in the shape of the actual form is shown in (75). Disyllabic bases with an open syllable epenthesize a glottal stop, as shown in (75-a).[27] Biliteral monosyllables show reduplication.[28] This is shown in (75-b). Finally, where the base has the shape /C_1C_2əC_3/, where ə and C_3 may belong either to the verb root or suffix, C_2 and ə metathesize, as shown in (75-c). The suffixes in the examples are the control transitive {-ət} and the control middle {-əŋ}.

(75) *Allomorphy in the formation of the Saanich actual*

a.	*CVCəC, CVC+əC→CVʔCəC; ʔ-infixation*				
	√čaq'ʷəŋ	čáq'ʷəŋ	'sweat'	čáʔq'ʷəŋ'	'sweating'
	√weqəs	wéqəs	'yawn'	wéʔqəs	'yawning'
	√xʷit+əŋ	xʷítəŋ	'jump'	xʷíʔtəŋ'	'jumping'
b.	*C_1VC_2→$C_1VC_1C_2$; reduplication*				
	√t'ᶿeʔ	t'ᶿéʔ	'be on top'	t'ᶿét'ᶿəʔ	'riding (a horse)'
	√kʷul	s-kʷúl	'school'	s-kʷúkʷəl	'going to school'
	√ɬik'ʷ	ɬík'ʷsən	'trip (lit. snag-foot)'	ɬíɬək'ʷsən'	'tripping'
c.	*CCəC, CC+əC→CəCC; metathesis*				
	√sx̣+ət	sx̣ə́t	'push it'	sə́x̣t	'pushing it'
	√θk'ʷ+ət	θk'ʷə́t	'straighten it out'	θə́k'ʷt	'straightening it out'
	√ƛ'pəx̣	ƛ'pə́x̣	'scatter'	ƛ'ə́px̣	'scattering'

Following Stonham (2007), the lexical entry for the Saanich actual is something like (76).

(76) *Saanich actual*
$\mu \Leftrightarrow$ <Asp_{Prog}>

Here we provide an OT analysis of Stonham's insight and show that the allomorphy of the actual in Saanich is entirely managed by the phonology. The affixal mora always surfaces faithfully in one form or another, reflecting highly ranked Max-μ. We can also note straight away that the actual form is anchored in both the left and right edges of the base. Recalling our discussion of the templatic morphology of Cupeño, we take this to reflect two highly ranked constraints, L-Anchor and R-Anchor. Satisfaction of L-Anchor causes epenthesis of a copy of the base-initial consonant, as shown in (77). Epenthesizing any other consonant, or failing to epenthesize a consonant, incurs a fatal violation of L-Anchor.

(77) t'ᶿét'ᶿəʔ 'riding (a horse)'

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[27] There is an additional alternation in the glottalization of the word-final sonorant. We abstract away from this detail here.

[28] Note that the base vowel itself reduces to schwa, while its copy preserves the underlying quality. For discussion of identity relations between input and reduplicant see McCarthy and Prince (1995) and Fitzgerald (2000).

μ_x + t'$^{\theta}{}_1\overset{\mu_a}{\mathrm{e}}_2$ʔ$_3$	MAX-μ	L-ANCHOR	DEP	INTEGRITY
a. t'$^{\theta}{}_1\overset{\mu_a}{\mathrm{e}}_2$ʔ$_3$	$*_x$!			
b. $\overset{\mu_x}{\acute{\mathrm{e}}}_{2'}t'^{\theta}{}_1\overset{\mu_a}{ə}_2$ʔ$_3$		$*_2$!		$*_2$
c. ʔ$_\alpha\overset{\mu_x}{\acute{\mathrm{e}}}_{2'}t'^{\theta}{}_1\overset{\mu_a}{ə}_2$ʔ$_3$		$*_\alpha$!	$*_\alpha$	$*_2$
d. ☞ t'$^{\theta}{}_{1'}\overset{\mu_x}{\acute{\mathrm{e}}}_{2'}t'^{\theta}{}_1\overset{\mu_a}{ə}_2$ʔ$_3$				$*_1*_2$

For an input like /μ+t'$^{\theta}$eʔ/ 'riding (a horse)', there is no conceivable metathesis of a root which would have the effect of adding a mora. Metathesis is only an option with /CCVC/ inputs, and will only be optimal if LINEARITY is low ranked.[29] The tableau in (78) shows how this works for the input /μ+ƛ'pə́x̣/ 'scattering'.

(78) ƛ'pə́x̣ 'scattering'

---

[29] Note that it is not necessary to rank LINEARITY below DEP, even though metathesis is preferred to insertion, other things being equal. This is because the candidate with a single violation of DEP (by virtue of inserting a vowel) would be ruled out independently by L-ANCHOR. It is therefore not possible to argue that DEP outranks LINEARITY.

<table>
<tr><th>μ_x + μ_a
|
ƛ’$_1$p$_2$ə́$_3$x̣$_4$</th><th>Max-μ</th><th>L-Anchor</th><th>Integrity</th><th>Dep</th><th>Linearity</th></tr>
<tr><td>μ_a
|
a. ƛ’$_1$p$_2$ə́$_3$x̣$_4$</td><td>*$_x$!</td><td></td><td></td><td></td><td></td></tr>
<tr><td>μ_x μ_a
| |
b. ə́$_{3'}$ƛ’$_1$p$_2$ə$_3$x̣$_4$</td><td></td><td>*$_3$!</td><td>*$_3$</td><td></td><td></td></tr>
<tr><td>μ_x μ_a
| |
c. ƛ’$_{1'}$ə́$_{3'}$ƛ’$_1$p$_2$ə$_3$x̣$_4$</td><td></td><td></td><td>*$_1$*$_3$!</td><td></td><td></td></tr>
<tr><td>μ_x μ_a
| |
d. ʔ$_\alpha$ə́$_{3'}$ƛ’$_1$p$_2$ə$_3$x̣$_4$</td><td></td><td>*$_\alpha$!</td><td></td><td>*$_\alpha$</td><td></td></tr>
<tr><td>$\mu_a\mu_x$
| |
e. ☞ ƛ’$_1$ə́$_3$p$_2$x̣$_4$</td><td></td><td></td><td></td><td></td><td>*</td></tr>
</table>

Finally, let us turn to disyllabic bases with an open initial syllable. These epenthesize a glottal stop. However, since Linearity is low ranked, we have to ensure that an input like /μ+wéqəs/ is not mapped to **wéqsə*, so that the parsing of the second consonant in coda position allows it to pick up the affixal mora. Since metathesis permutes the final consonant with the preceding vowel, this is a violation of R-Anchor.

(79) wéʔqəs ‘yawning’

μ_x + μ_a μ_b w$_1$é$_2$q$_3$ə$_4$s$_5$	MAX-μ	R-ANCHOR	INTEGRITY	DEP	LINEARITY
a. μ_a μ_b w$_1$é$_2$q$_3$ə$_4$s$_5$	$*_x$!				
b. $\mu_a\mu_x$ μ_b w$_1$é$_2$q$_3$s$_5$ə$_4$		$*_4$!			*
c. μ_x μ_a μ_b w$_{1'}$é$_{2'}$w$_1$ə$_2$q$_3$ə$_2$s$_5$			$*_1$!$*_2$		
d. $\mu_a\mu_x$ μ_b w$_1$é$_2$w$_{1'}$q$_3$ə$_4$s$_5$			$*_1$!		
e. ☞ $\mu_a\mu_x$ μ_b w$_1$é$_2$ʔ$_\alpha$q$_3$ə$_4$s$_5$				$*_\alpha$	

Similar facts are reported for Halkomelem (Galloway 1980, 1993), and Alsea (Buckley 2007). See Zimmermann (2009) for an analysis along similar lines to the one presented here, which relies on the foot as an affix. Metathesis in Tunisian Arabic (Kilani-Schoch and Dressler 1986) works in a very similar way to (75-c), deriving nouns from verbs, e.g. *kðəb* 'he lies' vs. *kəðb* 'a lie' (p. 62).[30] While not primarily intended as such, McCarthy's (2000b) analysis of the Rotuman data may also be read as an argument against the realization-based view of morphological exponence.

Paiwan

Paiwan is an Austronesian language spoken in Taiwan with a suffixed reduplicant used to form the intensive (Yeh 2008).[31]

(80) *Paiwan intensive*

a.	kə.ḍi	'small'	kə.ḍi.$\underline{\text{kə.ḍi}}$	'very small'
b.	la.ḍuq	'long'	la.ḍu.$\underline{\text{la.ḍu}}$q	'a bit long'
	vu.laj	'good'	vu.la.$\underline{\text{vu.la}}$j	'very good'

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[30] Saba Kirchner (2010) analyzes a case from Kwak'wala (Wakashan; Vancouver Island, British Columbia) in which there is a wider range of repairs for floating moras. See also Bermúdez-Otero (2011) for discussion of Saba Kirchner's analysis.

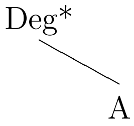
[31] According to *Ethnologue*, which adopts the classification of Blust (1999), Paiwan is the sole member of its family, Paiwanic, which is grouped directly under the Austronesian phylum. Similar reduplicative patterns are attested from languages in other families of Taiwan, including Amis (East Formosan) and Thao (Western Plains). See Yu (2007: 111f.) for examples and primary references.

	qa.ʎə.tsə.qəts	‘sour’	qa.ʎə.tsə.qə.tsə.qəts	‘a bit sour’
c.	ʔi.laŋ.da	‘listen’	ʔi.laŋ.daŋ.da	‘be listening’
	quŋ.vu.ʎ-an	‘dust’	quŋ.vuŋ.vuʎ	‘powder’
	maw.ɣam	‘poor’	maw.ɣaw.ɣam	‘very poor’
	vaŋ.tsul	‘odor’	vaŋ.tsuŋ.tsul	‘very stinky’

Yeh observes that the reduplicant is bimoraic, and we formalize this intuition by representing the intensive as in (81), inserted in a syntactic representation like that in (82) (and assuming a zero-morpheme A to derive denominal adjectives from nouns like ‘dust’ and ‘odor’).

(81) *Paiwan intensive*
$\mu\mu \Leftrightarrow$ <Deg>

(82)



While we agree with Yeh’s fundamental insight, her analysis utilizes constraints that refer to morphological constructs. We provide a more streamlined analysis that obviates reference to these. Following Yeh, we assume that word-internal codas project a mora, but word-final ones do not. As in Cupeño and Saanich, the infixation effect derives from highly-ranked R-Anchor. The first consonant of the reduplicant copies the coda of the preceding syllable rather than that of the following syllable. Since word-internal and word-final codas have different syllabic roles (only the first is moraic), we identify the constraint responsible as Ident[σ-role] from (60) above.

(83) vaŋ.tsuŋ.tsul ‘very stinky’

$\mu_a\mu_b$ μ_c + $\mu_x\mu_y$ v$_1$a$_2$ŋ$_3$ts$_4$u$_5$l$_6$	R-Anchor	Ident[σ-role]	Integrity
$\mu_a\mu_b$ $\mu_c\mu_x$ μ_y a. v$_1$a$_2$ŋ$_3$.ts$_4$u$_5$l$_6$.ts$_{4'}$u$_{5'}$	*!		$*_4*_5$
$\mu_a\mu_b$ $\mu_c\mu_x$ μ_y b. v$_1$a$_2$ŋ$_3$.ts$_4$u$_5$l$_6$.ts$_{4'}$u$_{5'}$l$_{6'}$		$*_6$!	$*_4*_5*_6$
$\mu_a\mu_b$ $\mu_c\mu_x$ μ_y c. ☞ v$_1$a$_2$ŋ$_3$.ts$_4$u$_5$ŋ$_{3'}$.ts$_{4'}$u$_{5'}$l$_6$			$*_3*_4*_5$

4 Prespecified prosodic and positional structure in lexical entries

We use prespecification to capture other kinds of non-concatenative phenomena. Prespecification has long been invoked in accounts of lexical exceptionality. Kiparsky (1982: 50) proposes that nouns like *Attı̂la* in English are lexically supplied with foot structure which blocks the application of stress assignment defaults. The lexical representation *At(tı̂la)* prevents treating the final syllable of the noun as extrametrical and building a trochee over the first and second syllables to give non-occurring **(Átti)la*. Inkelas and mee Yu Cho (1993), Idsardi (1997) and Kager (2008) argue for the usefulness of prespecification in describing three-way contrasts. Alderete et al. (1999) argue that certain instances of fixed segmentism should be explained in terms of prespecification. Here we argue that morphemes may prespecify certain aspects of the structure of the larger word or phrase in which they appear. In particular, an affix may be prespecified as not attaching at the edge it is introduced by the syntax or as associating to certain positions within the word so as to block the realization of lexical material. The first characterizes infixes, the second ablaut. Prespecifying these properties in the input at the level of the word and phrase allows us to dispense with morphological processes that directly overwrite material in the base. Word and phrase-level structure is not generally present underlyingly but are introduced as syntactic words and phases are spelt out. There are faithfulness constraints on identity of word and phrase level structure and content, but these are only active when there is such content in the input (as in the cyclic cases discussed in section **??**), otherwise they are vacuously satisfied. Where there is prespecified word- and phrase-level structure in the input, the demands of word- and phrase-level faithfulness constraints may take priority over those that hold over lower levels such as the segment.

4.1 Lexical antitropism

We take the edge orientation of the class to be determined by the syntax. Every affix is syntactically speaking either a prefix or a suffix, in that a default order can be read off of the syntactic hierarchy plus the * feature; if morphemes d and n spell out D and N respectively, then $\mathrm{D} > \mathrm{N}$ in the syntax corresponds to $d{\prec}n$ (in a phrase), and $\mathrm{D}^* > \mathrm{N}$ corresponds to $n{\prec}d$ (in a word), as discussed in section 2.

However, not all affixes surface in a position consistent with the syntax of their category. Some may surface on the opposite edge of the word the syntax would place them, while others (infixes) are intruded into the lexical material of the host word. We argue that both these types of affix may be united under the same lexically specified structural relation to the word. Some segment of the affix may be stipulated as ANTITROPAL, that is, as *not* aligned to the edge where it is introduced by the syntax. In the case of a left-oriented affix, specifying the initial segment as antitropal will, under the right phonological conditions, force the affix to surface to the right of its syntactically expected position. Specifying a non-initial segment will never have any visible effect as long as the initial segment of the affix is absent. Similarly, for a right-oriented suffix, specifying the final segment will give infixal behaviour under the appropriate circumstances. Antitropism, however it should be represented, is moreover a sufficient lexical condition for both infixes and prefixes/suffixes whose edge of attachment is quirky given the behavior of their class.[32] That is, given a particular affix is listed as antitropal, it is the ranking of phonological constraints that determines whether it attaches inside or on the opposite edge of the word and, if infixed, what is its ‘pivot’, to use Yu’s (2007) term. Our proposal is able to strike what is hopefully a judicious balance between the opposed accounts of infixation proposed by McCarthy and Prince (1993), who view infixation as phonologically motivated ‘failed’ prefixation or suffixation, and Yu (2007), who views infixation as reflecting idiosyncratic subcategorization requirements on affixes. In addition, we integrate our account of infixes naturally with antitropal prefixes and suffixes. It is important to note that antitropism is a structural relation; it is not a process (metathesis).

4.1.1 Antitropal prefixes and suffixes

Antitropal affixes in Tamazight Berber

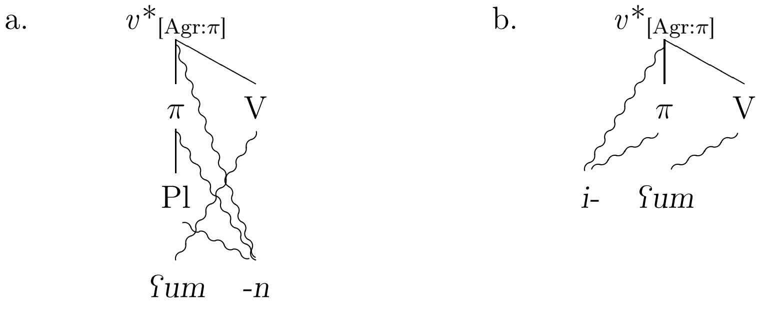
It is in general possible to read off the tree whether an affix is a prefix or suffix, but not always. Not all affixes are ‘homotropal’, attaching to the edge offered by syntax. Consider, for example, agreement affixes in Tamazight Berber, as described by Abdel-Massih (1968). The first singular /ɣ/ is a suffix, though other singular person and gender agreement affixes are prefixes. Most plural agreement markers are suffixes, but the first plural /n/ is a prefix. This is illustrated in (84) where the first person is compared with the third masculine.

(84) Tamazight Berber subject agreement on verb ‘swim’, based on Abdel-Massih (1968)

	Sg	Pl	
1	ʕum-ɣ	n-ʕum	‘I swam’; ‘we swam’
3m	i-ʕum	ʕum-n	‘he swam’; ‘they swam’

For such cases, a statement in terms of lexical properties of the individual affixes greatly simplifies the syntactic representation, e.g. V incorporates systematically into v, v bears an agreement node, and the lexical entries spelling out 1pl and 3m.sg on v are specified somehow as exceptionally prefixal (affixes not being so specified coming out as suffixes). The syntax provides the linearization diagrammed in (85-a), with morphemes in mirror order (associated with squiggly lines to underscore that these are not syntactic branches), while (85-b) requires a special specification on the the lexical entry for {i-} to prevent the normal linearization.

(85)



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[32] ‘Antitropal’ is a term we borrow from botany, where it refers to inverted embryos with “the radicle at the extremity of the seed opposite to the hilum” (*OED*).

Specifically, the lexical entry for 3m.sg may simply specify that it does not attach to the right edge of the word (where the syntax initially puts it), as in (86). The symbol ‘$\nsim$’ is to be read ‘does not align with’, ‘does not coincide with’, and so on.

(86) *Tamazight 3m.sg agreement*

$\mathrm{i} \nsim]_{\omega} \Leftrightarrow <v, \pi>$

Similarly for the 1pl marker in (87).

(87) *Tamazight 1pl agreement*

$\mathrm{n} \nsim]_{\omega} \Leftrightarrow <v, \pi, \text{Participant, Author, Pl}>$

The idiosyncratic distribution of the subject agreement affixes contrasts sharply with the distribution of object agreement markers and directional markers, which are consistently determined by tense; in the past tense they follow the verb and in the other tenses they precede, even as the subject markers continue to show their lexically determined distribution.

(88) Tamazight Berber directional marker on verb ‘swim’, based on Abdel-Massih (1968)

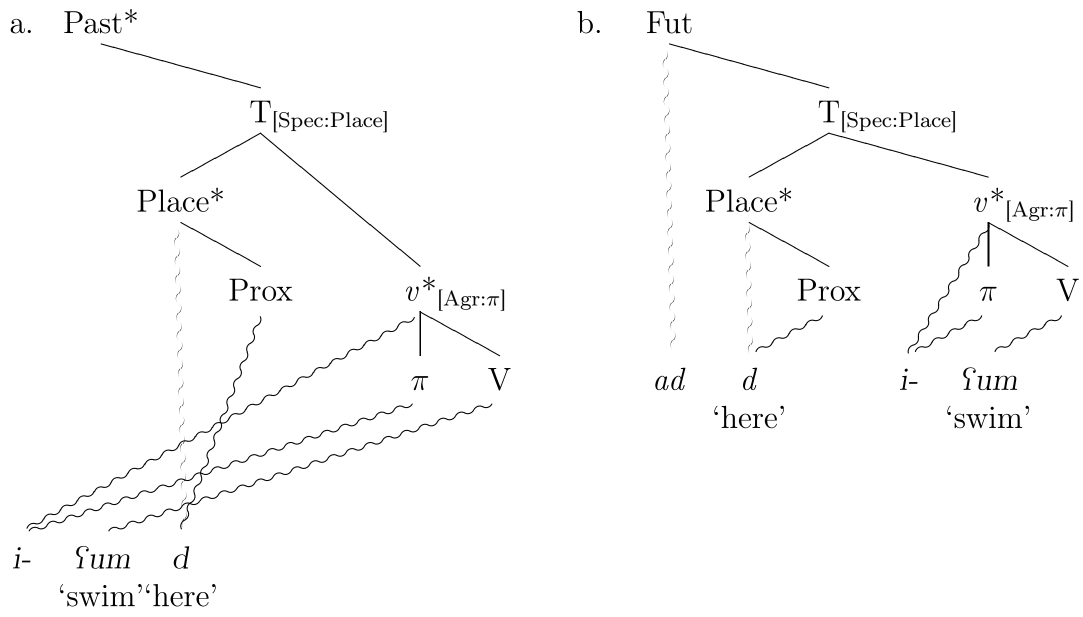
	Proximate -d-	
Past	i-ʕum-d	‘he swam here’
Fut	ad-d-i-ʕum	‘he will swim here’

(89) Tamazight Berber object agreement on verb ‘throw at’, based on Abdel-Massih (1968)

	3m Object -as-	
Past	i-ɣṛːf-as	‘he threw at him’
Pres	da-as-i-ɣṛːf	‘he throws at him’

The same markers can be seen to appear either before or after the verb, for the entire set of object markers and two different directionals. In this case it is more parsimonious to assume syntactic movement (as proposed for Arabic by Benmamoun 2000): the past tense attracts the verb to a higher position, while the Present and Future do not, as suggested by the following representations. Note that the inflected verb is linearized by the highest * dominating it in its extended projection, even if there is no overt spell-out for that head, as with the Past.

(90)



The squiggly lines in the diagram have no theoretical significance, but are there only for expository purposes. It is the job of the phonology to determine the surface position of affixes specified as antitropal. Let us assume there is a constraint Ident[antitropal] in (91) that assesses identity of correspondent nodes with respect to this attribute.

(91) Ident[antitropal]
Correspondent nodes are identical in their orthotropism.
If $x\Re y$ and x is antitropal with respect to edge E of the word, then y is antitropal with respect to edge E of word.

All affixes are introduced in the input at a syntactically determined edge. Ident[antitropal] is violated if an affix with this property surfaces at the same word edge offered by the syntax. Minimal satisfaction of Ident[antitropal] would involve pivoting the infix, or its associated phonological node (root node or syllable), around the adjacent node on the appropriate tier of representation. Since an antitropal infix will generally consist of a string of segments, this would mean pivoting the segmental material of the affix around the first or last segment of the base. This will minimally result in a violation of Linearity and, if the pivot node is not itself located on the opposite edge of the word, Contiguity will also be violated. As shown in (92), the antitropal affix does not pivot around the final segment of the word in Tamazight Berber, which violates O-Contiguity as in candidate (b), but migrates all the way to the beginning of the word domain as in candidate (c), at the cost of additional violations of lower-ranked Linearity. Candidate (a) is ruled out because it violates Ident[antitropal], unfaithful to the prespecified relationship that obtains between the affix and the right edge of the word in (87).

(92) n-ʕum 'we swam'

ʕ$_1$u$_2$m$_3$+[$_\omega$ n$_x$ $\nsim$]$_\omega$	Ident[antitropal]	O-Contiguity	Linearity
a. [ʕ$_1$u$_2$m$_3$n$_x$]$_\omega$	*!		
b. [ʕ$_1$u$_2$n$_x$m$_3$]$_\omega$		*!	$\begin{array}{cccc}\succ & 1 & 2 & 3\\ x & & & *\end{array}$
c. ☞ [n$_x$ʕ$_1$u$_2$m$_3$]$_\omega$			$\begin{array}{cccc}\succ & 1 & 2 & 3\\ x & * & * & *\end{array}$

This treatment unifies prefixes and suffixes with the 'wrong' edge and infixes, and makes a novel prediction. Other things being equal, a language should not allow both infixes and antitropal prefixes or suffixes. This greatly restricts the possibility of paradigms which mix prefixes, suffixes, and infixes.[33]

4.2 Infixation

In infixation the morphological exponent appears inside the base of affixation, which entails a violation of the concatenative ideal that morphemes do not introduce discontinuities into other morphemes or constituents. Some types of infixation effect do not seem to require assuming particular properties; the infixing pattern emerges from the ranking of the phonological constraints. We reviewed one such case from the Mon-Khmer language Katu earlier. A special case of this is the infixing effects found in cases of prosodic affixation, such as in Mangarayi and Cupeño. Not all infixation effects can be understood in this way, however. Yu (2007) shows that many languages have 'true infixes', whose status as infixes cannot be attributed to the phonology. Infixation has played a prominent role in the development of Optimality Theory (OT; Prince and Smolensky 2004 [1993]; McCarthy and Prince 1993). In a famous test case, Prince and Smolensky (2004 [1993]: 42) and McCarthy and Prince (1993: 102) argued that the positioning of the affix {-um-} in Tagalog could be made to fall out from constraints on syllable structure such as NoCoda and a violable morpheme-specific Alignment constraint Edgemost(*um*;L), by which {um} is essentially a prefix. In vowel initial words it surfaces as a prefix, (93). The tableaux in (93) and (94) are taken from Prince and Smolensky (2004 [1993]).

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[33] An illustrative case appears to be the Daghestanian language Dargi (Van den Berg 1999: 154), where gender markers may be prefixed, infixed or suffixed. Van den Berg provides very few examples and does not attempt to characterize the distribution of each type of affix but, based on the available evidence, the choice appears to be phonologically conditioned, as we expect: VC roots take prefixes (*b-ak'* 'come'), CV roots take suffixes (*sa-b* 'be (exist)'), and CVVC roots take infixes (*ka-b-iʔ* 'sit down').

(93)

/um/+/abot/	NoCoda	Edgemost(*um*;L)
a. ☞ .u.ma.bot.	*	
b. .a.um.bot.	**!	#a
c. .a.bu.mot.	*	#ab!
d. .a.bo.umt.	*	#ab!o
e. .a.bo.tum.	*	#ab!ot

In consonant-initial words, prefixation gives rise to an additional violation of NoCoda. If NoCoda outranks Edgemost(*um*;L), the most harmonic output candidate displays infixation with minimal displacement of prefixal material from the left edge of the word, as in (94).

(94)

/um/+/gradwet/	NoCoda	Edgemost(*um*;L)
a. .um.grad.wet.	***!	
b. .gum.rad.wet.	***!	#g
c. ☞ .gru.mad.wet.	**	#gr
d. .gra.um.dwet.	**	#gra!
e. .gra.dum.wet.	**	#gra!d
f. .grad.w...um...	**	#gra!dw...

The phonological displacement theory has been further elaborated in work by Crowhurst (1998, 2001) and Klein (2005).

A relevant challenge to McCarthy and Prince's view is recent work by Alan Yu (2004, 2007), who shows that a large number of languages have affixes that are inherently infixing. Yu argues moreover that it is not sufficient to specify true infixes as merely 'infixal'; they must be specified as attaching to or subcategorizing for a particular 'pivot', e.g. 'after the first consonant in the base', 'before the first vowel in the base', or 'before the last consonant in the base'.

Importantly with respect to the displacement theory of infixation, adherence to the pivot requirement may result in structures that are no better, or even worse, phonotactically speaking, than the counterfactual prefixed or suffixed candidates of the same input. For example, in Leti (Blevins 1999), the nominalizer {-ni-} is infixed immediately following the first consonant of the base, even when this leads to the introduction of complex onsets, e.g. *k-ni-aati* 'carving' (**ni-kaati*), *p-ni-olu* 'calling' (**ni-polu*). Even the Tagalog case, Yu argues, is inherently infixing, although there is variation in the choice of pivot: {-um-} must either follow the first consonant or precede the first vowel. The variation is visible in loanwords with initial clusters like *gradwet* 'graduate', which comes out as either *g-um-radwet* or *gr-um-adwet*.

Yu (2007) argues that the set of phonological pivots is restricted to positions that are psycholinguistically and/or phonetically salient. Salient positions are the initial syllable, final syllable and stressed syllable. The set of infixal pivots are shown in (95).

(95) *Infixal pivots*

Left edge pivots	**Right edge pivots**	**Prominence pivots**
First consonant	Final consonant	Stressed vowel
First vowel	Final vowel	Stressed syllable
First syllable	Final syllable	Stressed foot

Deriving the pivot phonologically

While we agree with the thrust of Yu's approach that there must be a non-phonological element in the placement of infixes, we suspect that the set of pivots is too rich. On our approach, affixal material is initially linearized by the syntax, and infixes therefore gravitate to the edge specified by the syntax. This should immediately obviate the need to specify initial versus final orientation in the lexicon. The next question is whether we have to lexically specify the pivot itself. We take the available evidence as broadly consistent with a phonological solution to the choice of pivot.

Take the example of the Mayan language Tzeltal, described by Slocum (1948). Tzeltal has a detransitivizing infix {-h-}, which follows the root vowel. Tzeltal stems may end in a consonant cluster, including a cluster of h+stop, e.g. *pahk'* 'wall of adobe', *pohp* 'straw mat', *ʔanc* 'woman', and complex onsets in derived words may begin with a sibilant /s ʃ/ or /h/, e.g. *k'ab* 'hand' *hk'ab* 'my hand', *k'op* 'language' *sk'op* 'his language'. On the basis of the examples Slocum provides, the glottal glide /h/ can in any event never be the second consonant in an onset cluster. We conclude that in Tzeltal the placement of the infix is phonologically determined, and does not have to be specified in the lexical entry beyond being antitropal with respect to its syntactic edge of origin.

Our approach also predicts that antitropism may be satisfied at the expense of violating the phonological canons of the language. This is apparently the case in Leti and in Atayal, where the infix is displaced a single consonant from the syntactically defined edge. In Atayal (Egerød 1965: 263–266),[34] animate actor focus is marked by infixing {-m-} immediately following the first consonant. Representative examples are given in (96).

(96)

qul	qmul	'snatch'
kat	kmat	'bite'
kuu	kmuu	'too tired, not in the mood'
hŋuʔ	hmŋuʔ	'soak'
sbil	smbil	'leave behind'

Adherence to the first consonant as pivot falls out from ranking Ident[antitropal] over Linearity, and Linearity over the syllabic well-formedness constraints such as *Complex Onset. This is illustrated in (97).[35]

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[34] Atayal is one of two languages in the Atayalic family, grouped directly under the Austronesian phylum.

[35] Jochen Trommer points out that this account raises the question why sequences of initial [#Cm] are canonically disallowed, since their apparent absence in non-derived words would seem to indicate the existence of a highly ranked markedness constraint (M). A more direct subcategorization-based approach such as that of Yu (2007) could achieve the result simply by ranking the morpheme-specific Alignment constraint above

(97) /$\not\sim$m+kuu/ ‘too tired (animate actor focus)’

$[_{\omega}\not\sim m_x+k_1u_2u_3$	Ident[antitropal]	Linearity	*CxOns
a. $m_xk_1u_2ː$	*!		*
b. $k_1u_2ːm_x$		$\prec$ 1 2 x * *!	
c. ☞ $k_1m_xu_2ː$		$\prec$ 1 2 x *	*

A different challenge is presented by Yurok (Robins 1958; Garrett 2001), in which the intensive form of the verb is formed by infixing {-eg-} before the first vowel of the stem ({-ɹg-} before the retroflex root vowel /ɹ/). Consider (98).

(98) *Yurok intensive*

laːy-	‘to pass’	legaːy-
kɹtk-	‘to fish for trout’	kɹgɹtk-
koʔmoy-	‘to hear’	kegoʔmoy-
tewomeɬ-	‘to be glad’	tegewomeɬ-
ɬkyork^{w}-	‘to watch’	ɬkyegork^{w}-
trahk-	‘to fetch’	tregahk-

We take the lexical entry of the intensive affix to be that in (99), assuming a category $\mathrm{Asp}_{\mathrm{Deg}}$ in the extended projection of the verb.

(99) *Yurok intensive*
$[_{\omega} \not\sim \mathrm{eg} \Leftrightarrow <\mathrm{Asp}_{\mathrm{Deg}}>$

The difference between the Yurok and Atayal patterns is that, in Yurok, onset clusters are not split by the infix. We take this to reflect a constraint Ident[σ_1] in (100), which assesses a mark for each segmental difference between correspondent word-initial syllables.

(100) Ident[σ_1]
Correspondent word-initial syllables have identical segmental structure and content.

(101) tregahk ‘to fetch (intensive)’

M. In our account, on the other hand, ranking M high would not only cause the offending cluster to surface unfaithfully in non-derived forms, but it would also leave the same operations free rein to make repairs to the infixed forms. We would have to find evidence that M was actually ranked low in Atayal, arguing that [#Cm] was of low lexical frequency but not ungrammatical. We have not attempted this for Atayal, but one of the authors has done precisely this for a entirely parallel case (Bye 2009). Javanese has an intensive form which consists in making the final vowel of the root tense. In the phonological literature on this phenomenon, tense vowels are described as disallowed in closed syllables except when the form in question is an intensive. When we look at the lexicon of Javanese in detail, however, this generalization is not quite correct. There is a significant number of non-derived words with tense vowels in closed syllables indicating the existence of a marginal contrast, and showing that intensive formation is actually structure-preserving. Repeating the experiment with a well-stocked dictionary of Atayal might bring to light a similar picture.

$[_\omega \nsim \mathrm{e}_x\mathrm{g}_y+\mathrm{t}_1\mathrm{r}_2\mathrm{a}_3\mathrm{h}_4\mathrm{k}_5$	IDENT[antitropal]	SYLLIDENT	LINEARITY
a. $\mathrm{e}_x\mathrm{g}_y.\mathrm{t}_1\mathrm{r}_2\mathrm{a}_3\mathrm{h}_4\mathrm{k}_5$	*!	$*_x*_y$	
b. $\mathrm{t}_1\mathrm{e}_x\mathrm{g}_y.\mathrm{r}_2\mathrm{a}_3\mathrm{h}_4\mathrm{k}_5$		$*_x*_y*_2*_3*_4!*_5$	$\prec$ 1 2 3 4 5 x $*$ y $*$
c. $\mathrm{t}_1\mathrm{e}_x.\mathrm{g}_y\mathrm{r}_2\mathrm{a}_3\mathrm{h}_4\mathrm{k}_5$		$*_x*_2*_3*_4*_5!$	$\prec$ 1 2 3 4 5 x $*$ y $*$
d. ☞ $\mathrm{t}_1\mathrm{r}_2\mathrm{e}_x.\mathrm{g}_y\mathrm{a}_3\mathrm{h}_4\mathrm{k}_5$		$*_x*_3*_4*_5$	$\prec$ 1 2 3 4 5 x $*$ $*$ y $*$ $*$

Consider in this light the claim that the variability between *g-um-radwet* and *gr-um-adwet* in Tagalog reflects a difference in the choice of pivot. We resist this conclusion for two reasons. First, the variability can easily be related to differences in the ranking of syllabic well-formedness constraints, since *g-um-radwet* entails violation of NOCODA, while *gr-um-adwet* entails violation of *COMPLEX ONSET. We thus find it plausible that the variation involves phonological constraint ranking rather than lexical choice of pivot. Second, if the pivot is specified as the initial consonant, this causes difficulties for analyzing prefixal behaviour that emerges when the stem begins with a vowel. (This is of course not a problem when the pivot is specified as an initial vowel.)

If our strategy for reducing pivot variation to phonological variation proves successful, this would also eliminate the many ambiguous cases pointed out by Yu (2007) where a unique pivot cannot be identified. For example, in the Angkamuthi dialect of Uradhi (Crowley 1983: 364, Yu 2007: 51,101) there is an infixed pluractional marker that is a copy of the following CV sequence and which may be described as following the first syllable or the first vowel, e.g. *wi.li* 'run' *wi.<u>li</u>.li* 'several run', *i.pi.ɲi* 'swim' *i.<u>pi</u>.pi.ɲi* 'several swim'.[36] A similar ambiguity is found in Samala[37] (Applegate 1976; Yu 2007: 110), which infixes CV either after the final vowel or before the final syllable, e.g. *mɨxɨn* 'to be hungry' *mɨxɨxɨn* 'to be hungry', which may be analyzed as either ⟦mɨxɨ⟦xɨ⟧n⟧ (after final vowel) or ⟦mɨ⟦xɨ⟧xɨn⟧ (before final syllable).

Infixation in Dolakha Newar

Dolakha Newar, a Sino-Tibetan language spoken in the Kathmandu Valley of Nepal, marks the negative of verbs with an affix {-mɑ-}. Verb roots in this language contain either one or two syllables. With monosyllabic verb roots, {-mɑ-} behaves like a prefix, as shown in (102). There is a productive process of vowel harmony (Genetti 2007: 58ff.) that changes /ɑ/ to [a]

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[36] The syllable infix is apparently introduced from the left hand side, although it copies segmental material from the right. It is possible this reflects a version of the INTEGRITY constraint against splitting the initial consonant specifically, ruling out candidate mappings like $/\sigma+\mathrm{w}_1\mathrm{i}_2\mathrm{l}_3\mathrm{i}_4/\rightarrow w_1i_2.\underline{w_1i_2}.l_3i_4$, which would violate INITIALINTEGRITY@1.

[37] Formerly known as Inezeño Chumash.

before an /a/ in the stem, and to [o] before an /o/ or /u/ in the stem. Since it is irrelevant to the analysis of infixation, we abstract away from it here. Genetti's transcriptions have been rendered in IPA.

(102) *Prefixed negative in Dolakha Newar* (Genetti 2007: 347)

/bir/	'to give'	mɑ-bir	'does not give'
/hɑt/	'to say'	mɑ-hɑt	'does not say'
/ja/	'to come'	ma-ja	'does not come'
/tʃõ/	'to stay'	mo-tʃõ	'does not stay'

Contrast the pattern in (102) with the one found with disyllabic verb stems, where {-mɑ-} is infixed, as shown in (103).

(103) *Infixed negative in Dolakha Newar* (Genetti 2007: 175f.)

/tʃhasɑr/	'to itch'	tʃhɑ-mɑ-sɑ	'does not itch'
/hakhɑr/	'to become black'	ha-mɑ-khɑ-u	'does not become black'
/onsir/	'to know'	on-mɑ-si-u	'does not know'
/jarkhar/	'to hang'	jar-ma-kha-u	'does not hang'
/tʃhusar/	'to send'	tʃhu-ma-sa-u	'does not send'
/lipul/	'to return'	li-mo-pul	'does not return'
/morlur/	'to bathe'	mor-mo-lu	'does not bathe'

Genetti (2007: 176) notes that it is possible in a few cases to see that the verb is the result of compound formation at a previous stage of the language, e.g. *lipul* 'to return' appears to be related to the adverb *li* 'back; behind'. She goes on to say, however, that 'the lexical source of the first syllable is not obvious, and these words have clearly lexicalized into unanalyzable units'. There is clearly no sense in which infixation gives a better phonotactic result: *tʃhɑ-mɑ-sɑ* 'not itch' is no better than nonexistent **mɑ-tʃhɑ-sɑ*. This is underscored by the existence of structurally identical prefixes {dɑ-} (prohibitive) and {thɑ-} (optative), which always precede the stem. We assume that these represent high mood features, above the highest * in the extended projection of V; other tenses are suffixal, suggesting that some relatively high head such as Fin is marked with *. Assuming that negation in this language is lower than Fin (as is typical), this will cause {-mɑ-} to be a suffix syntactically. The lexical entry for {-mɑ-}, which is given in (104), therefore marks the affix as antitropal to the right edge of the word.

(104) *Dolakha Newar negative*

mɑ $\nsim\ ]_{\omega} \Leftrightarrow$ <neg>

In the tableau in (105) below, the infixed candidate violates low ranked LINEARITY and O-CONTIGUITY. If underlyingly antitropal {-mɑ-} is parsed as a homotropal suffix, however, incurs a fatal mark on the more highly ranked constraint IDENT[antitropal], as shown in (105).

(105) tʃhɑ-mɑ-sɑ 'does not itch'

tʃh$_1$ɑ$_2$.s$_3$ɑ$_4$ + m$_x$ɑ$_y$ $\nsim$ $]_\omega$	IDENT[antitropal]	LINEARITY	O-CONTIGUITY
a. [tʃh$_1$ɑ$_2$.s$_3$ɑ$_4$.m$_x$ɑ$_y$]$_\omega$	*!		
b. [m$_x$ɑ$_y$.tʃh$_1$ɑ$_2$.s$_3$ɑ$_4$]$_\omega$		$\prec$ 1 2 3 4 x * * *! * y * * * *	
c. ☞ [tʃh$_1$ɑ$_2$.m$_x$ɑ$_y$.s$_3$ɑ$_4$]$_\omega$		$\prec$ 1 2 3 4 x * y *	*

With monosyllabic verb roots, parsing of the infix as an infix is impossible — the infix can only surface as a prefix or a suffix. For monosyllabic roots, the antitropism requirement may be satisfied without sacrificing O-CONTIGUITY. This is shown in (106).

(106) ma-ja 'does not come'

j$_1$a$_2$ + m$_x$a$_y$ $\nsim$ $]_\omega$	IDENT[antitropal]	LINEARITY	O-CONTIGUITY
a. [m$_x$a$_y$.j$_1$a$_2$]$_\omega$	*!		
b. ☞ [j$_1$a$_2$.m$_x$a$_y$]$_\omega$		$\prec$ 1 2 x * * y * *	

Phrasal infixation: Clitic placement

Descriptively speaking, the phenomenon of second-position clitics is extremely widespread, with certain clusters of morphemes turning up in a position that is 'second' in the clause or phrase in many unrelated languages (Halpern and Zwicky 1996). Analytically, the phenomenon is not unified; some second position elements appear to be placed entirely by syntax, for example the finite verb in most Germanic languages (e.g. Wiklund et al. 2007 for a recent treatment, with references to previous treatments). In other cases, it has been argued that a clitic forms a movement chain to the left edge of a clause, and that a prosodic requirement on the clitic forces it to spell out in the highest trace position, leading to a second position effect (Bošković 1995, 2001).

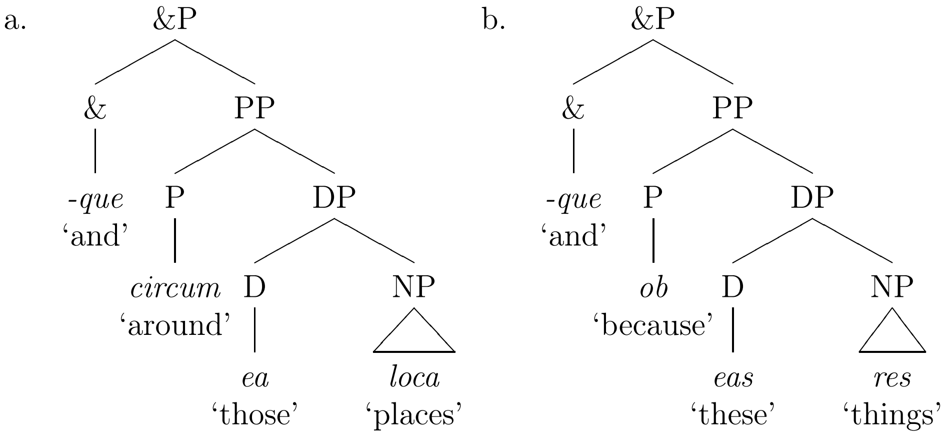
There is, however, also a different kind of second-position clitic, one which cannot be placed by independently motivated principles of syntactic movement. For these, we propose that the same mechanism we employed for infixes, namely an antitropal specification associated with certain lexical entries, makes the right predictions. The main difference is that infixes typically spell out in the same phase cycle as their hosts, while second-position clitics typically spell out in a later cycle, once everything in the phase has been prosodified (see section 2.3).

An example is the Latin coordinate morpheme *-que*, which appears after the first word in the second conjunct (discussed in Embick and Noyer 2001; Embick 2007).

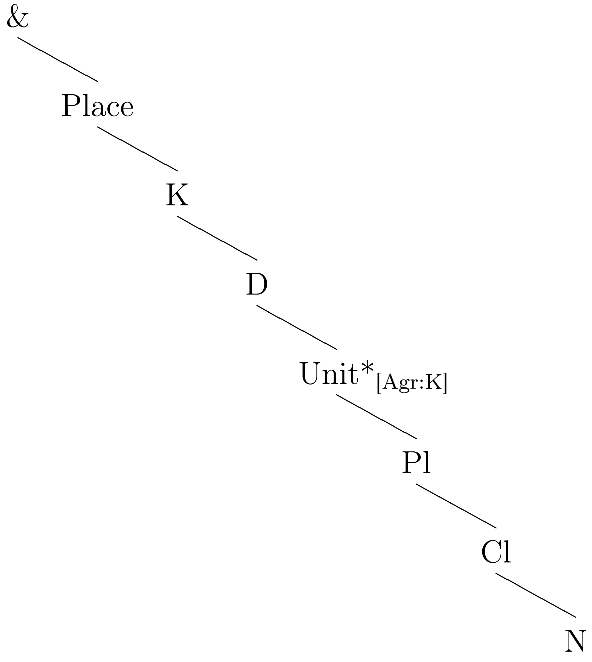
(107) a. bonī puerī bonae-que puellae
good boys good-and girls
‘good boys and good girls’ (kla ????)
b. in Apuliam circum-que ea loca
in Apulia around-and those places
‘in Apulia and around those places’
c. ob eās-que rēs
because these-and things
‘and on account of these achievements’ (hal ????: 165)

On syntactic grounds, we would expect the right conjuncts of the last two examples to look something like the following.

(108)



(109)

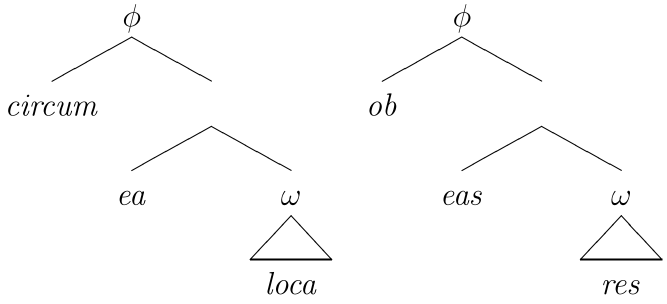


For present purposes we can take the prepositions to be spell-outs of <Place,K>, the determiners to be spell-outs of <K,D>, and the case/number suffixes to be spellouts of

<Unit,Pl,Cl>. We assume that Unit in Latin has [Agr:K] which will ensure that all phi-features are visible at the spell-out of Unit. Since Unit, by hypothesis a phase head, incorporates the material below it (i.e. is Unit* in Latin), the noun surfaces with suffixed case and number morphology. If the phase head did not attract the noun, then the phase complement would spell out with N inside it before K was merged; this would mean that case morphology could not be directly suffixed to the noun.

Thus, in the first phase, the phase complement Pl spells out with no phonological content. We can take the next phase complement to be Place (implying a higher phase head, but whether this is & or something else is unclear). When Place spells out, a word is built on Unit*, giving the inflected noun. In addition, the preposition and determiner spell out, but as function words rather than lexical words since they are not dominated by *. The structures in (110) show the prosodic structure that we can assume to be directly read off the syntax; it is unclear whether the prosodic structure-building algorithm makes any use of the syntactic nodes which are neither phrase nor word (if not, then the prosodic phrases are ternary branching). We leave those tentative nodes unlabeled.

(110)

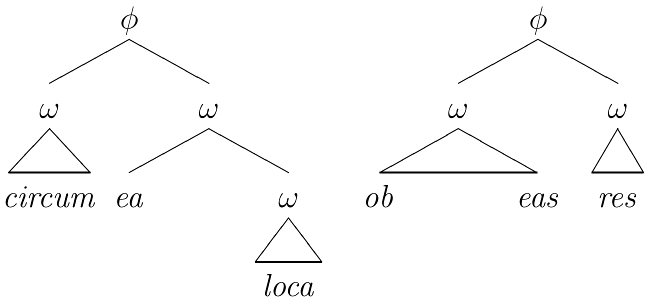


The positioning of -*que* is based on phonological constituency, rather than syntactic constituency; for one thing, movement rules generally do not affect one conjunct without affecting all conjuncts. For another thing, -*que* disrupts syntactic constituents in Latin which cannot be separated by movement, for example appearing between a preposition and its complement in (107-b). Furthermore, if a preposition is phonologically light (smaller than the lexical word minimum), -*que* appears after the following word, as illustrated in (107-c); this suggests that the light preposition does not form a phonological word on its own, a familiar phenomenon from many living languages. Thus in (107-c), *ob eās* is parsed as a single word in the phonology: [ob eās $]_\omega$.

Thus, we assume that the maximal extended projections which are coordinated (here, PP) are complete phases, so that higher prosodic structure has been built at the time the coordinate phrase is spelled out. This means that the linearization of *que* sees a structure consisting of phonological phrases and phonological words, not just segments or syllables. This provides a starting point for explaining why the conjunction -*que* does not disrupt words (e.g. there is nothing like **bon-que-ae* or **colos-que-seum*).

We can assume that in Latin, unlike in English, prosodic words are built by phonology on sequences of two unstressed syllables. Additional stray syllables are incorporated into some preexisting structure, perhaps adjoined to the following word, as shown here.

(111)



In the next phase, *-que* will be spelled out. Assuming that it appears after a following phonological word, the structures above will ensure, correctly, that it precedes the demonstrative when the preposition is phonologically wordlike, but will follow the demonstrative if the preposition is phonologically light.

We analyze *que* as having prespecified content to its left, which forces it to migrate rightwards within the phonological phrasal domain.

(112) *Latin conjunct* que

$[_{\phi}$ ≁ kwe ⇔ <&>

This linearization overrides the default linearization offered by syntax. Since it is the morpheme which is being linearized, and not the syntactic head which it lexicalizes, this reordering has no effect on syntax and cannot be constrained by syntactic rules. The & head is lexicalized only after words and phonological phrases have been built.

(113)

$\{_{\phi} \nsim \mathrm{k^w}_x\mathrm{e}_y + \{_{\phi}\ (_{\omega}\ \mathrm{b_1o_2n_3a_4e_5}\ )\ (_{\omega}\ \mathrm{p_6uellae}\ )\ \}$	Ident [antitropal]	O-Contig(ω)	Linearity	O-Contig(ϕ)
a. $\{_{\phi}\ \mathrm{k^w}_x\mathrm{e}_y\ (_{\omega}\ \mathrm{b_1o_2n_3a_4e_5}\ )\ (_{\omega}\ \mathrm{p_6uellae}\ )\ \}$	*!			
b. $\{_{\phi}\ (_{\omega}\ \mathrm{b_1o_2k^w}_x\mathrm{e}_y\mathrm{n_3a_4e_5}\ )\ (_{\omega}\ \mathrm{p_6uellae}\ )\ \}$		*!	$\prec$ 1 2 3 4 5 6 x * * y * *	*
c. ☞ $\{_{\phi}\ (_{\omega}\ \mathrm{b_1o_2n_3a_4e_4}\ )\ \mathrm{k^w}_x\mathrm{e}_y\ (\ \mathrm{p_6uellae}\ )\ \}$			$\prec$ 1 2 3 4 5 6 x * * * * * y * * * * *	*

Although it is clear that *-que* disrupts the phonological phrase ϕ, we are agnostic as to how it is further parsed into prosodic structure. Possibilities include adjunction to ω, or adjunction directly under the ϕ node. Grammars of Latin describe a special pattern of enclitic stress, which might suggest adjunction to the word, but scholars disagree on what the facts of enclitic stress actually were.

Another example is the second position adverbial element *chà'* 'maybe' in San Dionicio (SD) Ocotepec Zapotec as described by bro (????), illustrated in (114). As the examples show, *chà'* is possible in any of several positions in certain sentences.

(114) a. Juáàny-chà' gù Màríí ù-dáù còmííàd.
Juan=maybe or Maria COMPL-eat food
'Maybe either Juan or Maria ate the food.'

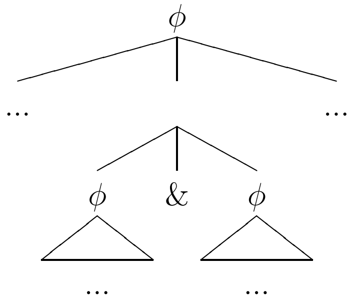
b. Juáàny gù-chà' Màríí ù-dáù còmííàd.
Juan or-maybe Maria COMPL-eat food
'Maybe either Juan or Maria ate the food.'

c. Juáàny gù Màríí-chà' ù-dáù còmííàd.
Juan or Maria-maybe COMPL-eat food
'Maybe either Juan or Maria ate the food.'

In principle, (114)c could have been derived by movement of the coordinate subject to the left of the clitic adverb. However, such an analysis is not possible for (114)a or (114)b, because of the Coordinate Structure Constraint (CSC) (Ross 1967), which is very well-motivated cross-linguistically (see Stassen 2000 for a cross-linguistic survey distinguishing *and*-coordination from *with*-coordination, and reaffirming the validity of the CSC for *and*-coordination). Broadwell shows that the CSC holds in SD Zapotec.

Broadwell shows that certain constituents, including the coordinate structure illustrated in (114) above, have multiple options for prosodic phrasing, hence the multiple placement options for the second position clitic. Since DPs are phases, on our assumptions, and phases map onto prosodic phrases, the prosodic structure of clause with a coordinate DP subject should have an input form like that shown in (115), where '&' is the coordinate function word, and as before we leave syntactic constituents that are not themselves spell-out domains unlabeled, assuming a language like Zapotec in which this is linearized between the two conjuncts. The symbol ϕ here stands in for prosodic phrase. Each conjunct is a minor phrase, if it does not contain additional prosodic phrases, or a major phrase, if it does. The clause is at least a major phrase (in fact an intonational phrase, but we set aside this distinction here).

(115)



This is the input to phonology. Phonological constraints may cause the stray function word to be integrated into one or the other conjunct. Phonological constraints may also cause the two coordinate phrases to be combined into one prosodic phrase; this may be sensitive to their size and to other factors such as focus. From Broadwell's description, we can conclude that both the integration of the coordinate morpheme to the left and the combination of the two prosodic phrases are optional. This gives the possible phrasings of the first phonological phrase shown in (116).

(116) a. { Juáàny }$_\phi$ chà' gù Màríí ù-dáù còmííàd.
b. { Juáàny gù }$_\phi$ chà' Màríí ù-dáù còmííàd.
c. { Juáàny gù Màríí }$_\phi$ chà' ù-dáù còmííàd.

Thus, the target for *chà’* is clearly prosodic, but is larger than that for Latin conjunction. We can thus assume that the relevant constituent is the first prosodic phrase in SD Zapotec.

One way to describe the pattern is to rank O-Contig(ϕ) above Linearity. *Chà’* thus never splits a phonological phrase, but it may split a prosodic constituent on the next level up, e.g. the Intonational Phrase.

Our approach predicts that a single language might have both syntactically placed clitics and lexically placed ones. This is confirmed by Bulgarian, as Franks (2006) shows. He demonstrates at length that the pronominal and auxiliary clitics show properties distinct from those of the interrogative clitic *li*. Franks accepts Bošković’s arguments for a primary role for syntax in the placement of pronominal and auxiliary clitics in Bulgarian (as in Serbo-Croatian). As for *li*, however, Franks shows that it does not show the distribution predicted by a syntactic movement analysis; for example it can appear after constituents which cannot be affected by movement, as illustrated in (117).

(117) a. Knigata li na Ivan Vazov si čel (ili raskaza)?
book.def Int of Ivan Vazov aux.2sg read or story
‘Was it the book you read by Ivan Vazov (or the story)?’
b. *Knigata si čel na Ivan Vazov.
book.def aux.2sg read by Ivan Vazov
(Bulgarian, Franks 2006: 193)

Franks proposes that *li* is placed in a high position in the clause by syntax, immediately after focused elements, and then undergoes prosodic inversion with the first prosodic word to its right (cf. Rudnitskaya’s (2000) persuasive analysis of similar facts in Russian). Prosodic inversion is a post-syntactic reordering operation proposed by Halpern (1995) for similar cases (see also Embick and Noyer 2001). In our terms, the clitic *li* is specified with a phonological edge attribute which requires it to linearize to the right of the adjacent prosodic phrase.

Clitics are only introduced at higher levels of syntactic structure, and so may follow the construction of phonological words and phrases. Words and phrases built on previous cycles are subject to faithfulness constraints requiring their integrity. As more and more word and phrase-level structure is built, more faithfulness constraints become active, O-Contiguity among them. Since violation of O-Contiguity(ω) and O-Contiguity(ϕ) logically entail violation of general O-Contiguity, the account therefore predicts that clitics are less likely to behave like infixes, since this would imply unfaithfulness at several layers of phonological structure. Since, by hypothesis, infixes are in general introduced before word-level structure has been built on their hosts, infixation is a less egregious violation of O-Contiguity, since it only violates the most general version of the constraint. However, endoclisis is not in principle excluded on our approach since Linearity can dominate O-Contiguity(ω). The classic (putative) case of endoclisis comes from Pashto (Tegey 1977; Kaisse 1981; Yu 2007: 212–218).

4.3 Ablaut

As we saw in Section 3.1, an affix underspecified for primary Place may parasitize a nearby segment that has it, giving rise to a mutation. In ablaut, segment with Place is suppressed or replaced by an affix segment with specified Place. This is often viewed in terms of process morphology, where it it may be known as 'melodic overwrite'. Here we reanalyze ablaut as a prespecified structural relation between the affixal material and the word to be constructed over root and affix.

Melodic prespecification in Tamashek

Here we will look at the formation of the plural in the Berber language Tamashek, also known as Tuareg of Mali, described in a major grammar by Heath (2005). The plural is marked in one of two ways in this language. One class of nouns takes a suffix in the plural, e.g. *laẓ* 'famine' vs. *laẓ-tăn* 'famines'. The majority of nouns additionally begin with a 'vocalic prefix' which, in the singular is {ə-∼ă-}, {a-}, or {e-}, depending on lexical factors, and invariant {i-} in the plural. Examples of nouns taking a vocalic prefix and a suffix in the plural include (masculine) *ă-danan* 'Cordia fruit' vs. *i-danan-ăn* 'Cordia fruits' and (feminine) *t-ă-mar-t* 'beard' vs. *t-i-marr-en* 'beards'.[38] In another large class of nouns, the plural is marked by ablaut. Tamashek has five full (long) vowels, transcribed /i e a o u/, and two short vowels /ə ă/, where /ə/ counts as a high vowel, /ă/ as low. Let us assume that the five full vowels are represented in prosodic structure with two moras, and the two short vowels with one. The status of the mid vowels /e o/ in the system is not clear. Heath characterizes them as "somewhat peripheral to the system" (p. 110). In addition to being contrastive segments of the language, they may be derived from lowering and backing in the environment of a guttural /r q ɣ x ʕ ħ/ or pharyngealized coronal /ḍ ṭ ḷ ṣ ẓ/.

In the plural, the final vowel in the stem is ablauted to a full low /a/ regardless of the underlying vowel quality. This is shown in (118), (119), and (127). (All examples are adapted from Heath 2005: 209-224.) The non-final vowel maps to a high vowel irrespective of its underlying height, but preserves its underlying length.[39] Thus an underlyingly full non-final vowel /e a o u/ surfaces as /u/ in the plural; an underlyingly short non-final vowel /ə ă/ surfaces as /ə/.

(118) *Full non-final V*

ă-dádis	i-dúdas	'small dune'
ă-mágʲor	i-múgʲar	'large quadruped'
e-ʃéɣer	i-ʃúɣar	'bustard'
ă-káfər	i-kúfar	'non-Muslim'
ă-fárăqq	i-fúraqq	'Chrozophora bush'
ă-kárfu	i-kúrfa	'rope'
t-a-ẓúẓem	t-i-ẓúẓam	'charcoal'
t-e-ẓérdəm-t	t-i-ẓúrdam	'scorpion'
t-ə-ɣúbbe	t-ì-ɣubba	'gulp'

(119) *Short non-final V*

---

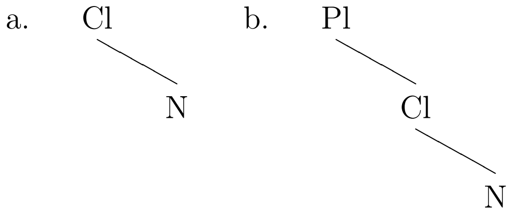
[38] The prefixed {t-} and suffixed {-t} are both markers of feminine gender.

[39] It is perhaps tempting to see the high vowel quality as connected to the invariant vocalic prefix {i-} which occurs in the plural. Heath does not appear to try and make such a connection, however, and neither will we. Given our assumptions, there is no obvious way to encode this into the analysis. The vocalic prefix is introduced in a later cycle after ablaut has applied, and ablaut depends on being able to prespecify the quality of designated nuclei of the word being built in the current cycle.

a-mə́knud	i-mə́knad	‘dwarf’
a-rə́ssuḍ	i-rə́ssaḍ	‘pus’
á-făṣko	í-fəṣka	‘early hot season’
a-s-ə́frəḍ	i-s-əfraḍ	‘broom’
t-a-gə́gger-t	t-i-gə́ggar	‘insult’
t-a-m-ắkʃoj	t-i-m-ə́kʃaj	‘ochre’
t-a-s-ắbḍăr-t	t-i-s-ə́bḍar	‘sacrificial ram’
t-é-lămse	t-í-ləmsa	‘plain’
t-a-twə́qqe-t-t	t-í-twəqqa	‘small quantity’

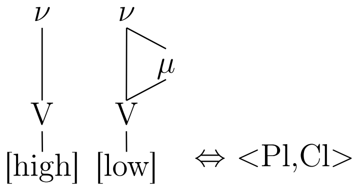
We assume that the singular vocalic prefix is a kind of classifier, Cl, as in (120-a), and the plural prefix {i-} is a portmanteau of Pl and Cl, in a structure like that in (120-b); no head-movement is observed, so there is no *.[40]

(120)



Let us for now take the lexical entry for the plural to be as shown in (121), although we shall have cause to revise this below. The structure of the entry incorporates the syllable nucleus. See Shaw (1993) for arguments for the nucleus as a primitive of prosodic structure.

(121) *Tamashek plural (to be revised)*



Deferring presentation of the relevant evidence for now, **??** only requires that the non-final vowel should be [high]; nothing is specified with regard to whether the vowel should be front or back (or rounded or unrounded). When the root vowel is short, there is only the option of /ə/, since there is no backness contrast in the short vowels. The choice of [u] is left to the phonology to fill in — specifically, the constraint *HIGH/FRONT in (122).

(122) *HIGH/FRONT
High vowels are not front.

---

[40] We set the feminine gender affixes ({t-} and {-t}) aside as we wish to concentrate on the morphophonology of the plural. The simplest assumption in our framework is that they are exponents of additional, agreeing heads (perhaps with head-movement to the lower of the two). An alternative, attractive for Berber in general, would be that they are spellouts of nonprojecting agreement features, following essentially Noyer (1992). Noyer assumes that a head (such as INFL in Berber) can have a feature [−Autonomous licensing] which specifies it as ‘Free licensing’, in which case each feature in it can be independently targeted by Spell-out. See also har (????).

In Section 4.2 we argued that true infixes, or their corresponding nodes in phonological structure, were lexically specified as antitropal with respect to their syntactic edge. This allowed us to state corresponding IDENTITY constraints that assess discrepancies between input and output with regard to this property. Intuitively what is going on in vocalic ablaut is that nuclei in specific positions of the word are prespecified as being filled with a particular kind of segmental content. Prespecification frustrates parsing of underlying stem material through the medium of appropriate faithfulness constraints. We can formulate constraints requiring identity of segmental content between correspondent nodes in the input and output. We define the constraint IDENT[ν] in (123).

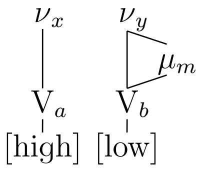
(123) IDENT[ν]
Correspondent nuclei have identical structure and content.

Blaho (2008) proposes an reformalization of IDENT for privative and geometric theories. Each segment may be represented as a set of n-tuples with the segmental anchor as the first element and the associated privative features proceeding downwards from the segmental anchor feature by feature. Violations of IDENT in Blaho's approach are assigned to segments whose set of n-tuples differs from that of its input correspondent. We can similarly think of IDENT[ν] as penalizing any input-output nucleus pair whose sets of n-tuples are not equal. For example, the last nucleus of an ablaut plural (a full low vowel) must contain the n-tuples $< \nu, \mathrm{V}_{\mathrm{[low]}} >$, $< \nu, \mu >$, and $< \nu, \mu, \mathrm{V}_{\mathrm{[low]}} >$.

In the unmarked singular case, the input will not contain any prespecified nuclei, and therefore IDENT[ν] will be vacuously satisfied by the nuclei in the output. Where the input does contain prespecified nuclei linked with particular vowels, as we believe is the case with ablaut, there will be a conflict between promoting identity with the prespecified association or remaining faithful to the underlying representation of the root. In the case at hand, the first and last vowels of the root must be suppressed in favour of the qualities prespecified as occupying the initial and final nuclei of the word. A necessary step towards securing the desired result is to rank IDENT[ν] above MAX. We must also close off other escape routes for the suppressed root vowel. A search of Heath's grammar turns up no examples of vowel clusters without an intervening consonant. We conclude that true diphthongs (as opposed to sequences of vowel + glide, which do exist in Tamashek) and vowel hiatus are disallowed in the language, thus ruling out hypothetical forms such as *[i.-dua.dias] or *[i.-du.a.di.as] for [i.-du.das] (< /dádis/ 'small dune'). Neither does epenthesis of a consonant seem to be a way of making these structures more palatable *[i.-du.ʔa.di.ʔas]. Tamashek has a rule of schwa epenthesis, but Heath makes no mention of a consonant epenthesis rule. As a result of these strictures, and the portmanteau <Pl,Cl>, the ablauted plural form contains the same number of nuclei and syllables as the singular stem.

The result is shown in (124). As an aid to the reader, violations of MAX are shown with subscript coindices for the deleted segment; violations of IDENT[ν] with the suppressed association between nucleus and vowel, given as an ordered pair of coindices $< i_{Nucleus}, j_{Vowel} >$. Note that ablaut shows both skipping of and intrusion into root material, which entails violation of both I- and O-CONTIGUITY. Violations of these low-ranked constraints are not shown in the next two tableaux, but we return to the role of CONTIGUITY in the last part of this section.

(124) i-dúdas ‘small dune’

 +$dá_1di_2s$	Ident[ν]	Max	*High/Front
a. $d\overset{\nu_x}{á}_1.d\overset{\nu_y}{i}_2s$	$*_{<x,a>}!*_{<y,m,b>}$	$*_a*_b$	
b. $d\overset{\nu_x}{í}_a.d\overset{\nu_y}{i}_2s$	$*_{<y,m,b>}!$	$*_1*_2$	*
c. $d\overset{\nu_x}{á}_1.d\overset{\nu_y}{a}{}_b^{\mu_m}s$	$*_{<x,a>}!$	$*_a*_2$	
d. $d\overset{\nu_x}{ú}_a.d\overset{\nu_y}{i}_2s$	$*_{<y,m,b>}!$	$*_1*_b$	
e. $d\overset{\nu_x}{í}_a.d\overset{\nu_y}{a}{}_b^{\mu_m}s$		$*_1*_2$	*!
f. ☞ $d\overset{\nu_x}{ú}_a.d\overset{\nu_y}{a}{}_b^{\mu_m}s$		$*_1*_2$	

Observe that all candidates in (124) violate Max twice. Because of the unavailability of vowel sequences and consonant epenthesis in Tamashek, each of the two root vowels and two affix vowels must either reach the safety of the nucleus or else be deleted. Candidates (a) to (d) all violate highly-ranked Ident[ν] by failing to ablaut one or both of the vowels. This leaves candidates (e) and (f), which are both faithful to the requirements of identity with the prespecified nuclei; their Max violations are for suppressing both of he root vowels. The choice of [u] is decided by *High/Front from (122), which militates against /i/, and therefore selects (f) as the winner.

The word-initial high vowel that characterizes the ablauted plural is not always [u], however. As shown in (125), a non-final /i/ in the root (as manifested in the singular form) appears to retain the [i]-quality in the plural form.

(125) *Full non-final /i/*

a-s-íngʲəḍ	i-s-íngʲaḍ	‘turban’
t-a-ɣími-t-t	t-í-ɣima	‘sitting’
t-ə-sísək-k	t-i-sísak	‘Bergia herb’

t-ítter-t	t-íttar	‘invocation’
t-a-wínəs-t	t-i-wínas	‘belly-strap ring’

In this case, the conflict between Ident[ν] and Max may be eliminated if we allow coalescence of featurally identical vowels and vowels whose featural contents stand in a proper subset relationship, such as is the case with the underspecified high affixal vowel and the fully specified front high root vowel /i/ in (125). We assume that there is a constraint Ident(Seg) that penalizes the removal of featural information but not the addition of featural information in correspondent segments.[41] Coalescence of subset-identical segments requires that Uniformity be ranked low.

In order to rule out coalescence in general, Ident(Seg) must be ranked high.[42] Since, given coalescence, the root vowel has a correspondent in the output, it is subject to featural Ident constraints. Since underlying /i/ surfaces faithfully in Tamashek, the ranking Ident[round]$\gg$*High/Front is independently motivated. The same ranking accounts for the behaviour of the plural forms in (125).

(126) i-títtar ‘invocation’

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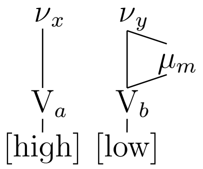
[41] The constraint would work similarly to Max[F], except we adhere to the view that features are attributes of nodes rather than nodes themselves. As far as we understand, this ontology does not preclude the view that features are essentially privative or hierarchically organized.

[42] The mid vowels /e o/ pose a challenge. Mid vowels may be thought of as having both a [high] and a [low] feature, and Heath presents evidence that could be interpreted as indicating the same may be true of Tamashek. Since this analysis would imply that both the low vowel /a/ and /I/ stand in a subset relation to /e/, it raises the question why a root-initial /a/ and affixal /I/ cannot coalesce in the formation of the plural. Since this pattern is absent in plural formation, we infer the existence of a more general, highly ranked, Identity constraint prohibiting *any* changes to Aperture specifications (additive or destructive). This would rule out coalescence of /$\mathrm{I}_a+\mathrm{a}_1$/ to [$\mathrm{e}_{1,a}$].

 +tí$_1$tte$_2$r	IDENT[ν]	MAX	IDENT [round]	*HIGH/ FRONT	UNIFORMITY
a. $\overset{\nu_x}{\text{tí}}_{1,a}$t.$\overset{\nu_y}{\text{te}}_2$r	$*_{<y,m,b>}$!	$*_b$		*	
b. $\overset{\nu_x}{\text{tú}}_{1,a}$t.$\overset{\nu_y}{\text{te}}_2$r	$*_{<y,m,b>}$!	$*_b$			
c. $\overset{\nu_x}{\text{tú}}_{1,a}$t.$\overset{\nu_y}{\text{te}}_2$r	$*_{<y,m,b>}$!	$*_b$			
d. $\overset{\nu_x}{\text{tí}}_{a}$t.$\overset{\nu_y}{\text{ta}}{}_b^{\mu_m}$r		$*_1*_2$!		*	
e. ☞ $\overset{\nu_x}{\text{tí}}_{1,a}$t.$\overset{\nu_y}{\text{ta}}{}_b^{\mu_m}$r		$*_2$		*	*
f. $\overset{\nu_x}{\text{tú}}_{1,a}$t.$\overset{\nu_y}{\text{ta}}{}_b^{\mu_m}$r		$*_2$	*!		

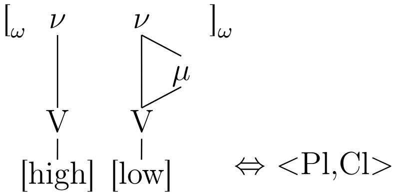
These patterns more or less generalize to polysyllabic (‘heavy’) stems except that the high vowel quality is spread or copied to all non-final vowels as well. This is illustrated in (127).

(127) *‘Heavy’ stems*

a-ẓắmmăẓro	i-ẓə́mməẓra	‘roller (bird)’
ă-m-ăttáŋkul	i-m-əttúŋkal	‘invisible one’
e-măgʲgʲégʲgʲăr	e-məgʲgʲúgʲgʲar	‘collarbone’
t-a-kədə́bdəb-t	t-i-kədə́bdab	‘large frog sp.’
t-a-s-əggərəjgə́ri-t-t	t-i-səggərəjgə́raj	‘roller (bird)’
t-a-făŋkăjámu-t-t	t-i-fəŋkə́juma	‘mussel shell’

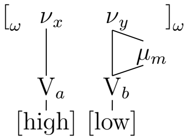
It is at this point we must make a further revision to our lexical entry since the plural melody spreads out to occupy the entire word. The high and low full portions of the plural melody must be specified as coinciding respectively with the left and right edges of the word. In the absence of such specification, there would be no reason why the plural melody should not be ‘discharged’ once each portion has become associated once, leaving left over syllables at the left or right edge of the word with their lexical vowel qualities intact. In addition, the high and low full nuclei must be lexically represented as adjacent, otherwise medial vowels could be skipped by ablaut, escaping with their underlying qualities preserved. The revised entry is given in (128).

(128) *Tamashek plural (revised)*



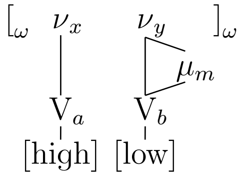
We take the phenomenon to represent copying of the word-initial nucleus along with its segmental content to be motivated by CONTIGUITY. In the input the prespecified nuclei of the affix are contiguous; the optimal output preserves this state of affairs. Copying violates low-ranked INTEGRITY. (129) shows violations of CONTIGUITY for the affix only.

(129) i-m-əttúŋkal ‘invisible one’

 +m-ă$_1$tta$_2$ŋku$_3$l	IDENT[ν]	CONTIGUITY	MAX	INTEGRITY
a. ν_x ν ν_y mă$_1$t.ta$_2$ŋ.ku$_3$l	$*_{<x,a>}!*_{<y,b>}*_{<y,m,b>}$		$*_a*_b$	
b. ν_x ν ν_y mə$_a$t.ta$_2$ŋ.ka$_b^{\mu_m}$l		*!	$*_1*_3$	
c. ☞ ν_x ν_x ν_y mə$_a$t.tu$_a$ŋ.ka$_b^{\mu_m}$l			$*_1*_2*_3$	$*_x,*_a$

The direction of copying still remains to be explained. Recall that the high portion of the plural ablaut melody did not entail any changes in the length of the vowel; ablauted non-final vowels surface with their lexical length intact. The low portion of the melody on the other hand is always a full /a/ vowel. Under the assumption that full vowels project an additional mora, copying a nucleus containing a long low vowel to medial syllables to satisfy CONTIGUITY would entail copying more structure. If INTEGRITY is also violated for every node under ν that is copied along with it, the candidate with left-to-right copying of the initial high vowel will harmonically bound the candidate with right-to-left copying of the final *full* low vowel. This is shown in (130). Only candidates that satisfy IDENT[ν] are shown.

(130) i-ẓə́mməẓra ‘roller (bird)’

 +ẓắ$_1$mmă$_2$ẓro$_3$	Ident[ν]	Contiguity	Max	Integrity
a. ν_x ν ν_y ẓə$_a$m.mă$_2$ẓ.ra$_b^{\mu_m}$		*!	$*_1*_2$	
b. ν_x ν_y ν_y ẓə$_a$m.ma$_b^{\mu_m}$ẓ.ra$_b^{\mu_m}$			$*_1*_2*_3$	$*_y*_b*_m$!
c. ☞ ν_x ν_x ν_y ẓə$_a$m.mə$_a$ẓ.ra$_b^{\mu_m}$			$*_1*_2*_3$	$*_x*_a$

There are a couple of phonologically motivated departures from this general pattern. We have already seen that an underlying non-final /i/ surfaces intact in the plural. When a non-final full vowel is followed by /w/ it does not surface as /u/ as expected, but as /i/, e.g. *ă-báwən* becomes *i-bíwan*, not **i-búwan*. This is clearly an instance of the OCP. Finally, schwa /ə/ in an open syllable syncopates wherever it can, unless this would result in the creation of a triliteral consonant cluster, e.g. the plural of *a-bắtol* is *í-btal*, not **í-bətal*, but the plural of *á-fắṣko* is *í-fəṣka*, not **í-fṣka*, which would violate *Complex.

5 Subtraction

Subtraction refers to the deletion of stem material and as such does not appear to fit into either the overarching deficiency or prespecification rubrics. It is a widespread conception that "[s]ubtractive morphology … is resistant to any but a rule-based approach" (Broadwell 1998: 429). Important theoretical treatments of subtraction that share this view include Martin (1988) and Anderson (1992). The OT treatments of subtraction that exist argue either for transderivational anti-faithfulness (Horwood 2001) or realizational morphology Kurisu (2001), both implementations of the process view of morphology.

Truly convincing examples of the phenomenon are hard to find and so most morpheme-based accounts have assumed that real subtraction does not exist. The difficulties are aptly illustrated with one of the earliest examples. In French, the masculine form of many adjectives seems to be based on the corresponding feminine form minus the final consonant, e.g. *blanc blɑ̃* 'white (m.sg)' vs. *blanche blɑ̃ʃ* (f.sg); *méchant meʃɑ̃* 'naughty (m.sg)' vs. *méchante meʃɑ̃t* (f.sg); *mauvais movɛ* 'bad (m.sg)' vs. *mauvaise movɛz* (f.sg), and so on. A number of scholars have argued that this is a case of morphological subtraction, notably Bloomfield (1933), Schane (1968), and Dell (1973). This view has also been contested by Kaye and Morin (1978) and others, who argue for a synchronic insertion rule. A later experiment by Fink (1985) based on nonce words found no evidence that either hypothesis could claim psychological reality. In 89% of the responses he elicited, the masculine and feminine forms were identical. In the remainder, subjects were as likely to use subtraction or insertion by ‘guessing’ the final consonant. To our knowledge similar experiments have not yet been conducted with putative cases of subtraction in other languages. Pending the results of these, Fink’s results for French suggest we should treat any claims regarding the reality of subtraction with circumspection.

Subtraction is also reported in Koasati, a Muskogean language of Louisiana and Texas that forms the pluractional of some verbs though subtraction of the word-final rhyme or coda (e.g. Kimball 1991; Horwood 2001; Kurisu 2001; Lieber 1992). However, there are different (additive) exponents of pluractional for most verbs, and the apparent subtractive cases are too restricted in number for us to be confident that they represent a productive rule.

Golston and Wiese (1996) describe a case of apparent subtraction in Hessian German. They propose that subtraction is regularly used to form the plurals of nouns ending in a homorganic sequence of sonorant⁀voiced obstruent stop, e.g. *faind* vs. *fain* ‘enemy, enemies’, *rauxfank* vs. *rauxfɛŋ* ‘chimney flue’. Non-subtractive plurals in Hessian end in a sonorant {-r}, {-n}, or {-ə}, and the authors propose that there is a morphologically specific constraint Son]$_{\mathrm{PL}}$ that requires plurals to end in a sonorant. In Hessian, they claim, this constraint is ranked above Parse-Seg, resulting in a subtractive pattern for words that do not take one of the other suffixes. Such an analysis is unavailable in our model because it mixes syntactic and phonological features in a constraint in what can only be a functionally arbitrary way.

On our account, the Hessian plural might involve suppletion, with the reduced plurals being listed portmanteaux (just as with *mouse∼mice*). If this is correct, then the set of reduced plurals will be a closed class, and the pattern will not be productively extended to new nouns. We do not have sufficient information to know whether this is the case.

In the absence of firm linguistic support for morphological subtraction we nevertheless venture a proposal that can handle it without positing a novel morphological process. We argue morphological subtraction may be understood as a special case of affixation, involving the insertion of an underspecified root node with a feature [F] that is contextually or absolutely objectionable such that the phonology deletes the entire segment. Unlike the cases dealt with in Section 3.1, this account will only work if the underspecified root node that sponsors [F] has already coalesced with the intended target of subtraction in the input. If we just defer for the moment the question how to motivate such a move, the phonological side of the analysis would then at least be trivial. Since the objectionable segment $C_{[F]}$ is the subtraction target, all that is required to force its deletion is that the markedness constraint $*C_{[F]}$ and the faithfulness constraint Ident[F] are both ranked above Max. This ranking favours deletion, in violation of low-ranked Max, over feature change, which incurs the severer penalty of violating Ident[F]. The more difficult question is where to allocate the coalescence. Suppose first that coalescence is phonological; in this case, coalescence must in any case precede deletion since coalescence both feeds and is counterbled by deletion, i.e. it is opaque.[43] The second possibility is that the underspecified root node of the affix and the subtraction target of the stem are coalesced in the input. This would entail assigning the coalescence to Spell-Out itself. One argument might proceed from the apparently anomalous role in the hierarchy of the constraint HavePlace introduced in Section 3.1. Under the assumption that constraints in OT are freely permutable, we would expect to find evidence from

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[43] See Bye (2010) for an overview of process ordering terminology.

some language that HAVEPLACE could be ranked low.[44] If HAVEPLACE penalizes structures that arguably *never* occur in surface forms, because they are phonetically uninterpretable in principle, we should deem this suspicious. We are forced to assume the existence of HAVEPLACE because we assume the input may contain underspecified root nodes.[45] A plausible alternative to HAVEPLACE-driven phonological coalescence may be to assume that inputs to the phonological grammar are subject to the same requirements of phonetic interpretability as surface forms. It may be helpful at this point to remind ourselves of the conceptual distinction between the underlying representation of an expression, which consists of stored lexical entries, and the input. Rule-based approaches to phonology did not generally distinguish these two. With the advent of OT and the importance of the richness of the base, one paraphrase of which is that the input to any language is universal, the distinction between underlying representation and input became crucial to make. Early discussions of 'Lexicon Optimization' (Prince and Smolensky 2004 [1993]) focused on minimizing the disparity between surface and underlying forms, but it is apparent that speakers are able to crystallize out lexical representations of some abstraction, including affixes consisting of bare features or underspecified root nodes. Underspecification may be a property of lexical entries, but it does not follow that it is a property of the input to the phonological grammar. Between the lexicon and the input there must be a step where lexical entries are preprocessed for phonetic interpretability. One of these processes is linearization discussed in Section 2. The advantage of this approach is that Spell-Out remains strictly information-adding. It's up to phonology to carry out the dirty work of deletion, which is independently needed.

Let's consider some examples of how an analysis along the lines sketched above might work. In the Hessian case, a plural allomorph consisting of an underspecified [sonorant] consonant might have the intended effect. In the input $C_{[son]}$ coalesces with the final obstruent of the stem giving a geminate, which then undergoes degemination in the phonology (//faind+$C_{[son]}$// → /fainn/ → [fain]). This could be productive if the allomorph is specified for a particular phonological environment, e.g. ending in a coronal. We do not have the data to develop the necessary details, however, and so turn to other cases which illustrate our approach. See Holsinger and Houseman (1999) for additional Hessian data and arguments supporting an analysis of the subtraction effect in phonological terms.

To motivate our general approach to subtraction, let us turn to a case of subtraction in Welsh. The data in (131) illustrates the well-known lenition of initial voiced stops. For an introduction to initial consonant mutations in Welsh, see Ball and Müller (1992).

(131) *Welsh lenition*

baner	vaner	'flag'
basked	vasked	'basket'
draig	ðraig	'dragon'
desk	ðesk	'desk'

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[44] For certain types of segment, such as 'bare' laryngeals [ʔ h], this argument has been made. For the following argument to go through, we have to assume that laryngeal segments too are assigned an explicit primary Place representation, Laryngeal.

[45] In the same way, and just as controversially, the constraint *FLOAT penalizes features that are not associated to a root node.

Lenition occurs in a variety of environments. One of the more well-studied from a syntactic point of view is the lenition of direct objects that occurs when a transitive verb is fronted, illustrated by the following examples (Roberts 2005: 75; he analyzes it as an exponent of accusative case).

(132) a. Mi welodd Megan blant.
PRT see.PAST M. children
'Megan saw children.'
b. Mae Megan wedi gweld plant.
be.3SG.PRES M. PRF.ASP see children
'Megan has seen children.'

The lenition of voiced stops can be described as the affixation of a root node $C_{\text{[continuant]}}$, which coalesces in the input with the initial consonant of the stem. In Roberts' analysis, the leniting morpheme is the exponent of v. Since lenition is part of exponence, the input to the phonology is a voiced fricative. In general, voiced fricatives are permitted in Welsh, reflecting the ranking Ident[cont]≫*VoiFric. Both constraints can be satisfied by deleting the initial consonant. In order to prevent this, Max must dominate *VoiFric. This is illustrated in (133), letting a bullet point stand in for the root node.

(133)

//•+draig//→/Draig/ | | [cont]$_v$ [cont]$_v$	Ident[cont]	Max	*VoiFric
a. draig	*!		
b. raig		*!	
c. ☞ ðraig			*

Radical /g/ alternates with zero, as in (134), and this is clearly linked to the fact that Welsh lacks a voiced velar fricative [ɣ].

(134) *Welsh lenition of* /g/

gorsav	orsav	'station'
garð	arð	'garden'

The subtractive pattern presented by words with radical /g/ can be derived by ranking both Ident[cont] and the specific markedness constraint *ɣ above Max, as in (135).

(135)

//•+gorsav//→/Gorsav/ | | [cont]$_v$ [cont]$_v$	*ɣ	Ident[cont]	Max	*VoiFric
a. gorsav		*!		
b. ɣorsav	*!			*
c. ☞ orsav			*	

Subtraction in Tohono O'odham

The account developed in the previous subsection for Welsh can be readily extended to other cases of subtraction, even where subtraction is not the allomorph of a mutation process. What distinguishes cases of pure subtraction from cases like Welsh is poverty of the stimulus: the learner cannot uniquely identify a feature for the mutation. In such cases, we submit that the learner arbitrarily selects some feature which in combination results in segments that are impossible in that language.

Probably the most famous case of subtractive morphology comes from O'odham (a.k.a. Papago), a Uto-Aztecan language of southern Arizona and northern Mexico (Hale 1965; Mathiot 1973; Zepeda 1983; Hill and Zepeda 1992; Weeda 1992; Stonham 1994; Fitzgerald and Fountain 1995; Fitzgerald 1997; Yu 2000). Descriptively speaking, the perfective form of the O'odham verb is regularly formed by deleting the final consonant of a consonant-final stem, which corresponds to the imperfective. As shown in (136), the set of subtracted consonants is diverse and includes /p t k d ɖ g m n w/. Furthermore, the residue does not appear to correspond to any definable phonological template. This seems to make subtraction the most parsimonious description of the pattern.[46]

(136) *O'odham perfective: consonant-final stems*

bídʂp	bídʂ	'paint object'
pisalt	pisal	'weigh'
hikčk	hikč	'cut'
gátwid	gátwi	'shoot object'
híhidòɖ	híhidò	'cook'
ɨ́ɖapig	ɨ́ɖapi	'gut'
hɨ́hɨm	hɨ́hɨ	'laugh'
čɨ́lkon	čɨ́lko	'scrape'

The perfective is marked by suffixing an underspecified root node with a feature [F].

(137) *Tohono O'odham perfective*

$$\begin{array}{l} \bullet \Leftrightarrow <\text{Asp}_{\text{Perf}}> \\ | \\ [\text{F}] \end{array}$$

In the phonology, the segment sponsoring [F] falls afoul of the constraint $*\bullet_{[\text{F}]}$. Either [F] must be deleted, violating IDENT[F], or the root or class node to which it is attached, violating MAX. Ranking IDENT[F] above MAX ensures that the entire root is deleted, allowing IDENT[F] to be vacuously satisfied. This interaction is shown in (138).

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[46] Although they exist, Zepeda (1983) provides very few examples of verbs whose stems end in a vowel. Vowel-final stems would seem to evince a lexical split between those that undergo subtraction in the perfective and those that don't undergo any overt change. Examples of the former include: ʔíːɨ∼ʔiː 'drink', híwa∼híw 'rub against object', moːto∼moːt 'carry on head or in vehicle'; of the latter: cicwi 'play', gagswua 'comb', kaː 'hear'. The first set matches the lexical entry of the perfective given in (137). The remainder we will assume are lexically listed.

(138)

//bídʂp+•//→/bídʂp/ | | [F] [F]	*•$_{[F]}$	Ident[F]	Max
a. bídʂp		*!	
b. bídʂp | [F]	*!		
c. ☞ bídʂ			*

Subtraction creates a situation where word minimality requirements have to be satisfied by mora epenthesis as in (139).[47]

(139) *O'odham perfective: lengthening under minimality*

mɨ́ɖ	mɨ́ː	'run'
him	hiː	'walk'
ǰuɲ	ǰuː	'being a certain time of day or night'

Let us briefly comment on the most important phonological complications of the pattern. In some cases, more than one segment is subtracted. A handful of these, like *cipkan*, 'work (IMPF)' *cipk* (PERF) are lexicalized, but there is also an entirely general pattern. When the final consonant is preceded by a sequence of a coronal consonant followed by a high vowel, both the final consonant and the high vowel fail to surface, e.g. *hɨ́lig* 'hang object to dry out (IMPF)' vs. *hɨ́l* (PF), *hɨ́li; *číčwičùd* 'make someone swim (IMPF)' vs. *číčwič* (PF); *čɨ́ːčig* 'call out name of object (IMPF)' vs. *čɨ́ːč* (PF). Here we follow the account of Fitzgerald and Fountain (1995), who view the deletion of the high vowel as phonologically motivated. They propose a constraint *CORONAL-HIGH, banning the feature sequence [coronal][high]. Ranked above MAX, this results in deletion of high vowels preceded by coronals in open syllables. In closed syllables, of course, such deletion does not take place, as shown by the imperfective base forms. This failure to delete may be attributed to a requirement that syllables be properly headed by a vocalic nucleus.[48]

6 Conclusions

In this paper, we have taken as our starting point the observation that morphology at its core involves the concatenation of segmental phonological content in a linear order which directly reflects syntactic hierarchy. We have pursued the intuition that independently needed mechanisms of syntax (such as agreement and movement), underspecification and prespecifi-

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[47] The discussion of phonological readjustment draws heavily on Fitzgerald and Fountain (1995).

[48] A final complication concerns verbs whose imperfective has the shape . . . VʔV, such as *gíʔa* 'grasp (IMPF)'. These regularly evince subtraction, but it is the glottal stop that is unpronounced: *gía* (PERF). As argued by Hill and Zepeda (1992), the pattern may be derived by assuming that the glottal stop is underlyingly final, i.e. /gíaʔ/. In the imperfective form, the glottal stop and the vowel undergo metathesis to *gíʔa* as a response to a constraint *Lar]$_{\mathrm{PrWd}}$.

cation in lexical entries, and interaction of phonological markedness and primitive faithfulness constraints can be exploited to handle putative cases of non-concatenative morphology.

Our conclusion is that the 'morphological' residue in language is manageably small. Portmanteau, agreement, phonologically conditioned allomorphy selection, underspecification and prespecification in lexical entries, and sensitivity to edges are all necessary. But we have found no cases in which process morphology is needed, suggesting that in fact there is no non-concatenative morphology; all morphology is concatenative, in a very straightforward sense. There are non-concatenative *effects*, but these arise as purely phonological responses to underspecified and prespecified lexical entries in the input. Our view of morphology thus falls out from our notion that morphology is simply the Spell-Out of the syntactic tree: matching of syntactic structure with lexical entries, which are Saussurean signs, or morphemes. Such a mapping is a conceptual necessity, so the morpheme-based view we espouse may be taken to represent a minimal assumption.

We have not developed a theory of prosodic structure here, but the domains of lexical insertion appear to line up well with the prosodic domains, strengthening the conclusions of previous researchers that prosodic domains are directly reflected in the input to the phonology.

Perhaps the most esoteric part of our proposal concerns our use of prespecification to account for several cases which are challenging to a strictly concatenative approach. True infixes form a class with antitropal prefixes and suffixes: all have in common that they resist attaching to the edge specified by the syntax. Whether they infix or attach to the opposite edge, on our account, is determined by the phonology. So too, is the pivot in the case of infixes. We believe that this offers a conceptual improvement over previous treatments, apparently without empirical loss. Affixes may also come with prespecified prosodic associations, which results in a kind of ablaut generally referred to as 'melodic overwrite'. This prespecification approach relies on the cyclic nature of Spell-Out and the fact that words and phrases are built late in Spell-Out of the phase.

References

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Abdel-Massih, Ernest T. 1968. *Tamazight verb structure: A generative approach*. The Hague: Mouton.

Adger, David. 2007. Stress and phasal syntax. *Linguistic Analysis* 33:238–266.

Adger, David. 2010. Variability and grammatical architecture. Ms. Queen Mary University of London; to appear in a volume based on Barcelona Workshop on Linguistic Variation in the Minimalist Framework.

Adger, David, Daniel Harbour, and Laurel J. Watkins. 2009. *Mirrors and microparameters: Phrase structure beyond free word order*. Cambridge: Cambridge University Press.

Adger, David, and Peter Svenonius. 2011. Features in minimalist syntax. In *Oxford handbook of linguistic minimalism*, ed. Cedric Boeckx, 27–51. Oxford: Oxford University Press.

Akinlabi, Akinbiyi. 1996. Featural affixation. *Journal of Linguistics* 32:239–289.

Alber, Birgit, and Sabine Arndt-Lappe. 2011. Truncation. In *The Morphology and Phonology of Exponence: The State of the Art*, ed. Jochen Trommer. Oxford: Oxford University Press.

Alderete, John. 1999. Morphologically Governed Accent in Optimality Theory. Doctoral Dissertation, University of Massachusetts, Amherst. Rutgers Optimality Archive #309. Available at `http://roa.rutgers.edu`.

Alderete, John. 2001. Dominance effects as transderivational anti-faithfulness. *Phonology* 18:201–253.

Alderete, John, Jill Beckman, Laura Benua, Amalia Gnanadesikan, John McCarthy, and Suzanne Urbanczyk. 1999. Reduplication with fixed segmentism. *Linguistic Inquiry* 30:327–364.

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

Anderson, Stephen R. 1984. On representations in morphology: case agreement and inversion in Georgian. *Natural Language and Linguistic Theory* 2:157–218.

Anderson, Stephen R. 1986. Disjunctive ordering in inflectional morphology. *Natural Language and Linguistic Theory* 4:1–31.

Anderson, Stephen R. 1992. *A-Morphous Morphology*. Cambridge: Cambridge University Press.

Applegate, Richard. 1976. Reduplication in Chumash. In *Hokan Studies*, ed. Margaret Langdon and Shirley Silver, 271–283. Mouton.

Archangeli, Diana. 1983. The root CV-template as a property of the affix: Evidence from Yawelmani. *Natural Language and Linguistic Theory* 1:348–384.

Archangeli, Diana. 1984. Underspecification in Yawelmani Phonology and Morphology. Doctoral Dissertation, MIT. Published 1988 in Outstanding Dissertations in Linguistics Series, Garland, New York.

Archangeli, Diana. 1988. Aspects of Underspecification Theory. *Phonology* 5:183–207.

Archangeli, Diana, and Douglas Pulleyblank. 1994. *Grounded Phonology*. Cambridge, MA: MIT Press.

Aronoff, Mark. 1976. *Word Formation in Generative Grammar*. Cambridge, MA: The MIT Press.

Aronoff, Mark. 1994. *Morphology by Itself*. Cambridge, MA: The MIT Press.

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

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

Ball, Martin J., and Nicole Müller. 1992. *Mutation in Welsh*. London: Routledge.

Bates, Dawn, and Barry Carlson. 1998. Spokane (Npoqínišcn) Syllable structure and reduplication. In *Salish Languages and Linguistics: Theoretical and descriptive perspectives*, ed. Ewa Czaykowska-Higgins and M. Dale Kinkade, 99–123. Berlin: Mouton de Gruyter.

Béjar, Susana. 2004. Phi syntax. Doctoral Dissertation, University of Toronto, Toronto.

Benmamoun, Elabbas. 2000. *The feature structure of functional categories: A comparative study of Arabic dialects*. New York: Oxford University Press.

Benua, Laura. 1998. Transderivational Identity: Phonological Relations between Words. Doctoral Dissertation, University of Massachusetts, Amherst.

Bermúdez-Otero, Ricardo. 2011. Alternations: distinguishing between phonology, morphology, and the lexicon. In *The Morphology and Phonology of Exponence: The State of the Art*, ed. Jochen Trommer. Oxford University Press.

Blaho, Sylvia. 2008. The syntax of phonology: A radically substance-free approach. Doctoral Dissertation, University of Tromsø.

Blevins, Juliette. 1999. Untangling Leti infixation. *Oceanic Linguistics* 38:383–403.

Bloomfield, Leonard. 1933. *Language*. Chicago: Chicago University Press.

Blust, Robert. 1999. Subgrouping, circularity and extinction: Some issues in Austronesian comparative linguistics. In *Selected papers from the Eighth International Conference on Austronesian Linguistics*, ed. Elizabeth Zeitoun and P. J. K. Li, 31–94.

Borer, Hagit. 2005. *In name only (structuring sense, vol. i)*. Oxford: Oxford University Press.

Bošković, Željko. 1995. Participle movement and second position cliticization. *Lingua* 96:245–266.

Bošković, Željko. 2001. *On the nature of the syntax-phonology interface: Cliticization and related phenomena*. Amsterdam: Elsevier Science.

Broadwell, George Aaron. 1998. Subtractive morphology in Southern Muskogean. *International Journal of American Linguistics* 59:416–429.

Brody, Michael. 2000a. Mirror Theory: Syntactic representation in Perfect Syntax. *Linguistic Inquiry* 31:29–56.

Brody, Michael. 2000b. Word order, restructuring, and Mirror Theory. In *The derivation of VO and OV*, ed. Peter Svenonius, 27–43. Amsterdam: John Benjamins.

Brody, Michael, and Anna Szabolcsi. 2003. Overt scope in Hungarian. *Syntax* 6:19–51.

Broselow, Ellen, and John J. McCarthy. 1983. A theory of internal reduplication. *Linguistic Review* 3:25–98.

Buckley, Eugene. 2007. Vowel-sonorant metathesis in Alsea. *International Journal of American Linguistics* 73:1–39.

Bye, Patrik. 2007. Allomorphy — selection, not optimization. In *Freedom of Analysis?*, ed. Sylvia Blaho, Patrik Bye, and Martin Krämer, volume 95 of *Studies in Generative Grammar*, 63–92. Berlin: Mouton.

Bye, Patrik. 2009. Three Types of Marginal Contrast. Talk presented at the Toronto-Tromsø Workshop on Phonology, 8th – 11th October 2009, Toronto.

Bye, Patrik. 2010. Levels of Representation and Derivations in Phonology. In *The Continuum Handbook of Phonology*, ed. Bert Botma, Nancy Kula, and Kuniya Nasukawa. London: Continuum.

Bye, Patrik, and Peter Svenonius. 2011. Verb stem formation in Sierra Miwok redux: Syntax, morphology, and phonology. Ms., University of Tromsø.

Caha, Pavel. 2009a. Classical Armenian declension. In *Tromsø working papers on language and linguistics: Nordlyd 36.1,* Special issue on Nanosyntax, ed. Peter Svenonius, Gillian Ramchand, Michal Starke, and Knut Tarald Taraldsen, 1–34. Tromsø: University of Tromsø. Available at http://www.ub.uit.no/baser/nordlyd/.

Caha, Pavel. 2009b. The nanosyntax of case. Doctoral Dissertation, University of Tromsø.

Causley, Trisha. 1997. Identity and featural correspondence: The Athapaskan case. In *Proceedings of North East Linguistic Society (NELS) 27*, 93–105.

Chamora, Berhanu, and Robert Hetzron. 2000. *Inor*, volume 118 of *Languages of the World/Materials*. München: Lincom Europa.

Chomsky, Noam. 1995. *The minimalist program*. Cambridge, Ma.: MIT Press.

Chomsky, Noam. 2000. Minimalist inquiries: The framework. In *Step by step: Minimalist essays in honor of Howard Lasnik*, ed. Roger Martin, David Michaels, and Juan Uriagereka, 89–155. Cambridge, Ma.: MIT Press.

Chomsky, Noam. 2001. Derivation by phase. In *Ken Hale: A life in language*, ed. Michael Kenstowicz, 1–52. Cambridge, Ma.: MIT Press.

Chomsky, Noam. 2008. On phases. In *Foundational issues in linguistic theory: Essays in honor of Jean-Roger Vergnaud*, ed. Robert Freidin, Carlos P. Otero, and Maria Luisa Zubizarreta, 133–166. Cambridge, Ma.: MIT Press.

Cinque, Guglielmo. 1999. *Adverbs and functional heads: A cross-linguistic perspective*. New York: Oxford University Press.

Clements, G. N., and Elizabeth V. Hume. 1995. The internal organization of speech sounds. In *The Handbook of Phonological Theory*, ed. John Goldsmith, 245–306. Oxford: Basil Blackwell.

Costello, Nancy A. 1998. Affixes in Katu of the Lao P.D.R. *Mon-Khmer Studies* 28:31–42.

Crowhurst, Megan. 1994. Foot extrametricality and template mapping in Cupeño. *Natural Language and Linguistic Theory* 12:177–201.

Crowhurst, Megan. 1998. *Um* infixation in Toba Batak. *Language* 74:590–604.

Crowhurst, Megan. 2001. Coda conditions and *um* infixation in Toba Batak. *Lingua* 111:561–590.

Crowhurst, Megan. 2004. Mora alignment. *Natural Language and Linguistic Theory* 22:127–177.

Crowley, Terry. 1983. Uradhi. In *Handbook of Australian Languages, Vol. 3*, ed. R. M. W. Dixon and Barry J. Blake, 306–428. ANU Press.

Davis, Stuart, and Isao Ueda. 2006. Prosodic vs. Morphological Mora Augmentation. *Lexicon Forum* 2.

De Lacy, Paul. 2006. *Markedness: Reduction and preservation in phonology*, volume 112 of *Cambridge Studies in Linguistics*. Cambridge: Cambridge University Press.

De Lacy, Paul. 2011. Morpho-phonological polarity. In *The Morphology and Phonology of Exponence: The State of the Art*, ed. Jochen Trommer. Oxford University Press.

Dékány, Éva. 2009. The nanosyntax of Hungarian postpositions. In *Tromsø working papers on language and linguistics: Nordlyd 36.1,* Special issue on Nanosyntax, ed. Peter Svenonius, Gillian Ramchand, Michal Starke, and Knut Tarald Taraldsen, 1–35. Tromsø: University of Tromsø. Available at http://www.ub.uit.no/baser/nordlyd/.

Dell, François. 1973. *Les règles et les sons*. Paris: Collection Savoir.

Di Sciullo, Anna Maria, and Edwin Williams. 1987. *On the Definition of Word*. Cambridge, MA: The MIT Press.

Dressler, Wolfgang U. 2000. Extragrammatical vs. marginal phonology. In *Extragrammatical and marginal phonology*, ed. Ursula Doleschal and Anna M. Thornton, 2–10. München: Lincom Europa.

Egerød, Søren. 1965. Verb inflection in Atayal. *Lingua* 15:251–282.

Elbert, Samuel H., and Mary Kawena Pukui. 1979. *Hawaiian grammar*. Honolulu: University of Hawaii Press.

Embick, David. 2007. Linearization and local dislocation: Derivational mechanics and interactions. *Linguistic Analysis* 33:2–35.

Embick, David, and Ralf Noyer. 2001. Movement operations after syntax. *Linguistic Inquiry* 32:555–595.

Embick, David, and Rolf Noyer. 2007. Distributed Morphology and the syntax/morphology interface. In *The handbook of linguistic interfaces*, ed. Gillian Ramchand and Charles Reiss. Oxford: Oxford University Press.

Fink, R. 1985. French adjective morphophonemic patterns: their generalization and representation. *Linguistics* 23:567–596.

Fitzgerald, Colleen M. 1997. O'odham Rhythms. Doctoral Dissertation, University of Arizona. Rutgers Optimality Archive #190. Available at `http://roa.rutgers.edu`.

Fitzgerald, Colleen M. 2000. Vowel Hiatus and Faithfulness in Tohono O'odham Reduplication. *Linguistic Inquiry* 31:713–722.

Fitzgerald, Colleen M., and Amy V. Fountain. 1995. The optimal account of Tohono O'odham truncation. Available at `http://www.faculty.english.ttu.edu/fitzgerald`.

Franks, Steven. 2006. Another look at *li* placement in Bulgarian. *The Linguistic Review* 23:161–211.

Freeland, Lynn. 1951. *Language of the Sierra Miwok*. Supplement to International Journal of American Linguistics, Vol 17, No. 1. Indiana University Publications in Anthrology and Linguistics Memoir 6. Bloomington, IA: Waverley Press.

Fukazawa, Haruka. 1997. A Correspondence-Theoretic Approach to Japanese Vocabulary Strata. In *Proceedings of MALC (Mid-America Linguistics Conference) 1997*.

Fukazawa, Haruka, Mafuyu Kitahara, and Mitsuhiko Ota. 1998. Lexical stratification and ranking invariance in constraint-based grammars. In *Chicago Linguistic Society (CLS) 34. Vol. II: The Panels*, ed. M. Catherine Gruber, Derrick Higgins, Kenneth Olson, and Tamra Wysocki.

Galloway, Brent. 1980. *The Structure of Upriver Halq'eméylem: A Grammatical Sketch and Classified Word List for Upriver Halq'eméylem.* Sardis, BC: Coqualeetza Education Training Centre.

Galloway, Brent. 1993. *A Grammar of Upriver Halkomelem*, volume 96 of *University of California Publications in Linguistics*. Berkeley, CA: University of California Press.

Garrett, Andrew. 2001. Reduplication and infixation in Yurok: Morphology, semantics, and diachrony. *International Journal of American Linguistics* 67:264–312.

Genetti, Carol. 2007. *A Grammar of Dolakha Newar*, volume 40 of *Mouton Grammar Library*. Berlin: Mouton de Gruyter.

Golston, Chris, and Richard Wiese. 1996. Zero morphology and constraint interaction: Subtraction and epenthesis in German dialects. In *Yearbook of morphology 1995*, ed. Geert Booij and Jaap van Marle, 143–159. Dordrecht: Kluwer.

Hale, Kenneth. 1965. Some preliminary observations on Papago morphophonemics. *International Journal of American Linguistics* 31:295–305.

Halle, Morris, and Alec Marantz. 1993. Distributed Morphology and the pieces of inflection.

In *The view from building 20: Essays in linguistics in honor of Sylvain Bromberger*, ed. Kenneth Hale and Samuel Jay Keyser, 111–176. Cambridge, Ma.: MIT Press.

Halle, Morris, and Alec Marantz. 1994. Some key features of Distributed Morphology. *MIT Working Papers in Linguistics* 21:275–288.

Halpern, Aaron. 1995. *On the placement and morphology of clitics*. Dissertations in linguistics. Stanford, Ca.: CSLI Publications Center for the Study of Language and Information.

Halpern, Aaron L., and Arnold M. Zwicky, ed. 1996. *Approaching second: Second position clitics and related phenomena*. Stanford, Ca.: Center for the Study of Language and Information.

Harley, Heidi, and Rolf Noyer. 1999. Distributed Morphology. *Glot International* 4:3–9.

Haugen, Jason D. 2008. *Morphology at the Interfaces*, volume 117 of *Linguistik Aktuell/Linguistics Today*. Amsterdam: John Benjamins.

Hayward, Richard J. 1998. Qafar (East Cushitic). In *The Handbook of Morphology*, ed. Andrew Spencer, 624–647. Oxford: Basil Blackwell.

Heath, Jeffrey. 2005. *A Grammar of Tamashek (Tuareg of Mali)*, volume 35 of *Mouton Grammar Library*. Berlin: Mouton de Gruyter.

Heath, Jeffrey. 2008. *A Grammar of Jamsay*, volume 45 of *Mouton Grammar Library*. Berlin: Mouton de Gruyter.

Henry, Jules. 1948. The Kaingang language. *International Journal of American Linguistics* 14:194–204.

Hill, J. H., and Ofelia Zepeda. 1992. Derived words in Tohono O'odham. *International Journal of American Linguistics* 58:355–404.

Hill, Jane H. 1970. A peeking rule in Cupeño. *Linguistic Inquiry* 1:534–539.

Hill, Jane H. 2005. *A Grammar of Cupeño*, volume 136 of *University of California Publications in Linguistics*. Berkeley, CA: University of California Press.

Hockett, Charles F. 1947. Problems of morphemic analysis. *Language* 23:321–343. URL `http://www.jstor.org/stable/410295`.

Hockett, Charles F. 1954. Two models of grammatical description. *Word* 10:210–231.

Holsinger, David J., and Paul D. Houseman. 1999. Lenition in Hessian: Cluster reduction and subtractive plurals. *Yearbook of Morphology* 1998:159–174.

Horwood, Graham. 2001. Anti-faithfulness and Subtractive Morphology. Rutgers Optimality Archive #466. Available at `http://roa.rutgers.edu`.

Horwood, Graham. 2008. Implications of Katu nominalization for infixation typology. Unpublished Ms., Thammasat University, Bangkok. Rutgers Optimality Archive #969. Available at `http://roa.rutgers.edu`.

Hualde, José Ignacio. 1991. *Basque Phonology*. London: Routledge.

Hualde, José Ignacio, and Jon Ortiz de Urbina. 2003. *A grammar of Basque*, volume 26 of *Mouton Grammar Library*. Berlin: Mouton de Gruyter.

Hume, Elizabeth. 2001. Metathesis: Formal and functional considerations. In *Surface Syllable Structure and Segment Sequencing*, ed. Elizabeth Hume, Norval Smith, and Jeroen van de Weijer, 1–25. Leiden: HIL.

Idsardi, William J. 1997. Phonological Derivations and Historical Changes in Hebrew Spirantization. In *Derivations and Constraints in Phonology*, ed. Iggy Roca, 367–392. Oxford: Clarendon Press.

Inkelas, Sharon. 1998. The theoretical status of morphologically conditioned phonology: a case study from dominance. In *Yearbook of morphology 1997*, ed. Geert Booij and Jaap van Marle, 121–155. Dordrecht: Springer.

Inkelas, Sharon. 2011. Reduplication. In *The Morphology and Phonology of Exponence: The State of the Art*, ed. Jochen Trommer. Oxford: Oxford University Press.

Inkelas, Sharon, Orhan Ogun, and Cheryl Zoll. 1997. The implications of lexical exceptions for the nature of grammar. In *Derivations and Constraints in Phonology*, ed. Iggy Roca, 393–418. Oxford: Clarendon Press.

Inkelas, Sharon, and Young mee Yu Cho. 1993. Inalterability as Prespecification. *Language* 69:529–574.

Inkelas, Sharon, and Cheryl Zoll. 2005. *Reduplication. Doubling in Morphology*, volume 106 of *Cambridge Studies in Linguistics*. Cambridge: Cambridge University Press.

Ito, Junko, Yoshihisa Kitagawa, and Armin Mester. 1996. Prosodic faithfulness and correspondence: Evidence from a Japanese argot. *Journal of East Asian Linguistics* 5:217–294.

Itô, Junko, and Armin Mester. 1995. The core-periphery structure of the lexicon and constraints on reranking. In *Papers in Optimality Theory*, ed. Jill N. Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk. Amherst, MA: GLSA. University of Massachusetts Occasional Papers 18.

Itô, Junko, and Armin Mester. 1999. The structure of the phonological lexicon. In *The Handbook of Japanese Linguistics*, ed. Natsuko Tsujimura, 62–100. Oxford: Blackwell.

Iverson, Greg, and Joseph Salmons. 1995. Aspiration and Laryngeal Representation in Germanic. *Phonology* 12:369–396.

Iverson, Gregory K., and Joseph C. Salmons. 2003. Legacy specification in the laryngeal phonology of Dutch. *Journal of Germanic Linguistics* 15:1–26.

Jessen, Michael. 2001. Phonetic implementation of the distinctive auditory features [voice] and [tense] in stop consonants. In *Distinctive Feature Theory*, ed. T. Allan Hall, 237–294. Berlin: Mouton de Gruyter.

Julien, Marit. 2002. *Syntactic heads and word formation*. New York: Oxford University Press.

Julien, Marit. 2005. *Nominal phrases from a Scandinavian perspective*. Amsterdam: John Benjamins.

Kager, René. 2008. Lexical Irregularity and the Typology of Contrast. In *The Structure of Words. Studies in Honor of Paul Kiparsky*, ed. Kristin Hanson and Sharon Inkelas, 397–432. Cambridge, MA: The MIT Press.

Kahnemuyipour, Arsalan. 2009. *The syntax of sentential stress*. Oxford: Oxford University Press.

Kaisse, Ellen M. 1981. Separating phonology from syntax: A reanalysis of Pashto cliticization. *Journal of Linguistics* 17:197–208.

Kaye, Jonathan, and Yve-Charles Morin. 1978. Il n'y a pas de règles de troncation, voyons. In *Proceedings of the Twelfth International Congress of Linguistics*, ed. Wolfgang U. Dressler and Wolfgang Meid, Innsbruck, 788–792. Innsbrucker Beiträge zur Sprachwissenschaft.

Kayne, Richard S. 1994. *The antisymmetry of syntax*. Cambridge, Ma.: MIT Press.

Kayne, Richard S. 2005. Some notes on comparative syntax, with special reference to English and French. In *The oxford handbook of comparative syntax*, ed. Guglielmo Cinque and

Richard S. Kayne, 3–69. New York: Oxford.

Kennedy, Christopher. 1999. *Projecting the adjective: The syntax and semantics of gradability and comparison*. New York: Garland. (1997 UCSC Ph.D. thesis).

Kenstowicz, Michael. 2005. Paradigmatic Uniformity and Contrast. In *Paradigms in Phonological Theory*, ed. Laura J. Downing, Tracy A. Hall, and Renate Raffelsiefen, 145–169. Oxford University Press.

Kilani-Schoch, Marianne, and Wolfgang U. Dressler. 1986. Métathèse et conversion morphologiques en arable tunisien. *Zeitschrift für Phonetik, Sprachwissenschaft und Kommunikationsforschung* 39:61–75.

Kimball, Geoffrey. 1991. *Koasati Grammar*. Lincoln: University of Nebraska Press.

Kiparsky, Paul. 1982. Lexical Phonology and Morphology. In *Linguistics in the Morning Calm*, ed. I. S. Yang, 3–91. Hanshin, Seoul: Linguistic Society of Korea.

Kitto, Catherine, and Paul de Lacy. 1999. Correspondence and epenthetic quality. In *Austronesian Formal Linguistics Association 6*, 181–200. Toronto: University of Toronto, Department of Linguistics.

Klein, Thomas B. 2005. Infixation and segmental constraint effects: *um* and *in* in Tagalog, Chamorro, and Toba Batak. *Lingua* 115:959–995.

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

Kosseke, D., and J. Sitamon. 1993. Aka field notes. Ms., Summer Institute of Linguistics, Bangui.

Kratzer, Angelika, and Elisabeth Selkirk. 2007. Phase theory and prosodic spellout: The case of verbs. *The Linguistic Review* 24:93–135.

Kurisu, Kazutaka. 2001. The Phonology of Morpheme Realization. Doctoral Dissertation, University of California, Santa Cruz. Rutgers Optimality Archive #490. Available at `http://roa.rutgers.edu`.

Kurisu, Kazutaka, and Nathan Sanders. 1999. Infixal Nominal Reduplication in Maŋarayi. In *Phonology at Santa Cruz 6*, 47–56. University of California, Santa Cruz.

Lamontagne, Greg, and Keren Rice. 1995. A correspondence account of coalescence. In *Papers in Optimality Theory*, ed. Jill N. Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk, 211–223. Amherst, MA: GLSA.

Lieber, Rochelle. 1983. New developments in autosegmental morphology: Consonant mutation in Fula. In *Proceedings of the West Coast Conference on Formal Linguistics (WCCFL) 2*, ed. M. Barlow, D. Flickinger, and M. Wescoat, 165–175.

Lieber, Rochelle. 1984. Consonant gradation in Fula: An autosegmental approach. In *Language Sound Structure*, ed. Mark Aronoff and Richard Oehrle, 329–345. Cambridge, MA: The MIT Press.

Lieber, Rochelle. 1987. *An Integrated Theory of Autosegmental Processes*. Albany, NY: State University of New York Press.

Lieber, Rochelle. 1992. *Deconstructing morphology: Word formation in syntactic theory*. Chicago: University of Chicago Press.

Mahajan, Anoop. 2000. Eliminating head movement. *GLOW Newsletter* 23:44–45.

Marantz, Alec. 1982. Re reduplication. *Linguistic Inquiry* 13:435–482.

Marantz, Alec. 2001. Words. Ms. MIT.

Marantz, Alec. 2007. Phases and words. In *Phases in the theory of grammar*, ed. Sook-hee

Choe, 196–226. Seoul: Dong-in.

Martin, Jack. 1988. Subtractive morphology as dissociation. In *Proceedings of the West Coast Conference on Formal Linguistics (WCCFL) 7*, 229–240.

Marvin, Tatjana. 2002. Topics in the stress and syntax of words. Doctoral Dissertation, MIT, Cambridge, Ma.

Mathiot, Madeleine. 1973. *A Dictionary of Papago Usage*. Bloomington, IN: Indiana University Press.

Matthews, P. H. 1972. *Inflectional Morphology: A theoretical study based on aspects of Latin verb conjugation*. Cambridge: Cambridge University Press.

McCarthy, John J. 1979. Formal Problems in Semitic Phonology and Morphology. Doctoral Dissertation, MIT.

McCarthy, John J. 1981. A prosodic theory of nonconcatenative morphology. *Linguistic Inquiry* 12:373–418.

McCarthy, John J. 1984. Prosodic organization in morphology. In *Language Sound Structure*, ed. Mark Aronoff and Richard Oehrle, 299–317. Cambridge, MA: The MIT Press.

McCarthy, John J. 2000a. Faithfulness and Prosodic Circumscription. In *Optimality Theory. Phonology, Syntax, and Acquisition*, ed. Joost Dekkers, Frank van der Leeuw, and Jeroen van de Weijer, 151–189. Oxford: Oxford University Press.

McCarthy, John J. 2000b. The prosody of phase in Rotuman. *Natural Language and Linguistic Theory* 18:147–197.

McCarthy, John J. 2005. Optimal paradigms. In *Paradigms in Phonological Theory*, ed. Laura Downing, Tracy A. Hall, and Renate Raffelsiefen, 295–371. Oxford: Oxford University Press.

McCarthy, John J. 2008. The gradual path to cluster simplification. *Phonology* 25:271–319.

McCarthy, John J., and Alan S. Prince. 1986. Prosodic Morphology. Technical Report #32, Rutgers Center for Cognitive Science.

McCarthy, John J., and Alan S. Prince. 1990. Foot and word in Prosodic Morphology: The Arabic broken plurals. *Natural language and Linguistic Theory* 8:209–282.

McCarthy, John J., and Alan S. Prince. 1993. Prosodic Morphology I. Ms., University of Massachusetts at Amherst and Rutgers University.

McCarthy, John J., and Alan S. Prince. 1994. The Emergence of the Unmarked. In *NELS 24. Vol. 2*, ed. Mercè Gonzàlez, 333–379.

McCarthy, John J., and Alan S. Prince. 1995. Faithfulness and Reduplicative Identity. In *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*, ed. Jill N. Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk, 249–384. University of Massachusetts, Amherst: GLSA.

McCarthy, John J., and Alan S. Prince. 1999. Faithfulness identity in Prosodic Morphology. In *The Prosody-Morphology Interface*, ed. René Kager, Harry van der Hulst, and Wim Zonnefeld, 218–309. Cambridge: Cambridge University Press.

McLaughlin, Fiona. 2000. Consonant mutation and reduplication in Seereer-Siin. *Phonology* 17:333–363.

Merlan, Francesca. 1982. *Mangarayi*. London: Routledge.

Molina, Felipe S., Herminia Valenzuela, and David L. Shaul. 1999. *Yoeme-English English-Yoeme Standard Dictionary. A Language of the Yaqui Tribe in the American Southwest* *and Northern Mexico. With a Comprehensive Grammar of Yoeme Language.* New York: Hippocrene Books.

Montler, Timothy. 1986. *Morphology and Phonology of Saanich.* Missoula, MT: University of Montana Press.

Montler, Timothy. 1989. Infixation, reduplication, and metathesis in the Saanich Actual Aspect. *Southwest Journal of Linguistics* 9:92–107.

Morén, Bruce. 2003. The Parallel Structures Model of Feature Geometry. *Working Papers of the Cornell Phonetics Laboratory* 15:194–270.

Muriungi, Peter Kinyua. 2008. Phrasal movement inside Bantu verbs: Deriving affix scope and order in Kîîtharaka. Doctoral Dissertation, University of Tromsø.

Muriungi, Peter Kinyua. 2009. The union spell-out mechanism. In *Tromsø working papers on language and linguistics: Nordlyd 36.1,* Special issue on Nanosyntax, ed. Peter Svenonius, Gillian Ramchand, Michal Starke, and Knut Tarald Taraldsen, 191–205. Tromsø: University of Tromsø. Available at http://www.ub.uit.no/baser/nordlyd/.

Myers, Scott. 1997. OCP effects in Optimality Theory. *Natural language and Linguistic Theory* 15:847–892.

Newell, Heather. 2008. Aspects of the morphology and phonology of phases. Doctoral Dissertation, McGill University, Montréal.

Noyer, Ralf. 1992. Features, positions and affixes in autonomous morphological structure. Doctoral Dissertation, MIT, Cambridge, Ma.

Odden, David. 1987. Dissimilation as deletion in Chukchi. In *Third Eastern States Conference on Linguistics (ESCOL '87): Selected Papers*, 235–246.

Okrand, Marc. 1979. Metathesis in Costanoan Grammar. *International Journal of American Linguistics* 45:123–130.

Olson, Kenneth S. 2005. *The Phonology of Mono*, volume 140 of *SIL International and the University of Texas at Arlington Publications in Linguistics*. Dallas: SIL International and the University of Texas at Arlington.

Orgun, Cemil Orhan. 1996. Sign-Based Morphology and Phonology with special attention to Optimality Theory. Doctoral Dissertation, Berkeley. Rutgers Optimality Archive #171. Available at `http://roa.rutgers.edu`.

Orgun, Cemil Orhan. 1999. Sign-based morphology: a declarative theory of phonology-morphology interleaving. In *The Derivational Residue in Phonological Optimality Theory*, ed. Ben Hermans and Marc van Oostendorp, 247–267. Amsterdam: John Benjamins.

Orgun, Cemil Orhan, and Sharon Inkelas. 2002. Reconsidering bracket erasure. In *Yearbook of morphology 2001*, ed. Geert Booij and Jaap van Marle, 115–146. Dordrecht: Springer.

Padgett, Jaye. 1995. Partial class behavior and nasal place assimilation. In *Proceedings of the 1995 Southwestern Workshop on Optimality Theory (SWOT)*, ed. Keiichiro Suzuki and Dirk Elzinga. Tucson, AZ: Department of Linguistics, University of Arizona.

Pantcheva, Marina. to appear. Decomposing path: The nanosyntax of directional expressions. Doctoral Dissertation, University of Tromsø.

Parker, Steve. 2001. Non-optimal onsets in Chamicuro: an inventory maximised in coda position. *Phonology* 18:361–386.

Paster, Mary. 2006. Phonological Conditions on Affixation. Doctoral Dissertation, University of California, Berkeley.

Pater, Joe. 2010. Morpheme-specific phonology: Constraint indexation and inconsistency resolution. In *Phonological Argumentation: Essays on Evidence and Motivation*, ed. Steve Parker. London: Equinox.

Payne, David L. 1981. *The Phonology and Morphology of Axininca Campa*. Arlington, TX: Summer Institute of Linguistics.

Petrova, Olga, Rosemary Plapp, Catherine Ringen, and Szilárd Szentgyörgyi. 2006. Voice and aspiration: Evidence from Russian, Hungarian, German, Swedish, and Turkish. *The Linguistic Review* 23:1–35.

Piggott, Glynne L. 2000. Against featural alignment. *Journal of Linguistics* 36:85–129.

Piñeros, Carlos-Eduardo. 2004. The creation of portmanteaus in the extragrammatical morphology of Spanish. *Probus* 16:203–240.

Poser, William J. 1982. Phonological representations and action-at-a-distance. In *The Structure of Phonological Representations, vol. 2*, ed. Harry van der Hulst and Norval Smith, 121–158. Dordrecht: Foris.

Poser, William J. 1992. Blocking of phrasal constructions by lexical items. In *Lexical matters*, ed. Ivan A. Sag and Anna Szabolcsi, 111–30. Stanford, CA: Center for Study of Lang. & Information.

Prince, Alan S., and Paul Smolensky. 2004 [1993]. *Optimality Theory: Constraint interaction in generative grammar*. Malden, MA: Blackwell. Originally distributed as Rutgers University Center for Cognitive Science Tech report #2.

Pulleyblank, Douglas. 1988. Vocalic underspecification in Yoruba. *Linguistic Inquiry* 19:233–270.

Pullum, Geoffrey K., and Arnold Zwicky. 1988. The syntax-phonology interface. In *Linguistics: The Cambridge survey*, ed. Frederick J. Newmeyer, volume 1, 255–280. Cambridge: Cambridge University Press.

Ramchand, Gillian. 2008. *Verb meaning and the lexicon*. Cambridge: Cambridge University Press.

Rice, Curt. 2004. Optimal gaps in optimal paradigms. Ms., University of Tromsø.

Riggle, Jason. 2004. Nonlocal reduplication. In *Proceedings of North East Linguistic Society (NELS) 34*, 485–496.

Rizzi, Luigi. 1997. The fine structure of the left periphery. In *Elements of grammar: Handbook in generative syntax*, ed. Liliane Haegeman, 281–337. Dordrecht: Kluwer.

Roberts, Ian G. 2005. *Principles and Parameters in a VSO Language: A case study in Welsh*. Oxford: Oxford University Press.

Roberts, J. S. 1994. Nontonal features as grammatical morphemes. Paper presented at 25th Annual Conference on African Linguistics, Rutgers University.

Robins, R. H. 1958. *The Yurok Language*, volume 15 of *University of California Publications in Linguistics*. Berkeley, CA: University of California Press.

Rooy, Bertus van, and Daan Wissing. 2001. Distinctive [voice] implies regressive voicing assimilation. In *Distinctive Feature Theory*, ed. T. Allan Hall, 295–334. Berlin: Mouton de Gruyter.

Rose, Sharon. 1997. Theoretical issues in comparative Ethio-Semitic phonology and morphology. Doctoral Dissertation, McGill University.

Rose, Sharon, and Rachel Walker. 2004. A typology of consonant agreement as correspondence. *Language* 475–531.

Ross, John Robert. 1967. Constraints on variables in syntax. Doctoral Dissertation, MIT, Cambridge, Ma.

Rudnitskaya, Elena. 2000. The derivation of yes-no *li* questions in Russian: Syntax and/or phonology? In *Annual Workshop on Formal Approaches to Slavic Linguistics: The Philadelphia meeting, 1999*, ed. Tracy Holloway King and Irina A. Sekerina, 347–362. Ann Arbor, Mi.: Michigan Slavic.

Saba Kirchner, Jesse. 2010. Minimal Reduplication. Doctoral Dissertation, University of California, Santa Cruz.

Samek-Lodovici, Vieri. 1992. A unified analysis of cross-linguistic morphological gemination. In *Proceedings of CONSOLE 1*, 265–283. Utrecht. Rutgers Optimality Archive 149. Available at `http://roa.rutgers.edu`.

Schane, Sanford. 1968. *French Phonology and Morphology*. Cambridge, MA: The MIT Press.

Selkirk, Elisabeth. 1995. Sentence prosody: Intonation, stress, and phrasing. In *The handbook of phonological theory*, ed. John Goldsmith, 550–569. London: Blackwell.

Selkirk, Elisabeth. 1996. The prosodic structure of function words. In *Signal to syntax: Bootstrapping from speech to grammar in early acquisition*, ed. James L. Morgan and Katherine Demuth, 187–213. Hillsdale, NJ: Lawrence Erlbaum.

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

Shaw, Patricia A. 1993. Templatic Evidence for the Syllable Nucleus. In *Proceedings of the North East Linguistic Society (NELS) 23, Vol. 2*, ed. Mercè Gonzàlez, 463–477.

Siddiqi, Daniel. 2009. *Syntax within the word: Economy, allomorphy, and argument selection in Distributed Morphology*. John Benjamins.

Slocum, Marianna C. 1948. Tzeltzal (Mayan) noun and verb morphology. *International Journal of American Linguistics* 14:77–86.

Smith, Jennifer L. 2002. Phonological augmentation in prominent positions. Doctoral Dissertation, University of Massachusetts at Amherst.

Son, Minjeong, and Peter Svenonius. 2008. Microparameters of cross-linguistic variation: Directed motion and resultatives. In *Proceedings of the 27th west coast conference on formal linguistics*, ed. Natasha Abner and Jason Bishop, 388–396. Somerville, Ma.: Cascadilla.

Starke, Michal. 2009a. Nanosyntax. Seminar lectures at CASTL, University of Tromsø.

Starke, Michal. 2009b. Nanosyntax: A short primer to a new approach to language. In *Tromsø working papers on language and linguistics: Nordlyd 36.1,* Special issue on Nanosyntax, ed. Peter Svenonius, Gillian Ramchand, Michal Starke, and Knut Tarald Taraldsen, 1–6. Tromsø: University of Tromsø. Available at http://www.ub.uit.no/baser/nordlyd/.

Stassen, Leon. 2000. AND-languages and WITH-languages. *Linguistic Typology* 4:1–54.

Steriade, Donca. 1982. Greek prosodies and the nature of syllabification. Doctoral Dissertation, MIT.

Steriade, Donca. 1988. Reduplication and syllable transfer in Sanskrit and elsewhere. *Phonology* 5:73–155.

Steriade, Donca. 1995. Underspecification and markedness. In *Handbook of Phonological Theory*, ed. John Goldsmith, 114–174. Oxford: Basil Blackwell.

Stonham, John T. 1994. *Combinatorial Morphology*, volume 120 of *Amsterdam Studies in the Theory and History of Linguistic Science*. Amsterdam: John Benjamins.

Stonham, John T. 2007. Metathesis as prosodic repair. *Journal of Phonetics, Phonology and Morphology* 3:3–24.

Stump, Gregory T. 2001. *Inflectional Morphology. A Theory of Paradigm Structure.* Cambridge: Cambridge University Press.

Svenonius, Peter. 2004. On the edge. In *Peripheries: Syntactic edges and their effects*, ed. David Adger, Cécile de Cat, and George Tsoulas, 261–287. Dordrecht: Kluwer.

Svenonius, Peter. 2007. Interpreting uninterpretable features. *Linguistic Analysis* 33:375–413.

Svenonius, Peter. 2008. The position of adjectives and other phrasal modifiers in the decomposition of DP. In *Adjectives and adverbs: Syntax, semantics, and discourse*, ed. Louise McNally and Chris Kennedy, 16–42. Oxford: Oxford University Press.

Svenonius, Peter. 2010. Spatial prepositions in English. In *Mapping spatial PPs: Cartography of syntactic structures, vol. 6*, ed. Guglielmo Cinque and Luigi Rizzi, 127–160. Oxford: Oxford University Press. Prepublication draft available at http://ling.auf.net/lingBuzz/000001.

Svenonius, Peter, Gillian Ramchand, Michal Starke, and Knut Tarald Taraldsen, ed. 2009. *Tromsø working papers on language and linguistics: Nordlyd 36.1,* Special issue on Nanosyntax. Tromsø: University of Tromsø. Available at http://www.ub.uit.no/baser/nordlyd/.

Taraldsen, Knut Tarald. 2010. The nanosyntax of Nguni noun class prefixes and concords. *Lingua* 120:1522–1548.

Tegey, Habibullah. 1977. A grammar of clitics: Evidence from Pashto and other languages. Doctoral Dissertation, University of Illinois at Urbana-Champaign.

Thomas, Jacqueline M.C., Serge Bahuchet, Alain Epelboin, and Susanne Fürniss, ed. 1983–2008. *Encyclopédie des Pygmées aka.* Société d'Études Linguistiques et Anthropologiques de France (SELAF). Peeters. Multivolume work with 13 volumes published to date.

Thompson, Laurence C., and M. Terry Thompson. 1969. Metathesis as a grammatical device. *International Journal of American Linguistics* 35:213–219.

Urbanczyk, Suzanne. 1996. Patterns of Reduplication in Lushootseed. Doctoral Dissertation, University of Massachusetts, Amherst.

Van den Berg, Helma. 1999. Gender and person agreement in Akusha Dargi. *Folia Linguistica* 33:153–168.

Weeda, Donald S. 1992. Word Truncation in Prosodic Morphology. Doctoral Dissertation, University of Texas, Austin.

Wetzels, W. Leo, and Joan Mascaró. 2001. The typology of voicing and devoicing. *Language* 77:207–244.

Wiesemann, Ursula. 1972. *Die phonologische und grammatische Strukture der Kaingang-Sprache.* Mouton.

Wiklund, Anna-Lena, Gunnar Hrafn Hrafnbjargarson, Kristine Bentzen, and Thorbjörg Hróarsdóttir. 2007. Rethinking Scandinavian verb movement. *Journal of Comparative Germanic Linguistics* 10:203–233.

Williams, Edwin. 2003. *Representation theory.* Cambridge, Ma.: MIT Press.

Winfield, W. W. 1928. *A Grammar of the Kui Language.* Calcutta: The Asiatic Society of Bengal.

Wolf, Matthew. 2005. For an autosegmental theory of mutation. Rutgers Optimality Archive #754. Available at `http://roa.rutgers.edu`.

Wolf, Matthew. 2007. For an autosegmental theory of mutation. In *University of Massachusetts Occasional Papers in Linguistics 32: Papers in Optimality Theory III*, ed. Leah Bateman, Michael O'Keefe, Ehren Reilly, and Adam Werle, 315–404. Amherst, MA: GLSA.

Yeh, Shih-chi. 2008. Suffixal reduplication in Paiwan. In *Chicago Linguistic Society (CLS) 44. Vol. I. The Main Session*, 225–238.

Yip, Moira. 1982. Reduplication and CV skeleta in Chinese secret languages. *Linguistic Inquiry* 13:637–662.

Yu, Alan C. L. 2000. Stress assignment in Tohono O'odham. *Phonology* 17:117–135.

Yu, Alan C. L. 2004. The Morphology and Phonology of Infixation. Doctoral Dissertation, University of California, Berkeley.

Yu, Alan C. L. 2005. Quantity, stress, and reduplication in Washo. *Phonology* 22:437–475.

Yu, Alan C. L. 2007. *A natural history of infixation*. Oxford: Oxford University Press.

Zepeda, Ofelia. 1983. *A Papago Grammar*. Tucson, AZ: University of Arizona Press.

Zimmermann, Eva. 2009. Metathesis without reordering. Master's thesis, University of Leipzig.

Zoll, Cheryl. 1997. Conflicting directionality. *Phonology* 14:263–286.

Zoll, Cheryl. 1998. *Parsing below the level of the segment in a constraint-based framework*. Stanford, CA: CSLI.

Zwicky, Arnold. 1987. French prepositions: No peeking. *Phonology* 4:211–227.

Zwicky, Arnold. 1991. Some choices in the theory of morphology. In *Formal Grammar: Theory and Implementation*, ed. Robert Levine, 327–371. Vancouver: University of British Columbia.

Zwicky, Arnold M., and Geoffrey K. Pullum. 1986. The Principle of Phonology-Free Syntax: Introductory remarks. *OSU Working Papers* 32:63–91.