

# Exponence, phonology and non-concatenative morphology\*

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## 1 Introduction

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.

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.<sup>1</sup> Morphology, we argue, may be reduced entirely to the function

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<sup>1</sup>Over the years these two opposing theoretical styles, both of which precursors in the ancient and mediaeval grammarians [Aronoff \(1994\)](#), 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](#)

that spells out the syntactic tree by choosing and inserting phonologically contentful lexical items. Assuming late insertion, we make use of five devices, all of which have been argued for elsewhere in different ways: contextual allomorphy, autosegmental affixation, the affixation of prosodic units, complex exponents made up of more than one piece of phonological material, and lexically specified positional attributes for exponents. Non-concatenative effects arise from (i) the way the phonology deals with affixes that are deficient segmentally (they consist solely of features or abstract prosody) or featurally (they are composed of underspecified root nodes), and (ii) the way the phonology handles affixes that are lexically specified as requiring a position in structure that does not fall out from universal linearization principles. We propose that these devices taken together are sufficient for describing all of the metathesis, subtraction, ablaut, infixation, templatic effects and so on which are found in the morphologies of the world’s languages.

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). We also diverge from mainstream accounts of morphophonology in systematically banishing syntactic features from our phonological constraints. Nor do we resort to adding morphosyntactic diacritic features to the phonology, since such diacritics are simply proxies for non-phonological information. We further develop a more articulated notion of a position attribute than is usually encountered, in order to allow infixation and the placement of special clitics.

In analyses couched within the framework of Optimality Theory (Prince and Smolensky 2004 [1993]; McCarthy and Prince 1993), place in structure is typically dealt with using parochial ALIGNMENT constraints with jurisdiction over specific morphemes. To illustrate the idea, the actor trigger infix in Tagalog would be listed in the lexicon with the shape {-um-}, but its placement relative to the underlying stem might be described using an affix-specific constraint. Yu (2004) argues that {-um-} is subject to a requirement that it attach to the first *vowel* of the base, e.g. LEFTALIGN(*um*,  $V_1$ ). The use of language-specific constraints disguises what we believe is the correct approach, that place in structure, at least in certain cases, should be seen as part of the exponence of particular morphosyntactic features. As such, place in structure is either derived syntactically or specified in the lexical entry of the relevant affix — it is not the result of phonological constraint interaction. On this approach, the lexical entry for the Tagalog actor trigger affix might look something like in (1). Here, we adopt the familiar format  $/x/ \Leftrightarrow \langle y \rangle$  to mean ‘x lexicalizes y’, where x is phonological material and  $\langle y \rangle$  is a syntactic feature structure. We strictly separate phonological from syntactic information in the entries and in the derivation. Where a shape is associated with a lexically specified place, we separate the two with a colon (:). Where the shape has more than one part, we separate them using a semi-colon (;). In this case, the shape is aligned with respect to the left stem boundary ( $\{$ ). The right hand side is an (ordered) set of morphosyntactic features.

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1972; Aronoff 1976; Anderson 1982, 1984, 1986; Martin 1988; Zwicky 1991; Beard 1995), 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’. 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, 2001a) and Realizational Morphology Theory (Kurusu 2001).

- (1) *Tagalog actor voice*  
 /um/ : {\_\_V  $\Leftrightarrow$  <actor.topic>

This entry means that /um/, linearized before the first vowel after the left edge of its host, lexicalizes the syntactic feature ‘actor.topic’ (plausibly a kind of voice head, see e.g. Guilfoyle et al. 1992).

The structure of this chapter is as follows. Section 3 sets out the theory of exponence. Sections 4–10 lay out our approach to the various major types of apparently non-concatenative morphology, applying the model laid out in 3. Section 11 presents a single case study for templatic effects, from Sierra Miwok. Section 12 presents our main conclusions and proposes directions for future research.

## 2 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. We may define the concatenative ideal under six headings. These are not to be interpreted as constraints in the grammar.

- (2) *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 (2-a) and (2-b) concern relations of linear precedence between segments of different morphemes. Points (2-a) through (2-d) have in common that they involve various kinds of destructive alterations of underlying information (precedence relations or segments).

Surface violations of these principles may 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. The outcome of such processes should not be confused with the kinds of non-concatenative effects whose origin is morphological, however. The kind of violation we have in mind here are intrinsic to the way certain structures are spelt out. Violations of the concatenative ideal accordingly fall into six categories in (3).

- (3) *Non-concatenative phenomena*
- a. Autosegmental affixation  
/blurk+[spread glottis]/  $\rightarrow$  [p<sup>h</sup>lurk]

Edge association determined by syntax, else lexical specification of affix position. 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. Overwrite

/blurk+a/ → [bl-a-rk]

Combines properties of both autosegmental affixation and infixation with overwrite of root material. Overwriting by affixal material derives from syntactic structure and cyclic nature of insertion.

e. Template satisfaction, copying

/blurk+σ<sub>μ</sub>σ<sub>μμ</sub>/ → [bəlurk]

Affix is segmentally un(der)specified prosodic node. Material supplied through epenthesis or copying in phonological component.

f. Haplology

/blurk<sub>i</sub>+urk<sub>j</sub>/ → [bl{urk}<sub>ij</sub>]

Copying is found in reduplication, and is dealt with in detail in Inkelas (this volume), so we will not address it here.

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. Blending is illustrated in Spanish (Piñeros 2004), e.g. /xéta+fôtoğrafía/ ‘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. /batsugun-no fumen/ ‘fantastic score’ → *gunbatsu-no menfu*. 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. *połica* ‘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.

### 3 The model

In this section we lay out the model which we are proposing. We draw heavily on previous work here, in particular 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, 2007); Marvin (2002); Newell (2008), and also on ongoing research being conducted CASTL group in Tromsø under the rubric of Nanosyntax, including Starke (2009a); Caha (2009b); Svenonius et al. (2009); Taraldsen (2010). Since DM is the most well-established similar model, we note at relevant points where our assumptions are similar and where they diverge.

As in phase-based DM, we assume that syntax builds tree structures from an inventory of syntactic atoms (categories), and that syntax designates certain domains (phase complements) as cyclic. Cyclic domains are processed by Spell-Out, which associates lexical entries (Vocabulary Items, or VIs) with the syntactic trees (late insertion) and linearizes them. The output of Spell-Out is a description of the underlying representation of the expression that serves as the input to Phonology, which produces the surface representation. (For arguments in favor of Late Insertion, see for example Anderson (1992); Halle and Marantz (1994); Borer (1998); Harley and Noyer (1999) or, in a rather different framework, Stump (2001).)

Thus, we are making the following assumptions about Spell-Out.

- (4) *Spell-Out*
  - a. *Cyclicity*  
Spell-Out applies at designated points of a syntactic structure, termed cyclic nodes, defining cyclic domains.
  - b. *Post-syntactic (Separation)*  
Spell-Out takes place after all syntactic operations in a given domain.
  - c. *Pre-phonological*  
Spell-Out feeds the phonological component

Because Spell-Out matches syntactic trees to phonological representations, it makes use of lexical entries which contain both types of information (like the one illustrated in (1) above). However, syntactic and phonological information do not interact freely (Zwicky and Pullum 1986; Pullum and Zwicky 1988). We therefore distinguish two separate components of the Spell-Out procedure, which we call Match and Insert.<sup>2</sup>

- (5) *Spell-Out has a syntactic side, Match, and a phonological side, Insert*
  - a. **Match** matches lexical entries to tree structures, making no reference to phonology
    - (i) Targets categories
    - (ii) Sees syntactic features, including both the projecting, semantically interpretable category features and the non-projecting, uninterpretable agreement features
    - (iii) Sees syntactic structure, including dominance relations among features, syntactic words (the output of head-movement), and phase boundaries
    - (iv) May not uniquely determine a specific allomorph for insertion: The output of Match may include alternatives
  - b. **Insert** selects exponents for realization, from the output of Match, making no reference to syntax
    - (i) Operates on exponents associated by Match
    - (ii) Sees phonological features, including segmental and autosegmental features
    - (iii) Sees class features in lexical entries (declension class, conjugation class, which have no syntactic content)

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<sup>2</sup>The term Match is also used for a part of the Agree operation since Chomsky (2000); we do not think that any confusion will arise from our different use of the term, but ours could be called L-Match for ‘lexical entry Match’, if necessary.

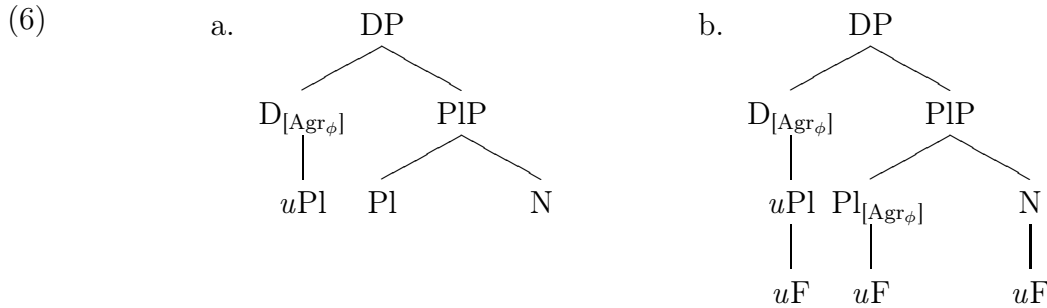
- (iv) Sees phonological structure, including both lower prosodic structure ( $\mu$ ,  $\sigma$ , F) and higher prosodic structure ( $\omega$ ,  $\phi$ , IP) which has been constructed in previous cycles.
- (v) See place attributes in lexical entries (for infixation and special clitics)
- (vi) The output of Insert may be phonologically underspecified and is the input to Phonology

We detail our assumptions about syntax in subsection 3.1; we discuss the phase and the cycle in 3.2, Match in 3.4, and Insert in 3.5.

### 3.1 Syntactic Structure

Syntactic representations are constructed by an operation Merge (Chomsky 1995) from syntactic categories which are interpretable in some way by semantics (e.g. T is connected to Tense interpretation; cf. Svenonius 2007; Adger and Svenonius to appear). In DM, certain semantically uninterpretable features (in particular agreement) can be added to a syntactic tree in the morphology (Marantz 1991); but since agreement is sensitive to syntactic domains (cf. e.g. Baker 2008) we believe it must be part of the syntactic representation. To capture the difference between semantically interpretable and uninterpretable features, we draw a distinction between projections, which have semantic content, and non-projecting features, which do not. Uninterpretable features do not project, but are related to other features in the tree by dominance relations.

The distribution of agreement features is determined by agreement probes (second-order properties in the sense of Adger and Svenonius to appear), associated with syntactic categories on a language-specific basis. Agreement probes are like EPP probes in that they form dependencies with features of a specified class, but where EPP probes create category dependencies, Agreement probes form feature dependencies. These features are part of what is lexicalized in the Spell-Out procedure, but because they do not project they are not constrained by the Extension Condition and so agreement can be upward or downward, unlike movement. We indicate agreement probes with a subscript [Agr $\phi$ ] and represent agreement features with a  $u$  for (semantically) ‘uninterpretable’ following Pesetsky and Torrego (2001).



Here, D, Pl, and N are interpretable categories merged into a tree structure, and F is an uninterpretable gender feature. In (6-a), D has the language-specific agreement property of copying Pl features in the same syntactic domain, allowing this language to distinguish singular from plural on the determiner (e.g. Finnish). In (6-b), the language also has gender (e.g. German), which for present purposes we take to be semantically uninterpretable,<sup>3</sup> and also has gender agreement on

<sup>3</sup>If a grammatical gender has some connection to semantics then our model predicts that the gender feature projects (as in Picallo 2008). This would have consequences for the system of the language in question, but what is



Pl; when D copies Pl it copies the dependent gender feature. The copied features do not contribute to the semantic interpretation, which is redundantly indicated here (for perspicuity) once by the failure to project (hence the vertical dominance line) and a second time by the diacritic *u*. The lexical insertion procedure may spell out the category together with the agreement features, or may spell each out separately, depending on what lexical resources are available.<sup>4</sup>

When exponents are associated with such nodes by Spell-Out, then they will have to be linearized, subject to at least three factors: universal principles of linearization, language-specific parametric settings, and morpheme-specific constraints. The most well-known proposals for universal principles of linearization are Kayne’s (1994) Linear Correspondence Axiom (LCA) and Brody’s (2000a; 2000b) Mirror Theory, which state what we can take to be principles of unmarked word and morpheme order: function words which are not affixal precede their complements, by the LCA, and affixes follow their hosts, by Mirror Theory. This reduces one basic point of word-order variation to another distinction, namely whether a morpheme is affixal or not, something which must be parameterized.

Language-wide parametrization is the second factor affecting linearization. If the morphological component is kept to a minimum, there are just two places in which to state such parametrization: in the syntax and in the phonology. Syntax affects morpheme order when elements move, as when finite verbs in a language move consistently to a functional projection, regardless of the morphological expression of finiteness on the surface form of the verb (Wiklund et al. 2007) or if a noun moves across D and Pl to a higher position in the DP (Aboh 2004). Similarly, syntax can effect head-final orders by moving a complement to the left of its selecting head (e.g. Zwart 1997; Holmberg 2000).

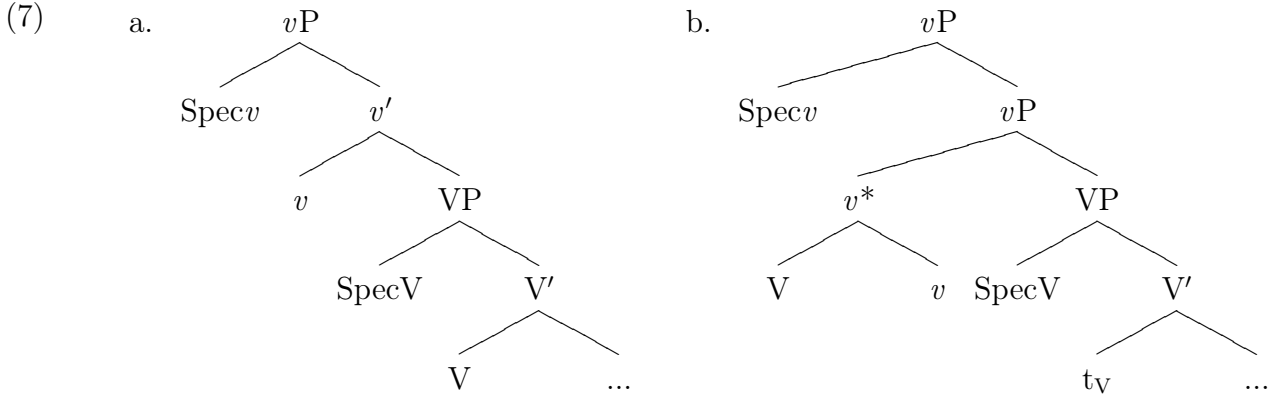
Importantly for the work at hand, most current work in syntax assumes something like head movement (e.g. Julien 2002): certain syntactic categories such as Finiteness or Plural are marked in certain languages as attracting heads from their complements. This attraction is independent of whether there is overt morphology to spell out the attracting head and we assume that it is a purely syntactic property, a marked option posited by a learner for a language when a given category (such as finite verbs) is observed to consistently appear in a moved position.

In the representations below, (7-a) would map according to standard assumptions onto a linear order  $\text{Spec}v < v < \text{Spec}V < V$ , e.g. a phrase with a subject followed by a light verb followed by a preverbal dependent followed by a main verbal predicate element. In the representation in (7-b), the head *v* is marked with a star to indicate that it triggers head-movement, and that single change leads to two differences: the surface order is  $\text{Spec}v < V < v < \text{Spec}V$ , and in addition a head-level constituent [<sub>v</sub>V-*v*] is created.

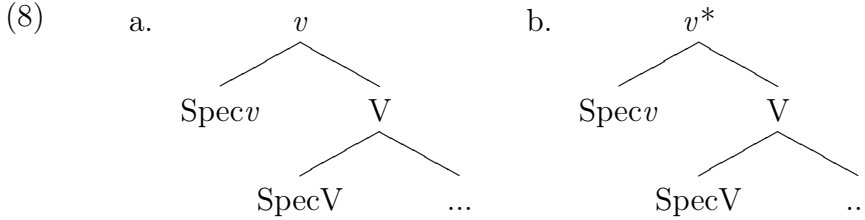
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relevant is simply that our model is set up to distinguish uninterpretable features from interpretable ones, in order to capture observed properties of agreement.

<sup>4</sup>To exemplify, in Spanish there is abundant evidence that *-s* is a plural marker, so a parse of the plural forms of the definite article *los* and *las* is potentially motivated, and the features D-F-Pl might be spelled out by three distinct morphemes {l-}, {-a}, and {-s}, as suggested by Harris (1995). In contrast, in the Austronesian language Hoava, there is no motivation for parsing *ria* ‘the (pl)’ compared with *sa* ‘the (sg)’ (based on the description in Davis 2003), so we assume that *ria* is a suppletive plural form, i.e. {ria} spells out <D,Pl>.



There are many alternatives to head movement, all of which assume some analogue of this basic parametric fact. One such alternative which we will make reference to later is Brody's (2000a; 2000b), in which the equivalent of head movement is to mark a functional head as the locus of Spell-Out for an extended projection. There are differences between Brody's model and the head-movement model, but for our purposes they can usually be treated as notational variants. The diagrams below are Brody-style conversions of (7). As before, the lack of a star in (8-a) means that V spells out in situ, to the right of SpecV, and the star in (8-b) indicates the spell-out position of the head-complex consisting of all the available heads in the extended projection (i.e.  $[_vV-v]$ ), immediately to the right of Specv, and to the left of SpecV.<sup>5</sup>



The Brodian representation is more parsimonious, in eliminating unnecessary repetitions of the category labels, but the head-movement representation provides easier visualization of the surface order  $V-v$ .

Another possible kind of language-wide parametrization of word order is phonological. There are parametric differences in the construction of prosodic structure, and some linearization effects are sensitive to prosody. We are unfortunately unable to treat this topic here; see for example Erteschik-Shir and Rochman (2010).

A final factor affecting linearization is the position attribute of certain lexical entries, which dictates a particular positioning for certain morphemes, e.g. following a certain kind of prosodic constituent. This attribute has been discussed at length in the literature in various forms, most often in the context of second position clitics (Halpern 1995) and infixes (Yu 2007). We treat this attribute in depth in section 8.

<sup>5</sup>Brody distinguishes the height of spell-out (indicated by a diacritic, as here) from morphological incorporation (indicated by the rightward slanting dependency lines), in effect allowing lowering; we do not discuss lowering in this paper so will stick to the assumption that if there is no head-movement diacritic, the heads spell out independently, hence with the higher  $v$  preceding the lower  $V$  as on Kayne's assumptions. See Adger et al. (2009) for a development of Mirror Theory in line with ours.



### 3.2 Cyclic Application of Spell-Out

Underspecification of lexical entries is motivated by suppletion patterns crosslinguistically (as discussed extensively in the DM literature).<sup>6</sup> Underspecification leads to a kind of competition among alternative lexicalizations, and hence requires a definition of the domain within which alternatives are considered. In DM, the domain is normally taken to be a ‘terminal node’ (Embick and Marantz 2008), after manipulations have been made by processes like Morphological Merger (Marantz 1984). Examples in which periphrastic combinations appear to compete with single words (e.g. the Latin passive perfect, Embick 2000; Kiparsky 2005) suggest that the domain for lexical selection is slightly bigger (Poser 1992). We believe that the domain for lexical selection, which we identify with the phase, is larger than the minimal syntactic units (terminal nodes), a point which is pursued in the Nanosyntactic literature (see references cited above). Important evidence for the size of the phase cycle comes from portmanteau morphs, Hockett’s (1947) term for morphemes which span more than one syntactic category which elsewhere are spelled out independently (discussed in subsection 3.3).

We thus follow Marantz (2007); Marvin (2002); Newell (2008) in assuming that certain phonological boundaries in complex words are due to cyclic application of Spell-Out; for example, certain differences between *timidity* and *timidness* are captured by assuming that *-ity* attaches inside the first phase cycle, while *-ness* attaches in the second phase cycle (Kiparsky 1982). Attachment inside the first cycle correlates with certain patterns of stress assignment, certain kinds of morphological irregularity, and certain kinds of semantic idiosyncrasy.

Chomsky (2004, 2008) focuses on the ‘strong’ or verbal phases transitive *v*P and finite CP, which bear certain distinctive classes of features. We use the term here also for non-verbal phases, including maximal extended projections, analogous to CP (KP, DegP, etc., cf. Grimshaw 2005), and also certain quasi-lexical maximal projections analogous to *v*P — roughly *n*P, *a*P, etc. (cf. Marantz 2007), but containing some functional material (cf. Svenonius 2004).

All of these phases are cycles in our sense. In general, only phases can merge as specifiers, which has the result that specifiers in a given domain will spell out independently, in general (the exceptions being clitic elements, see section 8). Thus the domain of Spell-Out (and most importantly, of its subcomponent Match) is normally a segment of an extended projection, or ‘span’.

Crosslinguistic patterns support the positing of a cyclic domain boundary between D and Pl; interactions between functional P and D are relatively common (Himmelman 1998), such as the fused P-D of languages like German, and suppletive plurals are very common. Examples which appear to represent fused D and Pl can also be found, however (like the Hoave case mentioned earlier); we assume that these involve movement and agreement. The existence of movement and agreement make the predictions of the model more difficult to test, but we believe that the predictions are still testable in a useful range of cases.

Thus, suppose that a typical argument DP consists of two phases, one including a case projection K above D, and one containing a lexical noun root and some functional material above it, for example a plural head: [K–D–[Pl–N]]. Languages might have no movement of N, movement of N to Pl\*, movement of N through Pl to D\*, or movement of N all the way to K\*. The first instance would give a prenominal plural marker or classifier, as in Hawaiian, illustrated in (9-a). Movement of N to Pl\* would give a suffixal plural, as in English, as illustrated in (9-b). Movement of N all the way to D\* would give a suffixal determiner, which is possibly the right analysis for a language

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<sup>6</sup>Just to illustrate: French *le* and *la* show that definite articles distinguish gender, but plural *les* does not; given certain assumptions, this suggests that *les* is underspecified for gender.

like Danish, illustrated in (9-c), and movement to K might be right for Icelandic, illustrated in (9-d).

- (9)
- a. kēia mau wāhine  
this PL woman  
'these women' (Hawaiian, [Elbert and Pukui 1979](#): 163)
  - b. the dog-s  
the dog-PL  
'the dogs' (English)
  - c. dreng-e-ne  
boy-PL-DEF  
'the boys' (Danish)
  - d. strákar-ar-n-ir  
boy-PL-DEF-NOM  
'the boys' (Icelandic)

The model makes the following claims about these examples. In Hawaiian, the first phase contains [Pl N], which spell out in a first cycle. A phonological unit is created, [ $\phi$  mau wāhine], which is part of the input to later cycles (partly language-specific considerations will determine whether it is a single phonological word or a larger prosodic unit). A later cycle includes [K D  $\phi$ ] ( $\phi$  being the prosodic phrase spelled out in the previous cycle), which spells out to create a larger phonological unit. English is similar except that the first cycle contains [N-Pl], i.e. syntactic movement has created a complex head. This has several consequences. First, Pl will linearize to the right of N. Second, the constituent is recognized by the Match procedure as a domain, and so may be associated with a portmanteau morph, if one is found in the lexicon (e.g. *geese*). Third, the constituent is recognized by the Insertion procedure (section 3.5) as a constituent and so will form a phonological word, [ $_{\omega}$  dʒgz]. The rest of the derivation is the same as for Hawaiian. German is like English in the lower phase, but in the higher phase appears to exhibit D to K, since determiners are case-marked.

In the Danish and Icelandic cases, N movement crosses the phase boundary. This means that when the lower phase is spelled out, it is empty (since these noun phrases do not contain specifiers or complements in the lower phase). In the higher phase, there is a head cluster N-Pl-D in Danish and N-Pl-D-K in Icelandic. However, word-internal phase boundaries have been shown to correspond to phonological boundaries ([Marvin 2002](#); [Newell 2008](#)), so they must be recognized by the Spell-Out procedure. This means that two passes are made in the second phase, one to lexicalize the raised inner phase head complex [N-Pl], and another to lexicalize the larger constituent. This has three consequences. One is that the N-Pl complex can be an irregular portmanteau form (e.g. *mús*~*mýs*, 'mouse-mice'), but no portmanteau can cross the phase boundary, so there are no irregular definite forms. Another is that the boundary should in principle be detectable phonologically; for example, in Icelandic, umlaut operates within domains but does not cross the phase boundary (e.g. *hjarta* 'heart' *hjörta* 'hearts', where the /u/ in the plural suffix causes umlaut in the stem, but in *hjártanu* 'the heart (dative)' the /u/ in the case suffix does not cause umlaut in the stem). The movement of the N-Pl complex into the higher domain also means that the syntactic domain is extended. For example, a plural suffix with an agreement probe for case features can agree in case in a language like Icelandic, and in fact it does (compare nominative *strákar* 'boys' to accusative *stráka*).

We treat the extended projection of the verb exactly analogously. A language can (i) lack V movement (highly isolating languages, perhaps Vietnamese), (ii) have V-movement within the

first phase, with *v*P-internal features such as transitivity showing up as suffixes but with preverbal tense and outer aspect markers (as in Boumaa Fijian, [Dixon 1988](#)), (iii) have V-movement to a low position in the second phase, giving rise to outer aspectual suffixes but with preverbal tense and modality (as in Gikuyu, [Mugane 1997](#)), or (iv) have V-movement to a high position in the second phase (languages with suffixal TAM, such as Northern Sámi). Finally, the verb can remain in the lower phase while an auxiliary moves to the TAM heads. In the analyses sketched in this paper, we take most of the TAM markers identified by [Cinque \(1999, 2004\)](#) to be outside the first phase, but certain aspectual elements in Sierra Miwok are inside it (section 11), and probably the causative and reversative in Kĩtharaka (subsection 3.3).

Within each cycle, we distinguish strictly between syntactic operations and phonological effects. Lexical insertion can be sensitive to the phonological content of earlier phase cycles, for example the indefinite article in English has two allomorphs, *a* and *an*, depending on whether the following material is vowel-initial or not. This shows that the inner structure in the DP must be spelled out by the time the allomorphic selection for the indefinite article takes place; the existence of such examples suggests that Spell-Out applies to the lowest part of a structure first.<sup>7</sup>

### 3.3 Portmanteaux

The assumption that a single lexical entry may lexicalize more than one syntactic head is the central tenet of Nanosyntax but also figures in different ways in much previous work, for example [Williams \(2003\)](#); [Borer \(2005a,b\)](#); [Ramchand \(2008\)](#) — in Williams’ terms, a single lexical entry can ‘span’ more than one syntactic node, if it has the appropriate featural specification. This means that a suppletive plural noun like *mice* can be assumed to spell out both N and Pl.<sup>8</sup> We also assume that the results of Spell-Out (most importantly its subcomponent Insert) cannot be freely undone (following DM in this case; see [Marvin 2002](#); [Newell 2008](#) on the importance of phonological information from earlier phase cycles). This means that the nonplural form *mouse* must not lexicalize N when N is dominated by Pl; if it did, then *mice* could not be inserted.<sup>9</sup> Thus, N cannot be a cyclic node, and the cycle for Spell-Out must be at least as large as Pl. This means that suppletive morphology and portmanteau morphs in general provide important evidence about cyclic nodes (see [Chung 2009](#) for evidence from Korean).

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<sup>7</sup>See [Bobaljik \(2000\)](#) and [Adger et al. \(2003\)](#) for arguments that phonologically sensitive allomorphy cannot see ‘upwards’. There are cases such as the enclitic Welsh definite article ([Hannahs and Tallerman 2006](#)) which appear to require a limited degree of sensitivity to the phonology of structurally higher material. Hannahs and Tallerman suggest that allomorphs can remain partly underspecified until a relatively late stage in the derivation. Alternatively, the Welsh definite article leaves the DP by syntactic movement and is spelled out in a higher domain.

<sup>8</sup>See [Siddiqi \(2009\)](#), who also works out an account in which suppletive stems can be inserted, and with whom we share several concerns and assumptions. Unlike Siddiqi, we do not assume that Fusion is necessary for insertion to apply. This avoids problems which arise on Siddiqi’s account, which lead him to rely on systematic insertion of negative feature specifications. To detail these issues would take us too far afield here, but very briefly, the issue is this: Suppletive morphology may affect some roots (*broke*) and not others (*smashed*). Since Siddiqi assumes that insertion is restricted to terminals, he requires Fusion to apply just in case there is a suppletive stem to be inserted. This requires a kind of look-ahead, where a morphological operation is sensitive to the material which is associated only after (late) insertion. Siddiqi fixes this by stipulating that regular stems are marked with a diacritic that prevents them from undergoing Fusion, but there is no independent motivation for the diacritic or for its distribution. Adopting the Nanosyntactic assumption that lexical insertion targets spans rather than terminals, we obviate Fusion and let the competition between portmanteaux like *broke* and regular multimorphemic constructions be resolved by the mechanism of Insert.

<sup>9</sup>Since umlaut is not a regular process in English, we do not consider the possibility that /maɪs/ is derived from /maʊs/. See section 8 for our treatment of regular ablaut.

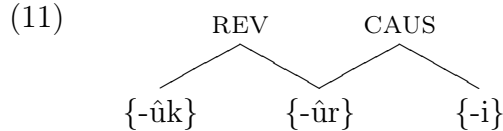
The model predicts that the domain boundaries for phonological processes which are derived from the phase cycle will be respected by portmanteau morphology; for example, if in a syntactic hierarchical structure K–D–Pl–N, the cyclic nodes are K and Pl ([K–D–[Pl–N]]), then we predict that there can be suppletive plural-noun combinations, and suppletive K–D combinations, but no suppletive K–Pl combinations. This seems to be borne out.<sup>10</sup>

Hockett (1947) gives as an example of a portmanteau morph a combined causative-iterative in Yawelmani. Similarly, Muriungi (2009) discusses a portmanteau morph in Kĩtharaka: there is a reversative *-ûk* and a causative *-i* but a causative reversative is spelled out with a single morpheme, *-ûr*.

- (10)
- 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)

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.

We can represent such portmanteaux as branching lexical entries.

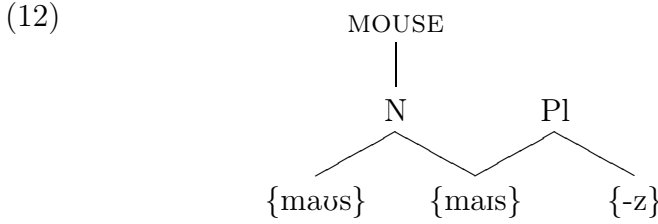


The branching entry graphically captures the fact that the causative and reversative features here are the same features in both cases; if the lexical entries were not linked, there would be no guarantee, for example, that *ûk* and *ûr* both denoted the same kinds of reversal. In the next subsection, we explain how we ensure that the portmanteau is chosen for insertion when both features are present.

To take another example, we can assume interlinked lexical entries for suppletive plurals like *mice*.

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<sup>10</sup>In the phase-based approach to cyclicity, drawing on Chomsky (2001) inter alia, cyclic nodes are determined by higher phase heads; so for example if what spells out is Pl, it is because something above it, say D, is a phase head. If Pl is absent, then the next head down, say N, spells out as the complement of D. See Newell (2008) for discussion of a possible difference in this regard between strong phases and other phases.



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 not listed twice in the lexicon (the computer mouse must have a separate lexical entry for those who do not use the suppletive plural there). With this in mind, the two parts of the entry in (12) can alternatively be represented as in (13).

- (13) *Suppletive plural*
- $$\begin{aligned} \{\text{maʊs}\} &\Leftrightarrow \langle N_{\text{MOUSE}} \rangle \\ \{\text{maɪs}\} &\Leftrightarrow \langle \text{Pl}, N_{\text{MOUSE}} \rangle \end{aligned}$$

Because the concept is doubly-linked, there is competition, unlike the case of paraphrase.<sup>11</sup> Here, again, Minimize Exponence will force the insertion of the plural form whenever the Plural node is present in the syntax. There is no need for a zero plural suffix in this word, in contrast to DM.

### 3.4 Selection of Lexical Entries

At the beginning of this section we outlined the properties of the syntactic side of Spell-Out, Match. Match is much like the Vocabulary Insertion procedure of DM. It targets categories, which are like the terminal nodes of DM. This means that uninterpretable features, which are distinguished from categories in that they do not project, can be treated differently by Match. This means that Match treats a Pl feature differently when it expresses semantically interpretable plural and when it expresses plural agreement on some projecting feature. This is controversial, but there are reasons to think it is correct; for instance, the distribution of interpretable features is constrained by semantic compositionality, so for example definiteness is expressed outside plural, but agreement allows features to cross other features. In Icelandic, a definite plural noun like *strákana* ‘the boys (acc)’ uses  $\{-a\}$  to mark accusative, masculine, and plural in two places, before and after the definite suffix  $\{-n\}$ , but is interpreted as a definite plural referent (not, for example, a plurality of definites or a plurality of definite plurals). Number must be copied upward onto the case head K at the top of the extended noun phrase, and case must be copied downward onto the Plural head below D, and gender must be copied onto both K and Pl.

When the Icelandic noun structure is spelled out, Match finds lexical entries with the appropriate features and associates a subset of them to the phase cycle. We will call this subset the Association. Underspecification is necessary to capture the many syncretisms in Icelandic morphology (see Müller 2005 for an analysis). Therefore there will be multiple ways of associating lexical items to the tree. Match resolves most of these in the way familiar from DM; the ‘best fit’ wins out, ideally with each feature in the tree being matched to a feature in the Association. The DM literature (see citations elsewhere in this article) includes much relevant discussion of

<sup>11</sup>E.g. *pink* does not block the paraphrase *pale red* (to use an example discussed by Poser) because the lexical entries of the different words are not interlinked. Part of learning suppletive morphology is learning that a lexical entry is complex in the way illustrated in (12).

how to identify which lexical entries are specified with what features, and how the best fit should be determined, for example whether there are feature hierarchies and so on. We will not develop that aspect of the account here, as we concentrate in this article on the kinds of morphophonological interactions that DM treats with a powerful set of ‘Readjustment rules’. However, there are some differences between our Match and the Vocabulary Insertion of DM, caused by the different concept we have of the domain of lexical insertion.

In DM, a set of candidates for Vocabulary Insertion are compared for insertion in one terminal node. Here, a set of candidates are compared for association with a span, that is one phase-sized subpart of an extended projection (recall that specifiers, being extended projections of their own, normally spell out in separate phases). Therefore, the operation is slightly more complex, and in particular portmanteaux may compete for association with sequences of morphemes. We discuss some additional facts about portmanteaux in subsection 3.5, where we argue that they should be treated by Insert, the phonological side of Spell-Out. This and other indications suggest that the Association which is the output of Match is not necessarily the final string of exponents, but may include some indeterminacies.

The indeterminacies must be such that they can be resolved on strictly phonological grounds (perhaps also with reference to non-syntactic class features). Thus, Match is responsible for whatever comparison of syntactic features is made. These considerations are summarized in (14).

(14) *Match*

- a. *Associate lexical items*  
For each category in a phase cycle, associate lexical items with matching features
- b. *Minimize unmatched Features*  
The associated lexicalization (the Association) leaves the smallest possible number of unmatched features for each category
- c. *Preserve equally good options*  
In case of a tie (i.e. same number of unmatched features), multiple competing lexicalizations are kept (to be compared by Insert)

The principle *Minimize unmatched Features* is probably assimilable to the *Elsewhere Principle* widely recognized in various contexts since Kiparsky (1973). We deliberately state it abstractly so as to remain neutral between the Subset formulation of Vocabulary Insertion in DM (Halle 1997) and the Superset formulation in Nanosyntax (Caha 2009b and various papers in Svenonius et al. 2009). The difference lies in whether syncretisms are modeled in terms of underspecification of lexical entries or overspecification. To illustrate, consider the French definite article. The plural *les* {le(z)} syncretizes masculine and feminine. Assuming the Subset principle, this is because {le(z)} is underspecified for gender, lacking the F[eminine] feature but still being a better fit for a D,Pl node with a *uF* feminine agreement feature than any alternative. Thus there is always an unmatched feature *uF* in a definite feminine structure. Assuming the Superset principle, the syncretism of {le(z)} suggests rather that the lexical entry is overspecified with a feminine gender feature, but again after lexicalization of a definite feminine structure there is an unmatched feature, this time on the lexical entry rather than in the syntactic tree. Both formalisms capture syncretisms in the same way and so have the same reliance on the Elsewhere Principle to favor better matches when possible, and the phenomena discussed in this paper do not seem to us to favor one version over the other.<sup>12</sup>

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<sup>12</sup>The difference is related to the domain for lexical insertion. In DM, each terminal node is the target of insertion, and only one lexical entry is inserted in each terminal node. The Subset Principle allows features in the



### 3.5 Insertion of Exponents

Once the lexical entries have been associated with the phase cycle, then phonological content can be accessed. The Phonology component subsequently operates on this preliminary output to determine a phonologically well-formed output, with no further reference to the syntax. For concreteness, we will assume that the phonological component is a language-specific ordering of universal constraints as in Optimality Theory (OT; Prince and Smolensky 2004 [1993]; McCarthy and Prince 1993).

In some cases, the surface pronunciation of a morphological exponent varies according to purely phonological considerations; the forms of the English plural, /s/~/z/~/ɪz/, can be derived from a single lexical entry {-z}, given independently motivated assumptions about English phonology.

There are, however, cases of allomorphic variation which are not predictable on the basis of independently motivated phonology. We have already dealt (in subsection 3.2) with cases where two distinct lexical entries have overlapping syntactic specifications, for example *mice* and {-z} are both specified as plural, and *mice* has additional specifications which constrain its insertion. As we suggested in the previous subsection, selection of the correct allomorph in those cases is determined purely on the basis of non-phonological information.

Another situation, however, is one in which the syntactic contexts for two allomorphs are identical, and only nonsyntactic properties distinguish them. We model such cases in terms of disjunctive exponents in a single lexical entry.

For example, the English indefinite article alternates between /ə/ and /ən/, depending on whether the following segment is a vowel or not. This is not determined on the basis of syntax, and so is not part of Match. Instead, a single lexical entry provides a disjunctive realization, as illustrated in (15).

- (15) *English indefinite article*
- a. {ən} /\_\_V ⇔ <INDEF>
  - b. {ə} ⇔ <INDEF>

Such disjunctive entries are identical on the right-hand side, meaning that Match cannot distinguish them; the choice can only be made once the phonological content is treated, by the process we call Insert. The Elsewhere principle favors the more restricted entry whenever possible.

The articles in English and French spell out in a separate phase cycle from the nominal phrase they precede, and so occur before a word boundary. However, the same principles of allomorphy selection can be observed within words, with allomorphy being sensitive to the phonological structure of its base in the lower phase cycle. 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.

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node to remain unexpressed. In the current Nanosyntactic literature, there is no restriction on the size of the target of insertion, and so the Subset Principle together with Minimize Exponence would lead to the result that every sentence would be at most one morpheme. To avoid this empirically false result, the principle which Fábregas (2007) calls Exhaustive Lexicalization is adopted, which states that every feature in the tree must be lexicalized. This in turn makes it necessary to reformulate the Subset Principle in order to capture syncretism. Overspecification is then used, and the features that are permitted to remain unmatched are the ones in the lexical entries, rather than the ones in the tree. Since we are assuming a domain for lexical insertion, our account is compatible so far with either formulation. We might for example assume that Exhaustive Lexicalization holds of projecting categories only, i.e. uninterpretable features may remain unexpressed, predicting that syncretism patterns should be different for uninterpretable features than for interpretable ones.

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 (16), 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.

- (16) *Axeninca Campa genitive*
- a.  $\{-ni\} \mid [\mu\mu] \_\_ \Leftrightarrow \langle \text{genitive} \rangle$
  - b.  $\{-ti\} \quad \quad \quad \Leftrightarrow \langle \text{genitive} \rangle$

Much of the time the choice of phonologically conditioned suppletive allomorph appears phonologically sensible, and it is tempting to leave the choice up to the phonological grammar, dispensing with the need to specify the phonological condition in the lexical representation of the marked allomorph. This has generally been the approach taken by practitioners of Optimality Theory, e.g. Tranel (1996, 1998) and Mascaró (1996). In Hungarian, for example, the second person singular present of the indefinite verb is marked by  $\{-s\}$ , e.g. *mondasz* [mondɒs] ‘you say’, except where the stem ends in a sibilant  $/s \int z/$ , in which case an alternative allomorph  $\{-El\}$  is selected, e.g. *vonzol* [vonzol] ‘you attract’ (the back round quality reflects the operation of Vowel Harmony). This choice of allomorph may be determined by the OCP (e.g. Leben 1973; Goldsmith 1976; McCarthy 1988).

In other cases, however, suppletive allomorph selection must be part of the function of Insert, before the phonological component applies to its output. Phonological processes may, for example, render the selection opaque. In Turkish, the genitive has two suppletive allomorphs,  $\{-sI\}$  after a stem ending in a vowel, and  $\{-I\}$  after a stem ending in a consonant. (The  $/I/$  is a high vowel underspecified for the features [back] and [round], which are determined by the root.) Thus we have *oda-su* ‘his room’, but *t/ān-u* ‘his bell’. Stems ending in a  $/k/$  also select the  $\{-I\}$  allomorph, but opaquely since there is a rule deleting  $/k/$  intervocally:  $/ajak+u/ \rightarrow aja.u$  ‘his foot’. See also Lubowicz (2006), Bye (2007), and Nevins (2011) for additional cases and further discussion.

Balancing these considerations, we will assume that suppletive allomorph insertion precedes phonological operations. Choosing the correct allomorph clearly can depend on insertions made lower down the tree on earlier phase cycles. Another question has to do with the point at which phonology applies to the strings of underlying forms that now inhabit the terminal nodes of the tree. If several morphemes are added in one phase cycle, does phonology take place every time a morpheme is added, or only once the cycle of insertion is complete, for that phase?

The answer to this question requires a careful comparison of the phonological conditions on allomorphy selection and placement with the syntactically motivated phase boundaries involved. For example, the Axeninca Campa and Turkish examples show that a possessive marker or a genitive suffix can be sensitive to the phonology of its host (both prosodic and segmental), but (alienable) possession and case are both likely to represent functors in the outer phase of the noun phrase (the ‘D-domain’ as opposed to the ‘N-domain’), so these examples are consistent with the stronger assumption that phonology is computed once per phase, not once per morpheme.

Another kind of relevant example is the host of infixation. For example, in Ulwa, the base of possessive suffixation is the leftmost iambic foot in the word (Hale and Lacayo Blanco 1989, McCarthy and Prince 1993), as illustrated in (17). Thus, foot structure must be constructed before the possessive morphology can be linearized.

- (17) *Ulwa possessive*
- |       |          |        |
|-------|----------|--------|
| (bas) | (bas)-ka | ‘hair’ |
|-------|----------|--------|

(kiː)	(kiː)-ka	‘stone’
(suː)lu	(suː)-ka-lu	‘dog’
(as)na	(as)-ka-na	‘clothes’
(sana)	(sana)-ka	‘deer’
(amak)	(amak)-ka	‘bee’
(sapaː)	(sapaː)-ka	‘forehead’
(siwa)(nak)	(siwa)(-ka-nak)	‘root’
(kulu)(luk)	(kulu)(-ka-luk)	‘woodpecker’
(anaː)(laː)ka	(anaː)(-ka-laː)ka	‘chin’
(arak)(bus)	(arak)(-ka-bus)	‘gun’
(karas)(mak)	(karas)(-ka-mak)	‘knee’

The possessive marker must be contiguous with whatever segment is last in the head foot (Ft’), which we specify using a position attribute in the left-hand side of the lexical entry (discussed more fully in section 8).

- (18) *Ulwa possessive*  
 /ka/: )<sub>Ft’</sub>\_\_\_ ⇔ <poss>

For McCarthy and Prince (2001 [1993]), phonology and morphology must crucially proceed in parallel. The following tableau is from McCarthy and Prince (2001 [1993]: 114).

(19)

Candidates	AFX-TO-FT	RIGHTMOST
a. [(siwa)nak]-ka	*!	
b. ➞ [(siwa)]-ka-nak		nak

Facts like those of the Ulwa possessive give us important insight into the mechanism of Insertion. On the one hand, parallelism of Spell-Out and phonological parsing is clearly not desirable given the facts of opaque allomorphy, discussed above in relation to Turkish. On the other hand, certain affixes must have access to information about how the base is phonologically parsed, not just its underlying shape. One way of dealing with this kind of phonological sensitivity in Insertion is to assume that morphemes are inserted one at a time and that the spelt out portion of the tree is phonologically parsed at every step so as to be continuously updated. In the case of the Ulwa construct, the stem is inserted first and then phonologically parsed, which returns a fully prosodified form: /siwanak/ → (siwa)nak. When the construct affix is inserted on the next pass, it has full access to the phonological structure of the stem. However, if the possessive head is outside the first phase in the noun phrase, then the prosodic structure could have been built on the first cycle, and we would not need iterative parsing.

To summarize the situation so far, the syntactic part of Spell-Out, Match, had to see the whole phase cycle in order to allow portmanteau which take up spans that are not syntactic words. It is less clear that the phonological part of Spell-Out, Insert, has the same wide perspective. We have seen that allomorph selection can be sensitive to phonological properties of other material but in the examples discussed so far, the phonological material was plausibly the output of an earlier cycle. The question is partly about domains and partly about directionality of sensitivity. For concreteness, we suggest that the procedure of Insert starts from the bottom of the phase cycle and resolves indeterminacies, which are of two types. One, the choice between phonologically sensitive

allomorphs is resolved, in the obvious way, and two, portmanteau are chosen over sequences of morphemes where this is not prevented by the first consideration.

Recall that the syntax is responsible for most morpheme linearization, in that words (the output of head movement) are right-headed, but non-words are left-headed. Linear order being a phonological phenomenon, we have assumed that this is determined only at the point of Insert, but this means that the distinction between (syntactic) word and non-word is visible to the Insert procedure.

Recall also that we posit place attributes for certain marked morphemes which cause them to linearize according to phonological domains, deviating from the default linearization offered by syntax.

Finally, the linearized sequence of phonological material is converted by phonology into a single phonological representation. Thus, Insert has the aspects listed in (20).

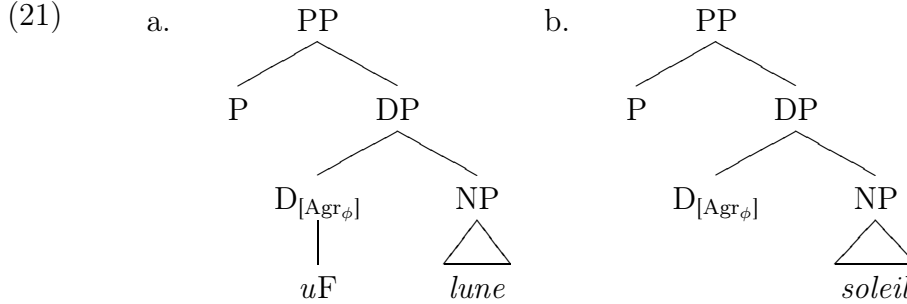
- (20) *Insert: Realize, Linearize, and Phonologize*
- a. *Bottom-up*  
Insertion applies from the bottom of the cyclic domain upward.
  - b. *Realize Context-Sensitive Allomorph*  
In case a lexical item has disjunctive exponence, then properties of the alternative allomorphs themselves determine which is realized (subject to Elsewhere 3).
  - c. *Maximize Links*  
All else being equal, an exponent with more links to the structure is preferred over one with fewer (intended to derive *Minimize Exponence*)
  - d. *Linearize*
    - (i) A non-affix is realized to the left of previously realized material in the same phase cycle (LCA)
    - (ii) An affix is linearized to the right of previously realized material in the same phase cycle (Mirror)
    - (iii) Linearization is subject to morpheme-specific position specifications of Vocabulary Items.
  - e. *Phonologize*  
Build a preliminary phonological representation (the input to the phonological derivation)

If allomorph selection can be sensitive to prosodic structure within a phase cycle (as opposed to prosodic structure in a previous phase cycle), then it might also be necessary to construct prosodic structure iteratively as exponents are added. This would mean that within a cycle, we have iterative rounds of Realize, Linearize, and Phonologize. We do not make use of such rounds in the analyses in this paper, so can see Insert either as a one-time processing of the output of Match, or a more fine-grained iterative process within each cycle.

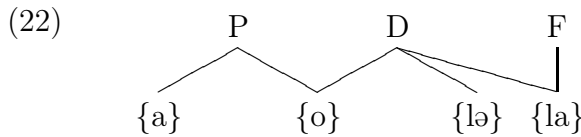
Maximize links is intended to derive Minimize Exponence, which was the preference for portmanteaux. The idea is that if Insert operates from the bottom up, then at a given category node, if it compares two competing exponents which lexicalize differently sized spans, it chooses the larger one, unless some other condition interferes. In principle, the Minimize Exponence property could have been a condition on Match. If that were the case, then sequences of morphemes would have been eliminated from the Association before it was processed by Insert. However, the fact that portmanteaux are sometimes prevented from being used in certain phonological contexts shows that Minimize Exponence (or at least one aspect of it) must be part of Insert, not of Match.

In the remainder of this subsection we briefly motivate this position using French *au* ‘to/at the (masc.sg.)’.

In addition to the Yawelmani causative-iterative, Hockett (1947) gives French *au* as an example of a portmanteau morph: the preposition *à* does not appear before the masculine singular definite article *le*, but rather both P and D are spelled out as *au* (*au soleil* ‘to the sun’). Since there is no independent motivation for general D to P movement in French (cf. *à la lune* ‘to the moon’), we assume that a single morpheme {o} can spell out P and D together. In the representations below, D has copied gender features from N (masculine being the unmarked gender in French), and an initial phase cycle has spelled out the noun.



Again, we can represent the morphemes as interlinked lexical entries (leaving out features that would distinguish the definite article from other D, and the basic locative preposition from other prepositions, cf. Zwicky 1987).



Alternatively the feminine definite article could be bimorphemic, namely {l-} :  $\Leftrightarrow$  <D> and {-a} :  $\Leftrightarrow$  <F>; the choice, as in DM, has to do with the distribution of forms in French more generally, a matter which we will not go into here.

Given the entries in (22), Match would apply to the tree in (21)(a) as follows. It associates categories (P and D) with lexical entries. The association leaving the smallest number of unmatched features would be {a}+{la} (*à la*); to select {o} would be to leave F in the tree unmatched, as would the selection of {a}+{lə}; to select {o}+{la} would leave F in the lexical entry unmatched.

Turning to (21)(b), Match produces three associations which leave no unmatched features: {o}, and {a}+{lə}, and {o}+{lə}. The correct choice is {o} (*au*), which seems to reflect a general principle favoring portmanteaux where possible, or preferring fewer morphemes over more morphemes, a principle which appears to hold even in domains larger than the syntactic word, as suggested for example by Poser (1992) and Kiparsky (2005). The principle must be constrained so as not to rule out paraphrases, which requires a careful consideration of the domain in which it applies (see Embick and Marantz 2008), and also of the nature of the features which are visible to the competition. The phase appears to provide a sufficiently constrained domain, and the interlinking of lexical entries would allow paraphrases to remain unaffected.

However, there is an important caveat concerning the French example: if the lower phase is vowel-initial, then the portmanteau is not used: *à l’eau*, ‘to the water’ (\**au eau*). This seems to violate the Minimize Exponence principle, since two morphemes are used to spell out P+D, instead of the portmanteau. One possibility is that what is spelled *à l’* is actually a single morpheme {al},

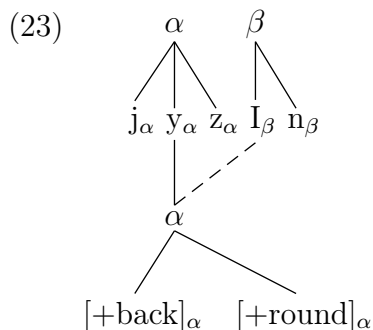
an allomorph of {o}. However, the French masculine definite article systematically appears as /l/ before vowels, and so the most parsimonious account assumes that *à l'eau* is simply {a} plus {l} (the form /lə/ could either be a phonologically conditioned allomorph or else be the result of epenthesis).

It seems plausible that what causes Minimize Exponence to fail here is a phonological condition on *au*, that it requires a following consonant. For example, Zwicky (1987) points out an alternation between *en* and *au* with proper place names used locatively, when the place name is normally used with a definite article: *au Canada* ‘in Canada’ but *en Iran* ‘in Iran’ (compare *le Canada*, *l’Iran*). There is no phonological condition on *en*, as can be seen by comparing feminine proper place names in the same circumstance: *en France*, *en Amérique* (cf. *la France*, *l’Amérique*). The preference for *en* in the feminine over *au* in the masculine must be resolved on the basis of gender features, which on our assumptions can only happen in Match. But in the Masculine gender, Match does not resolve the choice between *au* and *en*; possibly, each of them mismatches by one feature (e.g. *au* is masculine but not proper, and *en* has a feature restricted to proper names, but not masculine). In any case, the choice has to be phonological since there is no syntactically visible difference between *Canada* and *Iran*. Perlmutter (1998) notes this and proposes that the phonology makes the choice in this case, cf. the example of the Hungarian second person verbal agreement mentioned above. This could be made to work in our system, but we will assume that Insert resolves conflicts between portmanteaux versus multiple affixes, which means that *au* must be specified as requiring a following consonant. This is enough to cause Insert to choose the competing Association *à+l’* at the Realize stage, despite the multiple linkage of *au*.

### 3.6 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 usually the result of purely phonological processes, when the structural effects of the requirements of exponence are repaired in the phonology.

An assimilation process construed as autosegmental spreading might spread an exponent of morpheme  $\alpha$  to morpheme  $\beta$ , or a coalescence may result in a segment that was simultaneously the exponent of two morphemes. In Turkish, the marker of the genitive singular is {-In}, where /I/ is a high vowel unspecified for the features [back] and [round]. The values for these features are inherited from the root. A representation of *jyz-yn* (*yüzün*) ‘face-GEN.SG’ might look as in (23), where morphemes  $\alpha$  and  $\beta$  overlap.




This case of overlap is purely phonological in nature. In actual fact, this example illustrates a property we capitalize on here in order to derive non-concatenative effects phonologically, that of



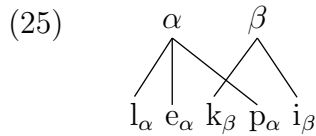
deficiency, in this case underspecified vowels (see section 4).<sup>13</sup>

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  $*_{\text{DORS}} \frown \text{LAB}$ , e.g. /lek+pi/ → lep-ki ‘to break PAST’.

(24)

/lekpi/	$*_{\text{DORS}} \frown \text{LAB}$	LINEARITY
a. lekpi	*!	
b.  lepki		*

Naturally, this introduces a discontinuity, in violation of the concatenative ideal, as illustrated in (25).



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. ɔp ‘to wrap’ ar-ɔp ‘wrapping’. If the root is disyllabic, on the other hand, the nominalizer is infixal, and adjusted so as to satisfy syllabic well-formedness requirements, e.g. ka.tʰiit ‘to be shy’ ka-r-tʰiit ‘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 8 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).

## 4 Deficiency and non-concatenativity

In the previous section we saw how phonological processes may bring about a certain amount of deviance from the concatenative ideal. One source of overlap, in the Turkish case, was underlying underspecification of segmental content. Such cases are common, and we discuss them further here. An underspecified morpheme may consist only of a place feature, or a tone, or even just a segmental “root” node, perhaps specified as a consonant or vowel.<sup>14</sup>

Alternatively, a morpheme may have only prosodic information, being specified for example as a mora ( $\mu$ ); it is commonly also assumed that a morpheme may consist only of a syllable ( $\sigma$ ), foot (Ft), or prosodic word ( $\omega$ ), though alternatives have been proposed and the issue is

<sup>13</sup>This is not a necessary feature of a phonological analysis of these facts. In an OT treatment, the absence of color contrast in suffixal vowels would standardly be expected to fall out from constraint interaction, not any assumptions we make about the input, according to the principle of the richness of the base.

<sup>14</sup>In this paper, we use two very 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.

controversial (see section 5). Such an affix acquires segmental content through copying material from the base. There are differing opinions on what affixes in prosodic morphology represent. In the earliest work by McCarthy (1979, 1981) and Marantz (1982), there were skeletal templates. McCarthy and Prince (1986) marks the beginning of a second phase, where the affixes were defined as ‘authentic units of prosody’. McCarthy and Prince (1995, 1999) present a third view according to which reduplicants are specified as affixes or stems. 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).

In this section, we discuss segmental root node affixation, distinguishing it from affixation of morae, and also autosegmental affixation. We discuss prosodic affixation in a separate section, 5.

## 4.1 Root node affixation

The affixation of a root node, possibly specified as a consonant or vowel, can be distinguished from the affixation of a mora. An example of root node affixation 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’, *sagád daylo* ‘cow’s offspring’, *sagáh iba* ‘cow’s legs’. We give additional evidence for root node affixation in our analysis of verb stem morphology in Sierra Miwok in section 11.

Moraic affixes are 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.

- (26) *Yaqui (Yoeme) habitual*
- |    |                       |                        |               |
|----|-----------------------|------------------------|---------------|
| a. | b <sup>w</sup> atania | b <sup>w</sup> 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 (26-a). When the first syllable is closed, the vowel is lengthened instead.

Other examples of prosodic affixation are discussed in section 5.

## 4.2 Featural affixation

The use of tones and other autosegments as affixes occurs reasonably frequently. 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 lexical stem (p. 107).

- (27) *Unaffixed imperfective in Jamsay*
- |           |     |             |             |
|-----------|-----|-------------|-------------|
| Bare stem |     | Locative    |             |
| /ka:, H/  | ká: | /ka:, H, L/ | kâ: ‘mouth’ |

/uro, H/	úró	/uro, H, L/	úrò	‘house’
/gɔ:, LH/	gǔ:	/gɔ:, LH, L/	gǔ̀:	‘granary’
/numo, LH/	nùmó	/numo, LH, L/	nùmô:	‘hand’

Some kinds of mutation may be seen as additive. Indeed, it is a widespread perception that mutation is essentially an additive process involving the affixation of an autosegment, although mutation may also be subtractive, as we shall see. 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).<sup>15</sup> Work on mutation carried out within the OT framework has tended to adopt autosegmental representations, developing constraints to handle autosegments that are ‘floating’ in the input (Zoll 1998; Myers 1997; McLaughlin 2000; Wolf 2007).

#### 4.2.1 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).<sup>16</sup> 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 somewhat with that of Wolf (2007); 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).<sup>17</sup>

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

a. *Alternating*

Class 5 sg (UR)	Class 5 sg (SR)	Class 6 pl	
/tèŋgé, [+voice]/	dèŋgé	mà-tèŋgé	‘piercing tool’
/kásá, [+voice]/	gásá	mà-kásá	‘palm branch’
/pàpùlàkà, [+voice]/	bàpùlàkà	mà-pàpùlàkà	‘lung’
/fókó, [+voice]/	bókó	mà-fókó	‘hole’

b. *Non-alternating*

<sup>15</sup>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 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). 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.

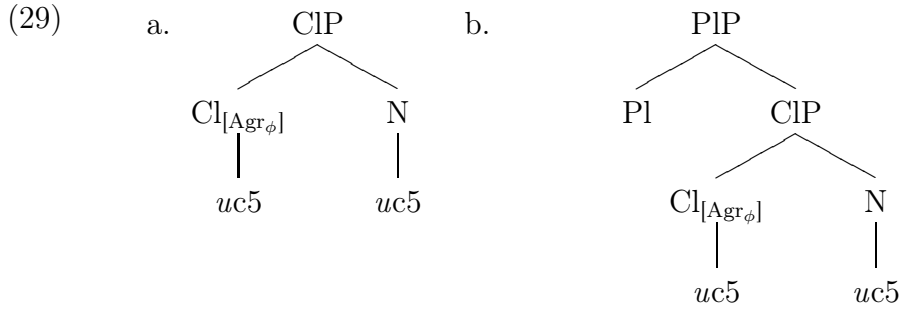
<sup>16</sup>The language is entered in *Ethnologue* (<http://www.ethnologue.com/>) as ‘Yaka’, with ‘Aka’ as one of the name variants.

<sup>17</sup>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). In correspondence between the reviewer and the first author of the encyclopaedia, Jacqueline Thomas, she points out that the class nomenclature used here is classical Bantu and now 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 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.

/gòàlà, [+voice]/	gòàlà	mà-gòàlà	game of imitation
/bèlèlè, [+voice]/	bèlèlè	mà-bèlèlè	‘sound of a waterfall’
/ɔ́ǵàmbà, [+voice]/	ɔ́ǵàmbà	mà-ɔ́ǵàmbà	‘mud’

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

In general, there are two alternatives for prefixes (see section 8): Either Cl and Pl incorporate their complements in the syntax, but exceptionally as prefixes, or else they do not syntactically form a complex  $X^0$  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. Assuming that the structure, with or without Pl, merges with a cycle-defining ‘phase’ head (see n. 10), the (Pl)–Cl–N sequence will spell out in the same phase cycle.



We treat the class feature, c5, as an uninterpretable agreement feature, with no projection, as discussed earlier.<sup>18</sup> The lexical entry for a Class 5 prefix is specified for insertion in  $\langle \text{Cl}, c5 \rangle$ , and the lexical entry for a Class 6 prefix is  $\langle \text{Pl}, \text{Cl}, c5 \rangle$ .

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](#)). See [Wolf \(2007\)](#) for an analysis assuming [voice] is a binary feature.

(30) *Aka Class 5*  
[voice]  $\Leftrightarrow \langle \text{Cl}, c5 \rangle$

(31) *Aka Class 6*  
/mà/  $\Leftrightarrow \langle \text{Pl}, \text{Cl}, c5 \rangle$


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 feature therefore docks on the initial consonant, violating LINEARITY ([McCarthy and Prince 1995](#)), which states that underlying relations of precedence must be preserved.

(32) LINEARITY  
 $S_1$  reflects the precedence structure of  $S_2$  and vice versa.  
If  $x, y \in S_1$ ;  $x', y' \in S_2$ ;  $x \mathfrak{R} x'$  and  $y \mathfrak{R} y'$ ; then  $x \prec y$  iff  $x' \prec y'$ .

<sup>18</sup>The question hinges on whether there is a semantic interpretation for class five. If there is, then it would dominate N and project a c5P node, and the bottommost instance would not have the diacritic *u*; a class five noun root would be a portmanteau which lexicalizes c5 as well as N. The rest of the analysis, including the copying of c5 onto Cl and other agreeing elements in the DP, would be the same.

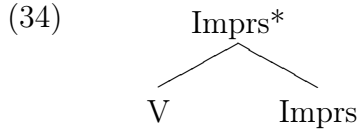
In the input, the [voice] feature precedes every possible docking site in the stem. Candidate (a) deletes [voice] in violation of top-ranked MAX[voice]. In candidate (b), the [voice] feature remains floating in the output, which falls foul of a constraint \*FLOAT.<sup>19</sup> Candidates (c) and (d) both violate LINEARITY, but to different degrees. In (d) [voice] fails to precede both /k/ and /s/, but in (c) [voice] only precedes /k/.

(33)

	[voi] <sub>1</sub> < k <sub>2</sub> as <sub>3</sub> a	MAX[voi]	*FLOAT	IDENT[voi]	*VCD OBS	LINEARITY
a.	k <sub>2</sub> as <sub>3</sub> a	*!				
b.	[voi] <sub>1</sub> k <sub>2</sub> as <sub>3</sub> a		*!			
c.	k <sub>2</sub> az <sub>1,3</sub> a			*	*	1 ↯ 2, 1 ↯ 3!
d.	 g <sub>1,2</sub> as <sub>3</sub> a			*	*	1 ↯ 2

#### 4.2.2 Heterotropic autosegmental affixation in Inor

In Inor, there is an ‘impersonal’ form of the verb, which we represent simply as V incorporating into a head Impr<sub>s</sub>, setting aside irrelevant details.



(35) *Inor Impersonal*  
 {-i} ; [lab] ⇔ <Impr<sub>s</sub>>

The morphological manifestation of the impersonal includes an *-i* suffix and labialization of the rightmost non-coronal consonant in the root (Chamora and Hetzron 2000). Examples are given in (36).<sup>20</sup>

(36) *Inor impersonal labialization*

ROOT	PERF	PERF.IMPERS	
$\sqrt{\text{nfg}}$	nəfəg	nəfəg <sup>w</sup> -i	‘to be greedy’
$\sqrt{\text{sbr}}$	səbər	səb <sup>w</sup> ər-i	‘to break’
$\sqrt{\text{bsr}}$	bəsər	b <sup>w</sup> əsər-i	‘to cook’
$\sqrt{\text{drs}}$	dənəs	dənəf-i	‘to break off the edge’

Coronal consonants do not have labialized counterparts and, in the event that the root lacks a non-coronal consonant, labialization is simply absent. The constraint \*CORLAB (37) must therefore dominate MAX[labial] as in (38).

(37) \*CORLAB  
 Labial coronals are disallowed.

<sup>19</sup>To the extent \*FLOAT is *never* violated in output forms, we might consider ruling out floating features in the output through additional restrictions on the generator function GEN.

<sup>20</sup>The palatalization of /s/ to [ʃ] in  $\sqrt{\text{drs}}$  is due to the front vowel context.

(38)

	dənəs+ <sup>w</sup> i	*CORLAB	MAX[lab]
a.	d <sup>w</sup> ənəfi	*!	
b.	dən <sup>w</sup> əfi	*!	
c.	dənəs <sup>w</sup> i	*!	
d.	☞ dənəfi		*

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 (39) and (40).

(39)

	səbər+ <sup>w</sup> i	*CORLAB	MAX[lab]
a.	s <sup>w</sup> əbəri	*!	
b.	səbər <sup>w</sup> i	*!	
c.	səbəri		*!
d.	☞ səb <sup>w</sup> əri		

(40)

	bəsər+ <sup>w</sup> i	*CORLAB	MAX[lab]
a.	bəs <sup>w</sup> əri	*!	
b.	bəsər <sup>w</sup> i	*!	*
c.	bəsəri		*!
d.	☞ b <sup>w</sup> əsəri		

Following Piggott (2000), we eschew an account of edge orientation in terms of ALIGNMENT. Where there is more than one labializable consonant in the root, the rightward orientation is a result of the low ranked constraint LINEARITY. In (41) below, both (c) and (d) fare equally well on \*CORLAB and MAX. LINEARITY, however, favours (d) with its one violation mark against (c)'s two.

(41)

	n <sub>1</sub> əf <sub>2</sub> əg <sub>3</sub> + <sup>w</sup> <sub>4</sub> i	*CORLAB	MAX[lab]	LINEARITY
a.	n <sup>w</sup> <sub>1,4</sub> əf <sub>2</sub> əg <sub>3</sub> i	*!		1 <del>✓</del> 4, 2 <del>✓</del> 4!, 3 <del>✓</del> 4
b.	n <sub>1</sub> əf <sub>2</sub> əg <sub>3</sub> i		*!	
c.	n <sub>1</sub> əf <sup>w</sup> <sub>2,4</sub> əg <sub>3</sub> i			2 <del>✓</del> 4, 3 <del>✓</del> 4!
d.	☞ n <sub>1</sub> əf <sub>2</sub> əg <sup>w</sup> <sub>3,4</sub> i			3 <del>✓</del> 4

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.

## 5 Prosodic affixation

Examples involving the affixation of suprasegmentals such as tones and moras seem relatively easy to come by. We discussed examples of each in 4. However, as we move further up the prosodic hierarchy to syllables, feet, words and so on, the issue becomes more complex. The first non-linear approaches to reduplication in the late 1970s and early 1980s defined templates in terms of skele-



tal units, C and V (McCarthy 1979, 1981; Marantz 1982; Yip 1982; Broselow and McCarthy 1983; Archangeli 1983, 1984). This was followed in the 1980s by the Prosodic Morphology Hypothesis (PMH) (McCarthy and Prince 1986), which claims that templates are defined exclusively in terms of the authentic units of prosody, such as moras, syllables and feet. For example, McCarthy (1993) argues that a disyllabic template  $\sigma\sigma$  underlies all Arabic verb morphology. With the advent of Optimality Theory, however, the Prosodic Morphology Hypothesis gave way to Generalized Template Theory (GTT; McCarthy and Prince 1994, 1995, 1999). 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. Ussishkin (2000) extends the GTT to Semitic root-and-template morphology, arguing that the disyllabic template falls out from independently needed phonological constraints. For further exploration of these issues with regard to reduplication, see Inkelas (this volume). A treatment of the Semitic root-and-template systems is beyond the scope of this chapter. We refer the reader instead to the works cited above. In this chapter we look at two systems that have been analyzed previously in templatic terms. Neither of them, we find, provide evidence for templates. The next section examines Cupeño. Later, in section 11, we provide a segmental reanalysis of the verbal stem system of Sierra Miwok.

## 5.1 Cupeño templates

A relatively clear candidate example of prosodic affixation 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). Here we briefly illustrate an example of affixation of a foot from McCarthy’s (2000a) analysis of the habilitative form. Crowhurst (1994) motivates an iambic analysis of Cupeño stress, but 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 (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 (42).

(42) *Cupeño habilitative*

(ŋáŋ)	(ŋá)(ʔaʔaŋ)	‘cry’
(kúʃ)	(kú)(ʔuʔuʃ)	‘take’
(tʃál)	(tʃá)(ʔaʔal)	‘husk’
(nəŋán)	(nəŋá)(ʔaʔan)	‘hide <i>sth.</i> ’
(həlʔóp)	(həlʔó)(ʔəʔəp)	‘hiccup’
(kəláw)	(kəlá)(ʔaʔaw)	‘gather wood’
(pá)tʃik	(pá)(tʃiʔik)	‘leach acorns’
(yúy)muk	(yúy)(muʔuk)	‘be cold’
(nó)nəŋ	(nó)(nəʔəŋ)	‘play pion’
(tʃáŋ)nəw	(tʃáŋ)(nəʔəw)	‘be angry’
(pí)(nəʔwəx)	(pí)(nəʔwəx)	‘sing enemy songs’
(xá)(ləyəw)	(xá)(ləyəw)	‘fall’

Note that the added material appears before the final consonant in each case. This could be due to the presence of a position attribute in the lexical entry (a notion we discuss in section 8); but here we can assume with McCarthy that the linearization of the added material is due to a kind

of faithfulness to the prosodic structure of the base; this is achieved through ANCHOR-POSITION constraints, whose general form is as in (43).

- (43) ANCHOR-POS(ITION) (Cat<sub>1</sub>, Cat<sub>2</sub>, P)  
 where P is one of {Initial, Final, Head}  
 If       $\varsigma_1, \text{Cat}_1 \in S_1$ ,  
           $\varsigma_2, \text{Cat}_2 \in S_2$ ,  
           $\varsigma_1 \Re \varsigma_2$ , and  
           $\varsigma_1$  stands in position P of Cat<sub>1</sub>,  
 then  $\varsigma_2$  stands in position P of Cat<sub>2</sub>.

ANCHOR-POS (Ft,Ft,P) requires that the output preserve the position 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 (44) is adapted from the corresponding tableau in McCarthy (2000a: 169). For completeness the constraint FTBIN has been added. The suffixed foot is disyllabic, an emergence of the unmarked effect (McCarthy and Prince 1994, 1995, 1999).

(44)

	(k <sub>1</sub> ə <sub>2</sub> l <sub>3</sub> á <sub>4</sub> w)+Ft	ANCHOR-POS (Foot, Foot, Head)	FTBIN	DEP
a.	☞ (k <sub>1</sub> ə <sub>2</sub> l <sub>3</sub> á <sub>4</sub> )(ʔaʔaw)			ʔ,a,ʔ,a
b.	(k <sub>1</sub> ə <sub>2</sub> l <sub>3</sub> á <sub>4</sub> )(ʔaw)		*!	ʔ,a
c.	(k <sub>1</sub> ə <sub>2</sub> )(l <sub>3</sub> a <sub>4</sub> ʔaw)	*!		ʔ,a

Note that the segmental material required to fill out the foot is infix. This is accounted for by ranking ANCHOR(Stem, Word, Final) above ANCHOR(Ft, Ft, Final). This is shown in (45), again adapted from McCarthy (2000a: 169).

(45)

	(č <sub>1</sub> á <sub>2</sub> l <sub>3</sub> )+Ft	ANCHOR-POS (Stem, Word, Final)	ANCHOR-POS (Foot, Foot, Final)	FTBIN
a.	☞ (č <sub>1</sub> á <sub>2</sub> )(ʔaʔal <sub>3</sub> )		*	*
b.	(č <sub>1</sub> á <sub>2</sub> )(ʔal <sub>3</sub> )		*	**!
c.	(č <sub>1</sub> á <sub>2</sub> l <sub>3</sub> )(ʔaʔa)	*!		

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

(46)

$(p_1 \acute{a}_2) \check{c}_3 i_4 k_5 + Ft$	ANCHOR-POS (Stem, Word, Final)	ANCHOR-POS (Foot, Foot, Final)	FTBIN	DEP
a. $\Rightarrow (p_1 \acute{a}_2) (\check{c}_3 i_4 ? i k_5)$				? , i
b. $(p_1 \acute{a}_2) (\check{c}_3 i_4 k_5)$			*!	
c. $(p_1 \acute{a}_2) (\check{c}_3 i_4 ? i ? i k_5)$				? , i, ?!, i
d. $(p_1 \acute{a}_2) (\check{c}_3 i_4 k_5 ? i)$	*!			? , i

(47)

$(p_1 \acute{i}_2) n \acute{o} ? w \acute{o} x + Ft$	ANCHOR-POS (Stem, Word, Final)	ANCHOR-POS (Foot, Foot, Final)	FTBIN	DEP
a. $\Rightarrow (p_1 \acute{i}_2) (n \acute{o} ? w \acute{o} x)$				
b. $(p_1 \acute{i}_2) (n \acute{o} ? w \acute{o} ? \acute{o} x)$				?!, $\acute{o}$

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), but here we adopt the suggestion of McCarthy (2000a) that the habilitative morpheme is simply a foot, with no internal specification. Its realization as two, one, or no added syllables is the result of its integration into the preliminary foot structure of the base.

## 6 Metathesis

The claim that metathesis may serve as 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). Claims for morphological metathesis have been put forward for other Salish languages Saanich and Halkomelem (see next section), the Yok-Utian languages Ohlone (a.k.a. Mutsun Okrand 1979), and Sierra Miwok (see section 11 below), 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 3. In this section we detail our approach with a more complex case.

Montler (1986, 1989) describes a case of putative morphological metathesis marking 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.<sup>21</sup> The idea that metathesis is a phonological effect rather than an exponent is further developed in recent work by Stonham (2007) and Zimmermann (2009), who argue that the allomorphy results, not from a template, but from the affixation of a mora.

The variation in the shape of the actual form is shown in (48). Disyllabic bases with an open

<sup>21</sup>Not addressed in Anderson (1992).

syllable epenthesize a glottal stop, as shown in (48-a).<sup>22</sup> Biliteral monosyllables show reduplication.<sup>23</sup> This is shown in (48-b). Finally, where the base has the shape /C<sub>1</sub>C<sub>2</sub>əC<sub>3</sub>/, where ə and C<sub>3</sub> may belong either to the verb root or suffix, C<sub>2</sub> and ə metathesize, as shown in (48-c). The suffixes in the examples are the control transitive {-ət} and the control middle {-əŋ}.

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

- a.  $CVCəC, CVC+əC \rightarrow CV?CəC$ ; ?-infixation
- |                          |                   |         |                    |            |
|--------------------------|-------------------|---------|--------------------|------------|
| $\sqrt{\check{c}aq'wəŋ}$ | $\check{c}aq'wəŋ$ | ‘sweat’ | $\check{c}á?q'wəŋ$ | ‘sweating’ |
| $\sqrt{weqəs}$           | $wéqəs$           | ‘yawn’  | $wé?qəs$           | ‘yawning’  |
| $\sqrt{x^wit+əŋ}$        | $x^witəŋ$         | ‘jump’  | $x^wí?təŋ$         | ‘jumping’  |
- b.  $C_1VC_2 \rightarrow C_1VC_1C_2$ ; reduplication
- |                   |            |                         |                  |                    |
|-------------------|------------|-------------------------|------------------|--------------------|
| $\sqrt{t'^{ə}e?}$ | $t'^{ə}é?$ | ‘be on top’             | $t'^{ə}ét'^{ə}?$ | ‘riding (a horse)’ |
| $\sqrt{k^wul}$    | $s-k^wúl$  | ‘school’                | $s-k^wúk^wəl$    | ‘going to school’  |
| $\sqrt{łík^w}$    | $łík^wsən$ | ‘trip (lit. snag-foot)’ | $łíłək^wsən$     | ‘tripping’         |
- c.  $CCəC, CC+əC \rightarrow CəCC$ ; metathesis
- |                             |                        |                     |                        |                        |
|-----------------------------|------------------------|---------------------|------------------------|------------------------|
| $\sqrt{s\bar{x}+ət}$        | $s\acute{x}ət$         | ‘push it’           | $səxt$                 | ‘pushing it’           |
| $\sqrt{\theta k^w+ət}$      | $\theta k^wət$         | ‘straighten it out’ | $\thetaák^wt$          | ‘straightening it out’ |
| $\sqrt{\acute{x}pə\bar{x}}$ | $\acute{x}pə\acute{x}$ | ‘scatter’           | $\acute{x}əp\acute{x}$ | ‘scattering’           |

Here we provide an OT analysis of Stonham’s insight. The affixal mora always surfaces faithfully in one form or another, reflecting highly ranked MAX- $\mu$ . 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, ANCHOR-POS(Stem,Word,Initial) and ANCHOR-POS(Stem,Word,Final). Satisfaction of ANCHOR-POS(Stem,Word,Initial) causes epenthesis of a copy of the base-initial consonant, as shown in (49). Epenthesizing any other consonant, or failing to epenthesize a consonant, incurs a fatal violation of ANCHOR-POS(Stem,Word,Initial). The constraint \*PLACE assesses marks against consonants bearing supralaryngeal place specifications.

(49)  $t'^{ə}ét'^{ə}?$  ‘riding (a horse)’

$\mu+t'^{ə}e?$	MAX- $\mu$	ANCHOR-POS (Stem,Word,Initial)	DEP	*PLACE
a. $t'^{ə}e?$	*!			
b. $ét'^{ə}?$		*!	*	
c. $?ét'^{ə}?$		*!	**	
d. $\text{☞ } t'^{ə}ét'^{ə}?$			**	*

For an input like / $\mu+t'^{ə}e?$ / ‘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 /CVCC/ inputs, and will only be optimal if LINEARITY is low ranked.<sup>24</sup> The tableau in (50) shows how this works for

<sup>22</sup>There is an additional alternation in the glottalization of the word-final sonorant. We abstract away from this detail here.

<sup>23</sup>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).

<sup>24</sup>Note that it is not necessary to rank LINEARITY below DEP, even though metathesis is preferred to insertion,

the input  $/\mu+\lambda'pə\chi/$  ‘scattering’.

(50)  $\lambda'pə\chi$  ‘scattering’

$\mu+\lambda'pə\chi$	MAX- $\mu$	ANCHOR-POS (Stem,Word,Initial)	DEP	*PLACE	LINEARITY
a. $\lambda'pə\chi$	*!				
b. $ə\lambda'pə\chi$		*!	*		
c. $\lambda'ə\lambda'pə\chi$			**!	*	
d. $\lambda'ə\lambda'pə\chi$		*!	**		
e. $\lambda'əp\chi$					*

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  $/\mu+wəqəs/$  is not mapped to  $*wəqsə$ . Since metathesis permutes the final consonant with the preceding vowel, this is a violation of ANCHOR-POS(Stem,Word,Final).

(51)  $wə'qəs$  ‘yawning’

$\mu+wəqəs$	MAX- $\mu$	ANCHOR-POS (Stem,Word,Final)	DEP	*PLACE	LINEARITY
a. $wəqəs$	*!				
b. $wəqsə$		*!			*
c. $wəwəqəs$			**!	*	
d. $wəwqəs$			*	*!	
e. $wə'qəs$			*		

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 an exactly similar way to (48-c), deriving nouns from verbs, e.g.  $kəḏəb$  ‘he lies’ vs.  $kəḏb$  ‘a lie’ (p. 62). 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.

## 7 Complex exponents

Prototypically, morphological exponents consist of a contiguous string of segments, but exponents may also be made up of more than one part. This is clearest in the case of a **circumfix**, which consists of discontinuous elements, neither of which make separate contributions to the meaning of the expression or occur independently of the combination. An example is the comparative/superlative

---

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 ANCHOR-POS. It is therefore not possible to argue that DEP outranks LINEARITY.

in Georgian (Hewitt 1995: 49), which is marked by a circumfix {u...-es-}, e.g. *lamaz-i* ‘beautiful’ *u-lamaz-es-i* ‘more beautiful’, *u/no* ‘ugly’ *u-u/no-es-i* ‘uglier’, *q’ru* ‘deaf’ *u-q’ru-es-i* ‘deafier’.

Complex exponents may also have a segmental and a non-segmental part, or more than one non-segmental part (we mentioned one such example in section 4, that of Inor). In Dinka (Andersen 1995), verb inflection may be marked by alternations in the tone, length, and voice quality of the root vowel. Although each of these features surfaces on the root vowel, there are no grounds for assuming that these features are linked to each other in underlying representation. The formation of the centripetal, for example, recruits all three of these dimensions, with the insertion of a low tone, mora and breathy voice feature. The lexical entry is thus: L;  $\mu$ ; [spread glottis]  $\Leftrightarrow$  <centripetal>, e.g. /wēc/ ‘kick’ + <centripetal>  $\rightarrow$  wēc ‘kick it hither!’ (p. 61). Coexponents stand in an arbitrary relationship to each other in the sense that neither can be considered a phonological response to the insertion of the other.

An example of coexponence involving both a segmental and an autosegmental affix comes from Northern Saami (Sammallahti 1998; Bye 2005; Svenonius 2008). Proto-Saami had an allophonic alternation between relatively long and relatively short singletons, geminates and clusters in foot medial position, where the relatively long allophones (‘strong grade’) occurred before an open rhyme and the relatively short allophones (‘weak grade’) before a closed rhyme. The reconstructed paradigm of *\*mon’a* ‘egg’ is shown in (52).

(52) *Proto-Saami* *\*mon’a*, ‘egg’

	SG	PL
NOM	<i>*mon’a</i>	<i>*mona:k</i>
GEN	<i>*mona’n</i>	<i>*mona:j</i>
ACC	<i>*mona’m</i>	<i>*mona:jta</i>
ILL	<i>*mon’a:sen</i>	?
INESS	<i>*mona’sna</i>	<i>*mona:jna</i>
ELAT	<i>*mona’sta</i>	?
ESS	<i>*mon’a:na</i>	
PART	<i>*mon’a:ta</i>	

At a later stage, certain word-final consonants and vowels disappeared, giving rise to new open and closed syllable environments. The distribution of the short and long variants remained constant but was no longer tied to the phonological environment. The strong grade is now a coexponent of the nominative and illative singular, and the numerically neutral essive.

(53) *North Saami* /monii/, ‘egg’

	SG	PL
NOM	monnii	moniih
GEN/ACC	monii	monij
ILL	monnaaj	monijðe
LOC	moniis	monijn
ESS	monniin	

The strong grade may be seen as a floating mora. In the nominative singular, this mora is the sole exponent, but in the illative singular and essive forms, it is a coaffix. As a first approximation, the lexical entry of the essive can be represented as something like:  $\mu$ ; /n/  $\Leftrightarrow$  <essive>.

Because of the way such cases arise, it is often difficult to tell whether the stem alternation that attends segmental affixation represents ‘real’ phonology or exponence, because the alternation



looks like it could be a natural one, given the phonological context. A case in point is metaphony in the Puglian dialect of Francavilla Montana (Maiden 1991: 156). As (54) shows, this dialect has metaphony of mid vowels in the second person singular.

(54) *Puglian metaphony* (Maiden 1991: 156)

1SG	kosu	dormu	leddʒu
2SG	kusi	durmi	liddʒi
3SG	kosi	dormi	leddʒi

As shown in (54), the second and third person singular inflectional suffixes both have the form {-i}, but there is a difference in the behaviour of the stem. In the second person singular form, the presence of {-i} seems to condition raising of the mid vowel in the verb root, but in the third person singular form it does not. It is natural to analyze the raising as phonologically conditioned, say, by positing the ranking AGREE[high]≫IDENT[high]. However, in the third person singular form, no such raising occurs, despite the fact that the phonological conditions and morphological structure are identical. The third person singular form, then, is evidence for positing the opposite ranking, IDENT[high]≫AGREE[high]. Under the assumption that metaphony in the second person singular form is an effect of grammar, there are several strategies for eliminating the paradox. One is to assign the affixes to different lexical strata (Kiparsky 2000; Bermúdez-Otero to appear). Solutions involving co-phonologies or indexed constraints (Pater 2009) are possible, but these solutions are theoretically costly, especially in the light of examples like Dinka and Northern Saami, which lend credence to the existence of arbitrary alternations. The superior solution for Puglian, we argue, is to see raising as the co-exponent of the second person singular. The analyst may conclude that certain alternations are best described as featural affixes. The well-known process of sequential voicing (*Rendaku*) in Japanese voices the initial segment of the second member of a compound (Itô and Mester 2003: 72ff.), e.g. *sake* vs. *ama-zake* ‘sweet sake’. *Rendaku* looks naively like intervocalic voicing, but Itô and Mester (2003: 72–87) show that it must be due to a linking morpheme, which happens to be an autosegment [voice].

Complex exponents should be distinguished from cases of **extended** and **multiple (exuberant) exponence**, both of which involve multiple agreement. See Caballero (2008) and Harris (2009) for recent discussion.

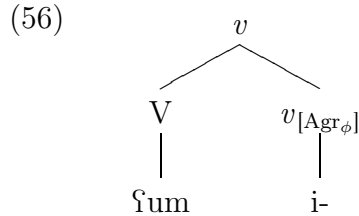
## 8 Lexically specified position

Some non-concatenative effects arise because certain affixes come with lexical stipulations as to where they attach, which we call position attributes. The clearest example of this is infixes, which we discuss in subsection 8.1. However, we also believe that some prefixes and suffixes are positioned by position attributes. Consider, for example, agreement affixes in Tamazight Berber, as described by Abdel-Massih (1968). Other singular person and gender agreement affixes are prefixes, but the first singular /ɣ/ is a suffix. Most plural agreement markers are suffixes, but the first plural /n/ is a prefix. This is illustrated in (55) where the first person is compared with the third masculine.

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

	Sg	Pl	
1	ɣum-ɣ	n-ɣum	‘I swam’; ‘we swam’
3m	i-ɣum	ɣum-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 as prefixal (affixes not being so specified coming out as suffixes). In other words, syntax might essentially provide (56), with the lexical entry for {*i*-} ensuring that it is prefixal.

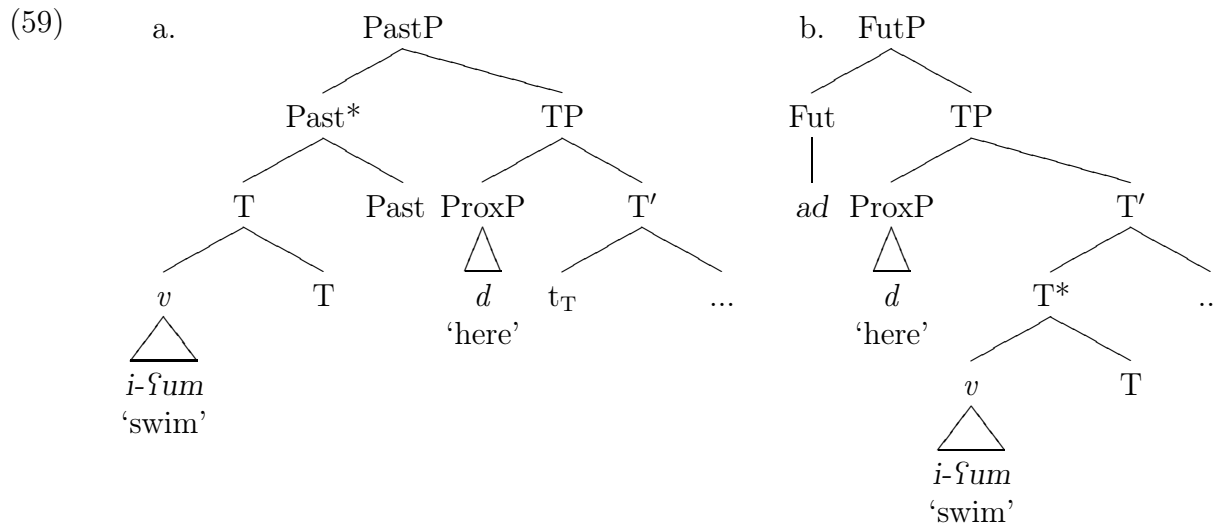


The idiosyncratic distribution of the subject agreement affixes contrasts sharply with the distribution of object agreement markers and directional markers, which are consistently determined by tense; in the past tense they follow the verb and in the other tenses they precede, even as the subject markers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

- (57) Tamazight Berber directional marker on verb ‘swim’, based on [Abdel-Massih \(1968\)](#)  
Proximate -d-  
Past i-ĩum-d ‘he swam here’  
Fut ad-d-i-ĩum ‘he will swim here’

- (58) Tamazight Berber object agreement on verb ‘throw at’, based on [Abdel-Massih \(1968\)](#)  
3m Object -as-  
Past i-ȳr:f-as ‘he threw at him’  
Pres da-as-i-ȳr:f ‘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.



## 8.1 Infixation


In infixation the morphological exponent appears inside the base of affixation. 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 ALIGNMENT constraint EDGEMOST(*um*;L), by which {um} is essentially a prefix. In vowel initial words it surfaces as a prefix (60).

(60)

/um/+/abot/	NOCODA	EDGEMOST( <i>um</i> ;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 (61).

(61)

/um/+/gradwet/	NOCODA	EDGEMOST( <i>um</i> ;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. True infixes must be specified as attaching to 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'. Adherence to the pivot requirement may result in structures that are no better, or even worse, phonotactically speaking, than the counterfactual prefixed or suffixed forms. 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 emerges as 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* (in violation of NOCODA) or *gr-um-adwet*.

This is not to say, however, that infixation *cannot* result from purely phonological considerations. See section 3.5 for a potential example of this.

Infixation entails a violation of the concatenative ideal that morphemes do not introduce discontinuities into other morphemes or constituents. Yu (2007) argues that infixes have a restricted set of phonological pivots 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 (62).

(62) *Infixal pivots*

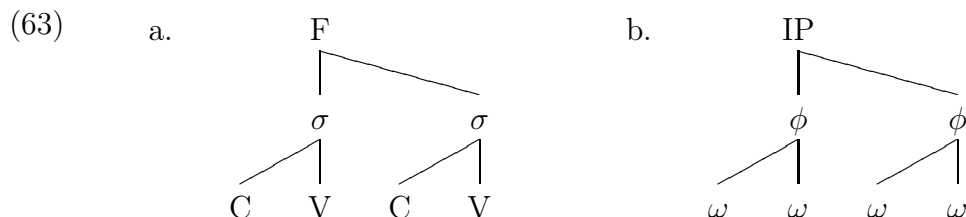
Left edge pivots	Right edge pivots	Prominence pivots
First consonant	Final consonant	Stressed vowel
First vowel	Final vowel	Stressed syllable
First syllable	Final syllable	Stressed foot

This inventory of pivots is very similar in structure to the inventories postulated for special clitic placement, except that the categories for clitic placement are ‘word’ and ‘phrase’ rather than ‘consonant/vowel’ and ‘syllable/foot’ (Klavans 1985; Halpern 1995). We believe that the two taxonomies can be unified by reference to the cycle. Roughly, each infix or special clitic is specified as attaching to the right or left of a pivot, as usual, but the pivot is either a “node” or a “branch” (whether the pivot is at the right or left edge of the host is determined by the same syntactic principles that place ordinary prefixes and suffixes).

A “node” is the smallest unit of substructure at a given level, and a “branch” is the highest. Within the phase cycle, reference to the node allows an unincorporated head to be before or after the leftmost onset or consonant; as the Tagalog example just mentioned shows, either is in principle possible, and what exactly controls the choice is unclear at this point. Similarly, an incorporated head (i.e. a suffix) can, by reference to the node, be specified to appear before or after a final consonant or coda. This might be the right analysis for the Cupeño habilitative we discussed above, though there we used anchor constraints instead.

Reference to the branch allows an unincorporated head to appear to the left or right of its sister, which in the first phase might be a syllable or a foot; this is what we assumed for the Ulwa possessive discussed in 3.5. Similarly, the exponent of an incorporated feature which is specified to appear to the left of the first branch might show up before the last foot; in the case of Tamazight Berber, this would ensure that the third person singular agreement marker surfaces as a prefix.

Cyclic applications of phonological processing build higher-order levels of prosodic structure, at which point the information from the earlier cycles is embedded. Schematically, we can distinguish between first-phase structures like (63-a) and the higher prosodic structure which embeds earlier phases, as in (63-b).



A morpheme which is introduced in a later cycle will not have access to the lower levels of phonological structure in (63-a). Instead, if it has a place specification, then a node will be a phonological word, in (63-b), and a branch will be a phonological phrase. Thus, we believe, the same place

specification we use for infixes will serve to determine the placement of special clitics. In what follows we state our specific analyses in more detailed terms than ‘node’ and ‘branch’ for precision, but we consider that a placeholder for the more abstract analysis which unifies infixation and clitic placement.

Section 8.1.1 looks at infixation in Dolakha Newar, a Tibeto-Burman language of Nepal. Section 8.2 examines phrasal infixation (clitic insertion) in a variety of languages.

### 8.1.1 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 {-ma-}. Verb roots in this language contain either one or two syllables. With monosyllabic verb roots, {-ma-} behaves like a prefix, as shown in (64). There is a productive process of vowel harmony (Genetti 2007: 58ff.) that changes /a/ to [a] before an /a/ in the stem, and to [o] before an /o/ or /u/ in the stem. Genetti’s transcriptions have been rendered in IPA.

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

/bir/	‘to give’	ma-bir	‘does not give’
/hat/	‘to say’	ma-hat	‘does not say’
/ja/	‘to come’	ma-ja	‘does not come’
/tʃõ/	‘to stay’	mo-tʃõ	‘does not stay’

With disyllabic verb stems, {-ma-} is infixal.

(65) *Infixal negative in Dolakha Newar* (Genetti 2007: 175f.)

/tʃhasar/	‘to itch’	tʃha-ma-sa	‘does not itch’
/hakhar/	‘to become black’	ha-ma-kha-u	‘does not become black’
/onsir/	‘to know’	on-ma-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: *tʃha-ma-sa* ‘not itch’ is no better than counterfactual \**ma-tʃha-sa*. This is underscored by the existence of structurally identical prefixes {da-} (prohibitive) and {tha-} (optative). The negative affix {-ma-} must simply be specified lexically as prefixing to the final syllable (or, branch) of its host.

(66) *Dolakha Newar negative*

/ma/ : \_\_σ] ⇔ <neg>

## 8.2 Phrasal infixation: Clitic placement

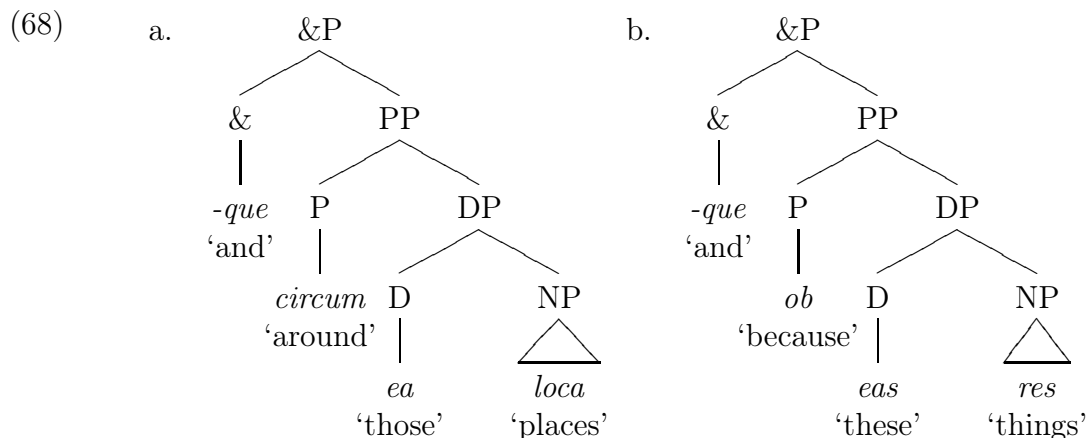
Descriptively speaking, the phenomenon of second-position clitics is extremely widespread, with certain clusters of morphemes turning up in a position that is ‘second’ in the clause or phrase in many unrelated languages (Halpern and Zwicky 1996). Analytically, the phenomenon is not unified; some second position elements appear to be placed entirely by syntax, for example the finite verb in most Germanic languages (e.g. Wiklund et al. 2007). 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 next lowest 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 a position 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. Thus, a plural infix attaching after the stressed syllable of the noun (as in Samoan, Yu 2007) and a question marker attaching after the first prosodic word in the clause (as in Russian, Rudnitskaya 2000) may both be specified as attaching after the nearest stress peak, but at different levels. For explicitness, however, in what follows we will stipulate the relevant prosodic category in the position attribute for each morpheme.

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).

- (67) a. bonī puerī bonae-que puellae  
           good boys good-and girls  
           ‘good boys and good girls’ (Klavans 1985)  
       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’ (Hale and Buck 1966: 165)

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





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 (67-b). Furthermore, if a preposition is phonologically light, *-que* appears after the following word, as illustrated in (67-c); this suggests that the light preposition does not form a phonological word on its own, a familiar phenomenon from many living languages.

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 morphemes and not syllables. This explains why the conjunction *-que* does not disrupt words (e.g. there is nothing like *\*bon-que-ae* or *\*colos-que-seum*).

Formally, we assume that *que* has a position attribute placing it after the first node, which because of its syntax will be the phonological word. For explicitness, however, we indicate the category prosodic word in the lexical entry.

- (69) *Latin conjunct que*  
 /kwe/ : PrWd}\_\_ ⇔ <&>

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.

Another example is the second position adverbial element *chà* ‘maybe’ in San Dionicio (SD) Ocotepéc Zapotec as described by Broadwell (2000), illustrated in (70). As the examples show, *chà* possible in any of several positions in certain sentences.

- (70) a. Juáàny-chà’ gù Màrí ù-dáù còmíiàd.  
 Juan=maybe or Maria COMPL-eat food  
 ‘Maybe either Juan or Maria ate the food’  
 b. Juáàny gù-chà’ Màrí ù-dáù còmíiàd.  
 Juan or-maybe Maria COMPL-eat food  
 ‘Maybe either Juan or Maria ate the food’  
 c. Juáàny gù Màrí-chà’ ù-dáù còmíiàd.  
 Juan or Maria-maybe COMPL-eat food  
 ‘Maybe either Juan or Maria ate the food’

In principle, (70)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 (70)a or (70)b, because of the Coordinate Structure Constraint (CSC) (Ross 1967), a very well-motivated cross-linguistic constraint (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 (70) above, have multiple options for prosodic phrasing, hence the multiple placement options for the second position clitic. Thus, the target for *chà* is clearly prosodic, but is larger than that for Latin conjunction. We can assume that the relevant constituent is the first the first prosodic phrase in SD Zapotec, that is, the first ‘branch’ in the relevant prosodic domain.

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 question 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 (71).

- (71) a. Knigata li na Ivan Vazov si čel (ili raskaza)?  
 book.DEF Q 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 position attribute which requires it to linearize to the right of the adjacent prosodic phrase.

### 8.3 On the integration of clitics with morphology

[Bermúdez-Otero and Payne \(to appear\)](#) argue that the placement of clitics cannot be entirely post-lexical as suggested by [Anderson \(2005\)](#), because some clitics trigger word-level phonological processes or allomorphy selection in their hosts. Our model predicts that clitics will be included in word-level phonology and allomorphy selection just when they are included in the Spell-Out domain of the host; in other words, they will behave in this regard just like affixes or words of the same syntactic category, the difference being only in that clitics have a marked specification for position. Notice that on our analysis, no syntactic features of *li* move; it is the morpheme which has a marked linearization, with no effect on the syntax.

For example, they point out that a plural nonhonorific imperative in Peninsular Spanish takes a *-d* suffix, with a null allomorph before the second person plural object enclitic *-os*.<sup>25</sup>

- (72) a. ama-d! ‘love!’ [a.mað]  
 b. ama-os ‘love each other!’ [a.ma.os]

They show that the mere presence of a second person plural object clitic is not sufficient to trigger the allomorphy; the clitic must in fact be attached to the verb in question.

- (73) a. Volv-e-d a am-a-r-os!  
 return-V-IMP.PL to love-V-INF-2PL  
 ‘Go back to loving each other!’  
 b. Volv-e-os a am-a-r!  
 return-V-2PL to love-V-INF

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<sup>25</sup>Our examples are based on theirs; thanks to Antonio Fábregas for discussion.

‘Go back to loving each other!’

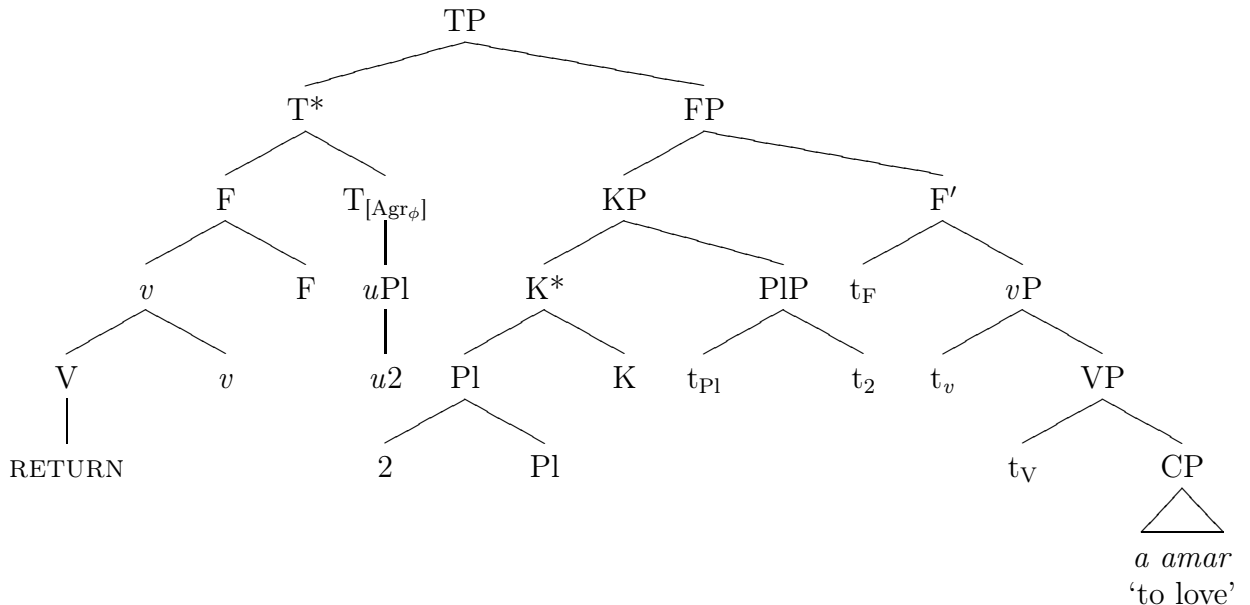
This is a problem for theories in which clitic placement happens only after all lexical material has been inserted. On our account, however, position attributes are essentially instructions to Spell-Out, so that clitics are ordered when they are inserted, and since lexicalization is cyclic, this means that some lexical material will be present when a clitic is placed, and some will not.

In general, it is clear that argument noun phrases constitute prosodic domains and so must spell out in separate phase cycles. However, since phase cycles are determined by syntax, certain syntactically ‘defective’ expressions may fail to define their own phase cycles, being spelled out as part of a larger Spell-Out domain (compare the suggestion in [Cardinaletti and Starke 1999](#) that clitics are structurally deficient). We suggest that this is the case for Peninsular Spanish *os* as described by Bermúdez-Otero and Payne.

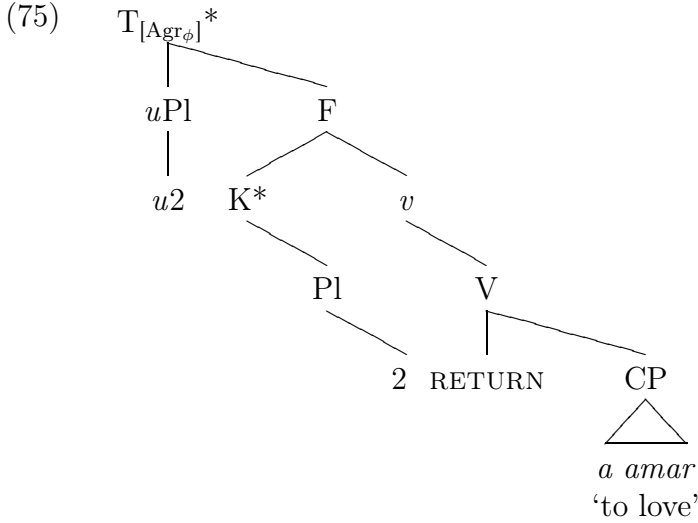
If the clitic KP moves to attach to a projection of I, then the lexical entry for second person plural *os* and the plural imperative *-d* will be in competition to spell out the same features. There are many ways in which this could be implemented, and discussing the details in a compressed space is confounded by the many alternative analyses of Romance clitics that have already been developed. But for explicitness, we sketch a simple example of a solution, building on Harris’ analyses of the clitics and the imperative ([Harris 1995](#) and [Harris 1998](#)), but adapting them to our assumptions, for example that all and only interpretable features project.

Spanish clitics systematically follow nonfinite verb forms; we will represent this by attraction of the clitic KP to a functional projection F ([Uriagereka 1995](#)) lower than the position to which the verb moves (T\*). Since the clitic contains interpretable structure, it branches, which makes it phrasal, so it is a specifier. Since the verb is higher, it has moved through the head attracting the clitic, incorporating it. This entails a structure something like that in (74) for the higher clause of sentence (73-b), modulo the exact labels, and letting K stand in for the accusative.

(74)



At this point it will be useful to switch to the Brodian representation, which eliminates the various traces and bar-level projections and therefore more directly reflects the actual dependencies. We import into Brody’s notation our convention of representing uninterpretable features by vertical dependency lines, and we also depict the root with a vertical dependency line. We retain the redundant *u* diacritics for convenience only.



For convenience, we will assume that {os} has a single lexical entry, rather than decomposing it into {o-} and {-s} as Harris does. Since it can be proclitic (with finite verbs) or enclitic, we assume it has no place specification.

- (76) *Spanish clitic os* (preliminary version)  
 /os/  $\Leftrightarrow$  <K,PL,2>

Starting from the rightmost branch, Match associates *volv-e-* with the V-*v* complex, which is a phase cycle.

Moving up the tree, Match must find a lexical entry for Uriagereka's F, which is involved in integrating the meaning of the clitic into the clause. There is no evidence that F is represented in verbal morphology, which might mean that it has a phonologically silent exponent. On the other hand, it might be spelled out by the clitics themselves, and this is what we will assume. This requires modifying the lexical entry slightly.

- (77) *Spanish clitic os* (intermediate version)  
 /os/  $\Leftrightarrow$  <F,K,PL,2>

But this is not a phase cycle, so Match continues to work outward, reaching T. Now Match finds lexical entries suitable for T, Pl, 2. The lexicon of Peninsular Spanish contains a formative {-d} which is used in the plural. We can assume a lexical entry like /d/  $\Leftrightarrow$  <T,PL,2>. This will not appear in finite tenses because there are additional features there and other more fully specified lexical entries will preempt {-d}.

But in Peninsular Spanish, {-d} is dropped when the enclitic {-os} is present. This is not explained given what we have said so far. However, a slightly different lexical entry for the enclitic can achieve the desired result.

- (78) *Spanish clitic os* (final version)  
 /os/  $\Leftrightarrow$  <T,F,K,PL,2>

We are assuming that relative dominance relations are respected by Match, but not precise structure. F dominates Pl and 2 in the structure, and T dominates (the copies of) Pl and 2; and T dominates F. All of these relations are consistent with the ordering in the lexical entry in (78).

If  $\{\text{os}\}$  is specified to spell out imperative T, as suggested, then Match can make two alternative associations, one with  $\{-d\}$  and one without it. If both of these alternatives are sent to Insert, then Insert will favor the one which involves the fewest morphemes, as discussed previously, and so  $d\}$  will fail to appear.

Insert will also linearize the structure; because  $V-v$  is incorporated into F-T (as seen by the rightward-sloping dependency lines in the Brodian tree), *volve-* will linearize to the left of whatever lexicalizes F-T. Also, because  $T^*$  dominates F, of which  $K^*$  is a specifier, *volve-* precedes what spells out  $K^*$ , i.e. *os*. Because  $K^*$  is a specifier of F, which dominates CP, *os* will linearize to the left of the previously spelled out CP. The linear order is easier to see in the pre-Brodian tree in (74).

Thus, we are suggesting that the clitic can spell out a piece of the clausal structure, and this is what allows it to interact with verbal morphology. It is crucial for our account that there is not a phase cyclic node between the clitic and the verbal inflection, otherwise Match would resolve a lexicalization before associating the clitic with the verbal inflectional heads; this is why this kind of effect can only happen with a clitic, which by assumption lacks a cyclic node.

## 9 Ablaut

In general, vowel harmony can be analyzed in terms of underspecified vowels in an affix, as we mentioned for Turkish in section 3.5, and mutation and umlaut can be seen as the combination of autosegmental material with the root, as we discussed in section 4. However, there are other cases involving vowels which seem to involve wholesale replacement of the root vowel with a different one, a process known as **ablaut** or **apophony**.

Ségéral and Scheer (1998) and Bendjaballah and Haiden (2001) examine such cases of apophony and conclude that there is something basic about the transition from I to A, and from A to U. Thus cases like the Germanic alternations in *drink-drank-drunk* are classic cases of apophony, reflecting something as yet poorly understood about the structure of vowels. However, there are still several issues to be explained, including in particular how to get the exponent into the right place. Furthermore, there are many cases of stem vowel change which do not involve I to A or A to U, some of which we discuss below. Therefore, we need a mechanism which will overwrite a root vowel with a vowel added by inflection.

Melodic overwrite appears at first glance to be incompatible with the morpheme-based view that each root and affix is a unique pairing (sign) consisting of meaning and form (Saussure 1995 [1916]) and that morphology essentially involves the combination of signs (roots and affixes) that, underlyingly at least, are phonetically invariant. To the extent that morphemes vary in their phonological shape, this variation is to be attributed as far as possible to the grammar, i.e. phonological processes.

To bring melodic overwrite into the fold of concatenative morphology, we have two particularly useful tools. One is underspecification, by which we can assume that the underlying vowel in the root is underspecified in some way, as suggested for certain vowel alternations in Hungarian by Stiebels and Wunderlich (1999). The other is the position feature, since we can specify for an inflectional vowel that it must occur in the nucleus of the root. Conflicts between exponence of root and affix are then resolved in favour of the affix as a corollary of cyclic spell-out, as we have argued for other cases.

An alternative view sees overwrite as the result of phonological constraint ranking rather than principles of Spell-Out. Ussishkin (2005, 2006) argues that overwrite arises from ranking AFFIX-

FAITH above ROOTFAITH, thereby inverting the universal metaranking ROOTFAITH≫AFFIXFAITH proposed by (McCarthy and Prince 1995, 1999). Some researchers have obviously interpreted this metaranking to imply the impossibility of melodic overwrite, which is patently at odds with the data. According to our understanding of this metaranking, given a structural target, and a choice between meeting that target through an unfaithful root mapping or an unfaithful affix, languages always opt for the latter. In English, obstruent clusters must agree in voicing AGREE[voice]. Given an input like /kæt+z/, this target is met by either of the candidates [kædz] or [kæts], but the latter is optimal by virtue of minimizing root unfaithfulness. A number of languages with underlyingly accented roots and affixes are generally nevertheless culminative, allowing only one accent per word. In the event of an input containing both accented root and accented suffix, only the root accent will surface. Examples of such systems include Russian (Alderete 1999), Greek (Revithiadou 1999), and Cupeño (Alderete 2001b).

## 9.1 Melodic overwrite in Tamashek

Here we will look at the formation of the plural in the Berber language Tamashek, also known as Tuareg of Mali. In a large class of nouns, the plural is marked by ablaut. Tamashek has five full vowels /i e a o u/ and two short vowels /ə ǎ/, where /ə/ counts as a high vowel, /ǎ/ as low. For expository purposes, we shall assume that these two sets are distinguished by a feature [full]. In the plural, the final vowel in the stem is ablauted to a low full /a/ regardless of the underlying vowel quality. This is shown in (79), (80), and (81). (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 specification for [full]. Thus an underlyingly full non-final vowel /e a o u/ surfaces as /u/ in the plural; an underlyingly short non-final vowel /ə ǎ/ surfaces as /ə/.

- (79) *Full non-final V*
- |                       |                       |                    |
|-----------------------|-----------------------|--------------------|
| ǎ-dádis               | i-dúdas               | ‘small dune’       |
| ǎ-máǵ <sup>j</sup> or | i-múǵ <sup>j</sup> ar | ‘large quadruped’  |
| e-ǰéyer               | i-ǰúyar               | ‘bustard’          |
| ǎ-káfar               | i-kúfar               | ‘non-Muslim’       |
| ǎ-fáraǵq              | i-fúraǵq              | ‘Chrozophora bush’ |
| ǎ-kárfu               | i-kúrfa               | ‘rope’             |
| t-a-zúzem             | t-i-zúzam             | ‘charcoal’         |
| t-e-zérdəm-t          | t-i-zúrdam            | ‘scorpion’         |
| t-ə-yúbbe             | t-ì-yubba             | ‘gulp’             |
- (80) *Short non-final V*
- |                |                         |                    |
|----------------|-------------------------|--------------------|
| a-móknud       | i-móknad                | ‘dwarf’            |
| a-réssud       | i-réssad                | ‘pus’              |
| á-fǎsko        | í-fǎska                 | ‘early hot season’ |
| a-s-ófrəd      | i-s-əfrad               | ‘broom’            |
| t-a-gógger-t   | t-i-góggar              | ‘insult’           |
| t-a-m-ákfoj    | t-i-m-ákfa <sup>j</sup> | ‘ochre’            |
| t-a-s-ábďār-t  | t-i-s-əbďar             | ‘sacrificial ram’  |
| t-é-lámse      | t-í-ləmsa               | ‘plain’            |
| t-a-twóqqe-t-t | t-í-twəqqa              | ‘small quantity’   |



These patterns more or less generalize to polysyllabic (‘heavy’) stems except that height spreads to all non-final vowels (81).

- (81) *‘Heavy’ stems*
- |   |   |                  |
|---|---|------------------|
| a-ṣāmmāṣro  | i-ṣāmmāṣra  | ‘roller (bird)’  |
| ā-m-āttāṅkul  | i-m-āttāṅkal  | ‘invisible one’  |
| e-māg <sup>j</sup> g <sup>j</sup> ég <sup>j</sup> g <sup>j</sup> ār | e-māg <sup>j</sup> g <sup>j</sup> úg <sup>j</sup> g <sup>j</sup> ar | ‘collarbone’     |
| t-a-kədóbdb-t   | t-i-kədóbdb   | ‘large frog sp.’ |
| t-a-s-əggərəjgóri-t-t   | t-i-səggərəjgóra  | ‘roller (bird)’  |
| t-a-fāṅkājāmu-t-t   | t-i-fāṅkājuma   | ‘mussel shell’   |

As shown in (82), an underlying non-final /i/ remains /i/ in the plural form.

- (82) *Full non-final /i/*
- |                         |                         |                    |
|-------------------------|-------------------------|--------------------|
| a-s-íng <sup>j</sup> əd | i-s-íng <sup>j</sup> əd | ‘turban’           |
| t-a-ṡími-t-t            | t-í-ṡima                | ‘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’ |

Each non-final vowel of the plural form inherits the lexical [front] specification by default. The lexical entry for the plural, given in (83), thus only requires that the non-final vowel(s) should be [high]; nothing is specified with regard to whether the vowel should be front or back. This is left to the phonology to fill in — specifically, the constraint \*HIGH/FRONT in (84). The asterisk ‘\*’ specifies multiple segmental hosts.

- (83) *Tamashek plural*
- $$/i/; [ \text{high} ] : \nu^* ; \left[ \begin{array}{c} \text{low} \\ \text{full} \end{array} \right] : \nu \} \Leftrightarrow \langle \text{plural} \rangle$$

- (84) \*HIGH/FRONT  
High vowels are not front.

The result is shown in (85).

- (85) i-dúdas ‘small dune’

i-dídas	IDENT[front]	*HIGH/FRONT
a. i-dídas		*!
b. $\Rightarrow$ i-dúdas		

The choice between the candidates is decided by \*HIGH/FRONT from (84), which militates against /i/. The realization of the non-final high vowel therefore defaults in the phonology to /u/. Since the value for [front] is not specified by the lexical entry for <plural>, IDENT[front] is vacuously satisfied by all candidate outputs.<sup>26</sup>

<sup>26</sup>There are a couple of departures from this general pattern. We have already seen that an underlying non-final /i/ surfaces intact in the plural. By ranking IDENT[front] above \*HIGH/FRONT it is ultimately inherited by the phonological form. When a non-final full vowel is followed by /w/ it does not surface as /u/ as expected, but as

## 9.2 Icelandic strong verbs

Strong verbs in Icelandic constitute a more complex case.<sup>27</sup> In Icelandic (e.g. Einarsson 1945), there is a basic morphological distinction between strong verbs and weak verbs, which apparently does not correspond to any semantic distinction. The two are partly distinguished by different sets of tense and agreement suffixes, and partly by the stem vowel changes which are especially systematic in the strong declension.

Traditional descriptions of Icelandic generally recognize seven classes of strong verb, the first six of which are illustrated in (86), showing the vowel differences between the infinitive and the past tense (for singular subjects). Class 7 has much more in the way of idiosyncrasies compared with the other classes, and is omitted here.

(86)	Class	gloss	infinitive	past sg	past participle
	1.	‘glance’	li:ta	lɛɪt	li:tɪð
	2.	‘erupt’	gjou:sa	gøy:s	gɔ:sið
	3.	‘find’	finna	fann	fɛndið
	4.	‘steal’	stɛ:la	sta:l	stɔ:lɪð
	5.	‘give’	geɪfa	ga:f	geɪfið
	6.	‘travel’	fa:ra	fou:r	fa:rið

One obvious possibility for analyzing these patterns is melodic overwrite. It is nonetheless suspicious that, although Icelandic has an ample vowel inventory, strong verbs only make use of a small number of root vowels. Within each class, the choice of root vowel is moreover either unique or appears predictable from the phonological environment. This suggests that the root vowel in the strong verb is intrinsically underspecified. We provide a partial analysis here, although an account of the system in all its complexities would be well beyond the scope of this chapter. Here we merely suggest the general lines focusing on the derivation of the vowel in the past singular.

We take the root vowel as it appears in the infinitive form as indicating the underlying flavor of the vowel. Taking into consideration systematic phonological correspondences, there are just four underlying types of root vowel, namely /i, u, a/ in classes 1, 2, and 6, respectively, and underspecified in Classes 3, 4, and 5. In Class 1, the root vowel surfaces as /i:/, and in Class 6, as /a:/. In Class 2, however, there is variation between /ju:/ and /jou:/. Anderson (1969: 63) points out that /jou:/ occurs only before coronals, e.g. *kjou:sa gjósa* ‘pour’, *xnjou:ta hnjóta* ‘stumble’, *ryjouða rjóða* ‘smear’, while /ju:/ appears elsewhere, e.g. *klju:fa kljúfa* ‘split’, *flju:ya fljúga* ‘fly’.<sup>28</sup>

Turning to Classes 3-5, they can all be analyzed as being underlyingly underspecified, usually surfacing as /ɛ/. The root vowel in the infinitive forms of verbs in Class 3 is /ɛ/ or /ɪ/, but /ɪ/ is only found before a nasal coda.<sup>29</sup> Classes 3-5 have essentially the same vocalization in the

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/i/, e.g. *ǣ-báwæn* 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 trilateral consonant cluster, e.g. the plural of *a-bǫtöl* is *í-btal*, not *\*í-bətal*, but the plural of *á-fǫsko* is *í-fǫska*, not *\*í-fška*, which would violate \*COMPLEX.

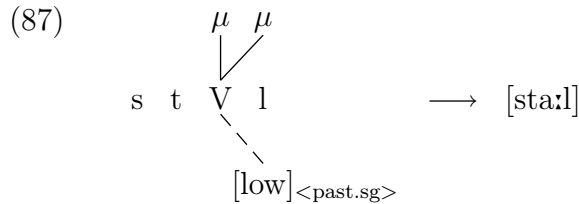
<sup>27</sup>Thanks to Martin Haiden and Sabrina Bendjaballah for discussion of the Icelandic strong verbs.

<sup>28</sup>With two exceptions, *lurta lúta* ‘stoop’ and *surpa súpa* ‘drink’, all Class 2 verbs have a theme /j/. There are no verbs in this class with root vowel /ou/ that lack /j/.

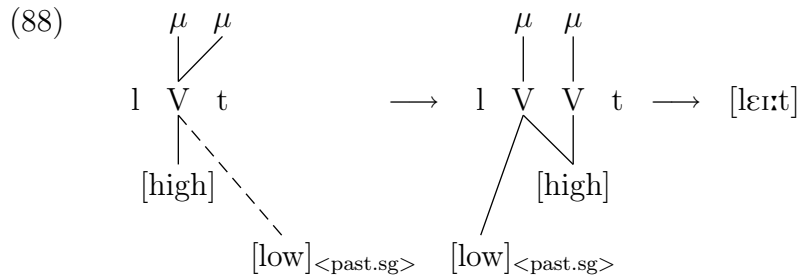
<sup>29</sup>There are two exceptions, *brenna brenna* ‘burn (intr.)’ and *renna renna* ‘run (intr.)’. In Old Icelandic (until the beginning of the 19th Century), these verbs had variant forms *brinna* and *rinna*, but in Modern Icelandic the infinitive forms have completely merged with those of the corresponding transitive weak verbs, *brenna* ‘burn (tr.)’ and *renna* ‘run (tr.)’. We will assume that the infinitive forms of the intransitive verbs are listed in the lexicon, with /e/, and the strong transitive forms are built from them. Our thanks to Þorbjörg Hróarsdóttir for discussion

infinitive. Class 3 is distinguished by having CVCC or CVG root structure, where G is a geminate. Classes 4 and 5 have CVC root structure. They are identical but for the difference in the vowel in the participle, which is /o/ in Class 4 and /e/ in Class 5 (the same as the infinitive and present tense forms). We take the difference between classes 4 and 5 to be that the participle has an allomorph with a [round] coexponent which is specified in its lexical entry to appear with Class 4, discussed further below.

The exponent of past tense singular involves lowering. This may be seen most clearly in classes 3-5, where a non-low front vowel in the infinitive and present tense alternates with /a/ in the past singular. [Anderson \(1969: 64\)](#) effectively posits an {-a-} infix, but here we propose the marker of past tense singular in strong verbs is simply a [low] feature. We assume the root vowel of classes 3-5 is an unspecified V node. Featural affixation of [low] to V is straightforwardly interpreted as [a].



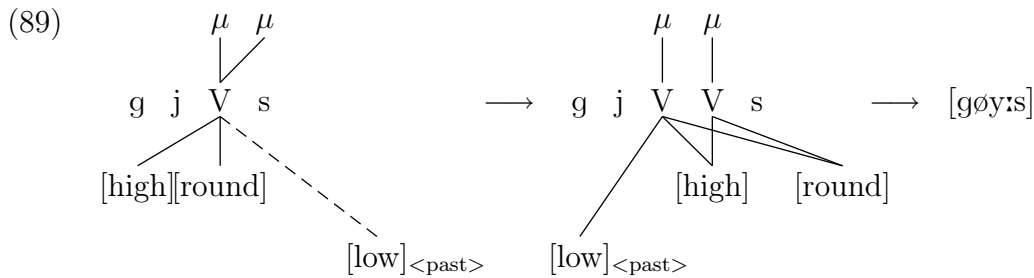
In the infinitive and present tense forms, featurally unspecified V is filled in as a front lax vowel, [ɪ] before a nasal coda, [ɛ] elsewhere. In classes 1 and 2, the insertion of [low] makes phonological adjustments necessary. When inserted on an underlyingly high vowel, this causes the root vowel to fission into a diphthong with an initial mid vowel. The diphthong surfaces as [front]. Following [Morén \(2003\)](#), we take mid vowels to have both [high] and [low].



The corresponding [round] root vowel behaves in the same way, first diphthongizing and being realized as [front]. In addition, the /j/ is deleted. This may well be a phonological effect. When preceded by consonant in the same syllable, /j/ cannot occur preceding a lax non-low vowel.<sup>30</sup>

of this data.

<sup>30</sup>A search through a recent Icelandic dictionary ([Hólmarrsson et al. 1989](#)) supports this. Sequences of Cjɔ and Cjʏ are lacking, with the exception of certain recent loanwords such as *tjɔp*: *djobb* ‘job’, *sjɔhker* *sjokker* ‘shocker’ and *cjʏðr* *kjuðr* ‘billiard cue’. However, past plural forms of certain strong verbs in classes 6 and 7 exhibit the sequence *hʏk:ʏm* *hʏggum* ‘hew.1PL.PAST’ (inf. *höggva*), *pʏk:ʏm* *bʏggum* ‘build.1PL.PAST’ (inf. *búa*), *jʏ:kʰʏm* *jukum* ‘increase.1PL.PAST’ (inf. *auka*), *jʏ:sʏm* *jusum* ‘scoop.1PL.PAST’ (inf. *ausa*).



This brings us to the infinitive and participle forms. In the infinitive, the vowel defaults to  $[\epsilon]$ . In classes 1 and 2, there is an alternation between a tense quality in the infinitive ( $/i:/$  or  $/(j)u:/\sim(j)ou$ ) and a lax vowel in the participle ( $/ɪ:/$  or  $/ɔ:/$ ). Since it is the participle that is marked in classes 3 and 4, let us also take the tense lax alternation in classes 1 and 2 to reflect a feature  $[RTR]$  which spells out the participle. The tense ( $[ATR]$ ) quality of the infinitive is then the phonological default. In Class 3, there is additionally a  $[round]$  feature as a coexponent of the participle. Before nasals, the root vowel surfaces as  $/ɣ/$ , as in *fundið*  $fɯndið$ , elsewhere as  $/ɔ/$ , as in *brostið*  $brɔstið$ , by the same process which causes the raising of the vowel in the infinitive of *finna*.

## 10 Subtraction

Subtraction refers to the deletion of stem material. It is a widespread conception that “[s]ubtractive morphology ... is resistant to any but a rule-based approach” (Broadwell 1998: 429). See also 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).

Good examples are hard to find and so most morpheme-based accounts have assumed that real subtraction does not exist. In French, for example, 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*  $mefɑ̃$  ‘naughty (M.SG)’ vs. *méchante*  $mefɑ̃t$  (F.SG); *mauvais*  $move$  ‘bad (M.SG)’ vs. *mauvaise*  $movez$  (F.SG). 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 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  $\frown$  voiced obstruent stop, e.g. *faind fain* ‘enemy, enemies’, *rauxfank rauxfɛŋ* ‘chimney flue’. Non-subtractive plurals in Hessian end in  $\{-r\}$ ,  $\{-n\}$ , or  $\{-ə\}$ , and the authors propose that there is a morphologically specific constraint  $\text{SON}|_{\text{PL}}$  that requires plurals to end in a sonorant. In Hessian, they claim, this constraint is ranked above  $\text{PARSE-Seg}$ , resulting in a subtractive pattern. Such an analysis is unavailable in our model because it mixes syntactic and phonological features in a constraint.

On our account, the Hessian plural might involve suppletion, with the reduced plurals being listed portmanteaux (just as with *mouse*  $\sim$  *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.

## 10.1 Deletion as a phonological reaction to an objectionable feature

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 autosegmental affixation, involving the insertion of a feature  $[F]$  so objectionable that the phonology deletes the entire segment. Unlike normal autosegmental affixation, this account will only work if  $[F]$  is associated with the subtraction target in the input, i.e. the lexical entry contains a position attribute explicitly associating the two. Assuming prelinking, then ranking  $*C_{[F]}$  and  $\text{IDENT}[F]$  above  $\text{MAX}$  will force deletion of the segment. 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.

For example, in the Hessian case, an autosegmental plural allomorph  $[\text{sonorant}]$  might have the intended effect, causing first assimilation and then degemination (*faind*+ $[\text{sonorant}] \rightarrow \text{fainn} \rightarrow \text{fain}$ ). 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 (90) illustrates the well-known lenition of initial voiced stops. For an introduction to initial consonant mutations in Welsh, see [Ball and Müller \(1992\)](#).

### (90) *Welsh lenition*

baner	vaner	‘flag’
basked	vasked	‘basket’
draig	ðraig	‘dragon’
desk	ðesk	‘desk’

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).

- (91) 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 [continuant] feature to the initial consonant. In Roberts’ analysis, the feature 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 (92).

(92)

	draig   [cont] <sub>v</sub>	IDENT[cont]	MAX	*VOIFRIC
a.	draig	*!		
b.	raig		*!	
c.	☞ ðraig			*

Radical /g/ alternates with zero, as in (93), and this is clearly linked to the fact that Welsh lacks a voiced velar fricative [ɣ].

(93) *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 (94).

(94)

	gorsav   [cont] <sub>v</sub>	*ɣ	IDENT[cont]	MAX	*VOIFRIC
a.	ə gorsav		*!		
b.	ə ɣorsav	*!			*
c.	☞ ər orsav			*	

## 10.2 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 (95), the set of subtracted consonants is diverse and includes /p t k d ɬ 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.<sup>31</sup>

(95) *O’odham perfective: consonant-final stems*

bídʂp	bídʂ	‘paint object’
pisalt	pisal	‘weigh’
hikčk	hikč	‘cut’
gátwid	gátwi	‘shoot object’
híhidòɬ	híhidò	‘cook’
íɬapig	íɬapi	‘gut’
híhim	híhi	‘laugh’
čílkon	čílko	‘scrape’

The perfective is marked by inserting the feature [F] on the final root node, which is picked out by the position attribute of the lexical entry for the morpheme. Recall that specification of position is necessary in order for the phonology to do the work of subtraction. If [F] were floating in the input, it could simply stay floating or be deleted in the output without incurring violations of \*C<sub>[F]</sub> or IDENT[F], and no subtraction would result.

(96) *Tohono O’odham perfective*

[F] : rt} ⇔ <perfective>

In the phonology, the feature [F] falls afoul of the constraint \*C<sub>[F]</sub>. 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 (97).

(97)

	bídʂp   [F]	*C <sub>[F]</sub>	IDENT[F]	MAX
a.	bídʂp   [F]	*!		
b.	bídʂp		*!	
c.	☞ bídʂ			*

Subtraction creates a situation where word minimality requirements have to be satisfied by mora epenthesis as in (98).<sup>32</sup>

<sup>31</sup>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: ?íi~?i: ‘drink’, híwa~híw ‘rub against object’, mo:to~mo:rt ‘carry on head or in vehicle’; of the latter: cicwi ‘play’, gagswua ‘comb’, ka: ‘hear’. The first set matches the lexical entry of the perfective given in (96). The remainder we will assume are lexically listed.

<sup>32</sup>The discussion of phonological readjustment draws heavily on Fitzgerald and Fountain (1995).

- (98) *O’odham perfective: lengthening under minimality*
- |     |     |  |
|-----|-----|--|
| míq | mí: | ‘run’                                  |
| him | hi: | ‘walk’                                 |
| ǰup | ǰu: | ‘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. *hílig* ‘hang object to dry out (IMPF)’ vs. *híl* (PF), \**híli*; *čícwičùd* ‘make someone swim (IMPF)’ vs. *čícwič* (PF); *čí:čig* ‘call out name of object (IMPF)’ vs. *čí:č* (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.<sup>33</sup>

### 10.3 Other cases of (apparent) deletion

Although subtraction itself is rare, the issue of morphological deletion arises more generally where more morphological structure correlates with the deletion of phonological material. Subtraction-like effects are also found in languages with lexical tone. In Japanese ([Zamma 2003](#)), for example, there are certain dominant suffixes that suppress lexical accent in the stem. An example is the suffix {-iro} ‘colour’, e.g. *ore`nji orenji-iro* ‘orange’, *emera`rudo emerarudo-iro* ‘emerald’; cf. underlyingly unaccented *nezumi* ‘mouse’ *nezumi-iro* ‘grey’, *kusa* ‘grass’ *kusa-iro* ‘green’.

The general strategy for dealing with such cases is to set up the conditions so that the phonology brings about the subtraction effect. Subtraction is not directly involved in exponence; it is a phonological response to the presence of some other purely additive morphological exponent. It is relevant in this connection to consider the prosodic typology of compound structures in Japanese given by [Itô and Mester \(2003: 218–224\)](#). The two lexical words of a compound may yield two phonological words each heading their own accentual phrase ( $\alpha$ ), e.g. /niho`n sakurama`turi/ → ( ( niho`n )<sub>ω</sub> ( sakurama`turi )<sub>ω</sub> )<sub>α</sub> ‘Japan cherry-festival’. There are three other types of compound in which the first lexical word surfaces without an accent. The compound may contain a single phonological word, as in /yo`sino sakura/ → ( ( yosino za`kura )<sub>ω</sub> )<sub>α</sub> ‘Yoshino cherry’, or two compound words under a single  $\alpha$ -phrase, e.g. /de`nki kamiso`ri/ → ( ( ( denki )<sub>ω</sub> ( ka`miso`ri )<sub>ω</sub> )<sub>ω</sub> )<sub>α</sub> ‘electric razor’ (with recursion on  $\omega$ ) /hatu` kaa`wase/ → ( ( hatu )<sub>ω</sub> ( kaa`wase )<sub>ω</sub> )<sub>α</sub> ‘initial face-off’. The single- $\omega$  compounds exhibit Rendaku. The difference between the recursive and non-recursive structures is that in the recursive structure there is a ‘junctural’ accent on the first syllable of the second lexical word, suppressing the underlying accent (/kamiso`ri/ → ka`miso`ri); in the non-recursive structure, the underlying accent of the second lexical word surfaces faithfully. As [Itô and Mester \(2003: 111f.\)](#) show building on earlier work by [McCawley \(1968, 1977\)](#),

<sup>33</sup>A final complication concerns verbs whose imperfective has the shape ...V?V, such as *gí?a* ‘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. /gía?/. In the imperfective form, the glottal stop and the vowel undergo metathesis to *gí?a* as a response to a constraint \*Lar]<sub>PrWd</sub>.

Poser (1984), Kubozono (1993) and Tanaka (2001), any lexical accent in the first lexical word of a compound is systematically deleted, including when the second lexical word itself is unaccented, e.g. /na<sup>h</sup>ka niwa/ → *naka niwa* ‘inner garden, courtyard’, /mizu hana/ → *mizu hana* ‘water-nose, running nose’. In the light of Ito and Mester’s analysis, an obvious reinterpretation of the facts reported by Zamma is that {-iro} is specified as forming the second member of a compound of the non-recursive type. An interesting avenue for future research would be to see to what extent this could be generalized to dominance effects (e.g. Alderete 2001b,a).

## 11 Case Study: Sierra Miwok

In this section, we present a case study of Sierra Miwok (Freeland 1951; Broadbent 1964; Smith 1985; Bullock 1990; Goldsmith 1990; Gafos 1998; Downing 2006), which is known to linguists as a language that has root-and-template morphology (as are several other members of the Penutian language family such as Yokuts Newman 1944; Archangeli 1991 and Takelma Sapir 1990 [1912]). Sierra Miwok has three main varieties which have been documented: Northern (Callaghan 1992), Central (Freeland 1951; Freeland and Broadbent 1960), and Southern (Broadbent 1964). This case study is based on the Central variety. On the account we develop here, there are no skeletal templates, in keeping with the overall approach developed in this paper, though we will use templates like CVCVVC descriptively. In fact, apart from the observation that verb stems are maximally disyllabic, our account makes no use of prosodic templates of any kind for Sierra Miwok, and no devices other than those already motivated in this paper.

In Sierra Miwok, verbs surface with one of four stem shapes, illustrated in (99). The First Stem may be any one of the shapes CVCVVC, CVC<sub>1</sub>C<sub>2</sub>V, CVCCV, or CVVC (Freeland 1951: esp. 11–13; §11, 93–97; §40.I–II). For reasons which will become clear, the First Stem is not equivalent to the underlying representation (UR) of the verb, which is shown in the leftmost column. The Second Stem has the shapes CVCVCC (for disyllabic roots) and CVCC (for monosyllabic roots), the Third CVCCVC, and the Fourth CVCCV. The Third and Fourth Stems may initially be characterized as ‘templatic’, since they consist of two syllables regardless of the number of syllables in the root.

### (99) *Sierra Miwok stems*

	UR	First	Second	Third	Fourth	
a.	/tuyaŋ/	tuyáaŋ-	tuyáŋŋ-	túyyaŋ-	túyŋa-	‘jump’
	/polaaŋ/	poláaŋ-	poláŋŋ-	póllaŋ-	pólŋa-	‘fall’
	/teley/	teléey-	teléyy-	télley-	télye-	‘hear’
b.	/čelku/	čélku-	čélúkk-	čélluk-	čélku-	‘quit’
	/koypa/	kóypa-	koyápp-	kóyyap-	kóypa-	‘suck’
	/nakpa/	nákpa-	nakápp-	nákkap-	nákpa-	‘catch up’
c.	/hame/	hámme-	haméʔʔ-	hámmeʔ-	hámʔe-	‘bury’
	/ʔupi/	ʔúppi-	ʔupíʔʔ-	ʔúppiʔ-	ʔúpʔi-	‘dive’
	/liwa/	líwwa-	liwáʔʔ-	líwwaʔ-	líwʔa-	‘speak’
d.	/lot/	lóot-	lótt-	lóttuʔ-	lótʔu-	‘catch’
	/wek/	wéek-	wékk-	wékkiʔ-	wékʔi-	‘dodge’
	/min/	míin-	mínn-	mínniʔ-	mínʔi-	‘swim’

## 11.1 Quantity and Stress in Sierra Miwok

To understand these alternations, some background regarding the quantity and stress system of Sierra Miwok is necessary. A heavy syllable is either closed or has a long vowel. Closed syllables containing a branching nucleus (CVVC) are disallowed, except word-finally. Main stress falls on either the first or second syllable of the word. The main-stressed syllable is always heavy. If main stress falls on the second syllable, the first syllable is light, as in (100). All page references are to Freeland (1951) although, where necessary, missing glosses in the source have been supplied from Freeland and Broadbent (1960).

- (100) a. (ha.yáː.)po-ʔ ‘chief-SUBJ (F21)’  
 (wa.káː.)li-ʔ ‘creek-SUBJ (F5)’  
 (ka.wáː.)či-ʔ ‘pestle-SUBJ (F5)’  
 (ʔa.séː.)li-ʔ ‘coyote-SUBJ (F19)’  
 (ʔi.šáː.)ma.ti-ʔ ‘bear-SUBJ (F66)’  
 b. (či.kíš.)mu-ʔ ‘towhee-SUBJ (F7)’ (a bird species)  
 (ta.yíš.)mu-ʔ ‘jay-SUBJ (F7)’  
 (pu.lís.)sa-ʔ ‘drinking.basket-SUBJ (F7)’  
 (sa.lí-k.)či-ʔ ‘young.man-DIM-SUBJ (F191)’  
 (pa.lát.)ṭa.ṭa-ʔ ‘woodpecker-SUBJ’

If an initial syllable is heavy, it always carries the main stress (101). Hayes (1995: 250–1,260) describes Sierra Miwok as having an iambic system.

- (101) a. (ʔúː.)ču-ʔ ‘house-SUBJ (F5)’  
 (hóː.)ko-ʔ ‘duck-SUBJ (F76)’  
 (sáː.)wi.ne-ʔ ‘hail-SUBJ (F149)’  
 (híː.)so.ku-ʔ ‘fur-SUBJ (F149)’  
 b. (náŋ.)ŋa-ʔ ‘man-SUBJ (F21)’  
 (óš.)ša-ʔ ‘wife-SUBJ (F38)’  
 (šúk.)ku.mi-ʔ ‘owl-SUBJ (F7)’  
 (šól.)lu.ku-ʔ ‘bow-SUBJ (F36)’  
 (tál.)li.li-ʔ ‘northerner-SUBJ (F26)’

An initial syllable bearing the main stress may be followed by another heavy syllable, as shown in (102).

- (102) a. (húh.)he.pi-ʔ ‘water.spirit-SUBJ (F7)’  
 (wák.)ka.li-ʔ ‘rattle.snake-SUBJ (F7)’  
 b. (yáː.)ya.li-ʔ ‘giant-SUBJ (F7)’  
 (máː.)hiː.na-ʔ ‘porcupine-SUBJ (F7)’  
 (kóː.)yoː.ṭi.mi-ʔ ‘Jamestown-SUBJ (F154)’  
 c. (ták.)kaw.wa-ʔ ‘ground.squirrel-SUBJ (F7)’  
 (húl.)luw.wi-ʔ ‘dove-SUBJ (F162)’  
 (héy.)yim.ma-ʔ ‘outsider-SUBJ (F152)’  
 (sít.)ṭik.ki.ni.wa-ʔ ‘obsidian-SUBJ (F7)’

## 11.2 The First Stem

At first sight, the variation in the shape of the First Stem looks like a lexical property of the verb. However, closer scrutiny reveals that the distribution of quantity and weight is in fact uniquely determined by whether the stem ends in a consonant or a vowel. Lexical stems ending in a consonant are always stressed on the final syllable, and this syllable always contains a long vowel (*tuyáaŋ-*, *lóot-*). Lexical stems ending in a vowel, on the other hand, are always stressed on the first syllable of the stem and contain a consonant cluster or geminate (*čélku-*, *hámm-*). Assuming verbs stems are, for whatever reason, maximally disyllabic, there are several possible stem types that should be deemed phonologically possible but which nevertheless are absent from the inventory of primary stems. There are for example no primary stems consisting of a sequence of two heavy syllables, and neither are there primary stems of the form  $\text{C}\acute{\text{V}}\text{VCV}$  (e.g. *\*hámm-*),  $\text{CVC}\acute{\text{V}}\text{V}$  (*\*hamé-*),  $\text{CVC}\acute{\text{V}}\text{CC}$ , or  $\text{C}\acute{\text{V}}\text{CCVC}$ , all of which are phonotactically and prosodically well-formed.<sup>34</sup> The last two are in fact attested surface forms — associated with the Second Stem of disyllabic verbs and the Third Stem. What all this shows us is that the First stem not a basic form, but is derived like the other stem forms. We take it to be an exponent of *v*, the category feature which is present in all verbs.

The lexical entry which spells out *v* has two allomorphs which are phonologically conditioned, and given in (103). We assume that *V* moves to *v* (and beyond) in Sierra Miwok, so that when *v* is lexicalized it is as a suffix. The allomorph which is selected in case the root is vowel-final is a consonantal mora with a place specification putting it to the left of the nearest branch, which means it is realized in the initial syllable of the root. The allomorph which is used elsewhere (i.e. with consonant-final stems) is a vocalic mora, which causes the nucleus of the final syllable to become heavy.

(103) FIRST STEM

- a.  $\begin{array}{c} \mu \\ | \\ \text{C} \end{array} ; \_ \sigma / \text{V} \_ \Leftrightarrow \langle v \rangle$
- b.  $\begin{array}{c} \mu \\ | \\ \text{V} \end{array} \Leftrightarrow \langle v \rangle$

## 11.3 Finite Tenses

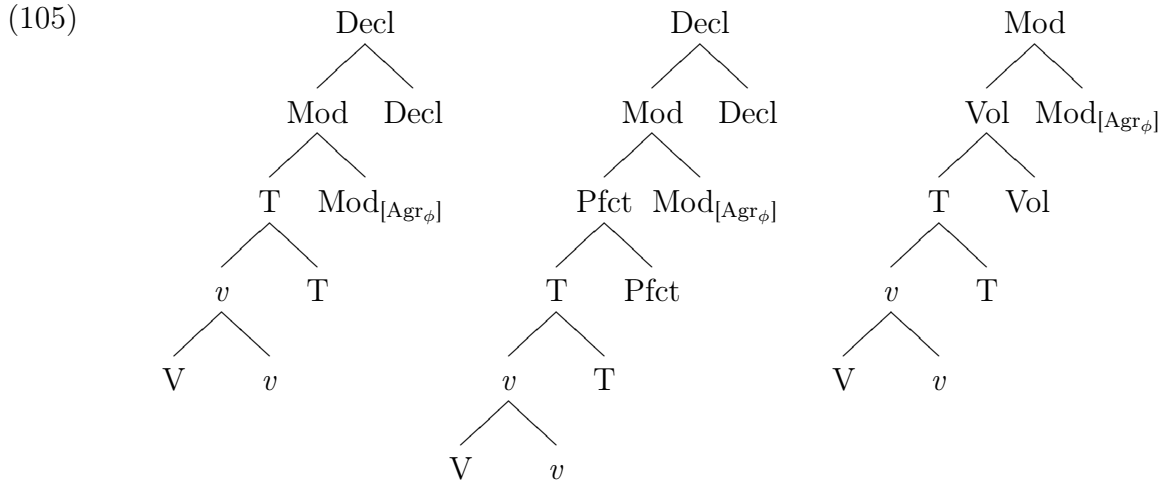
There are three finite tenses, called the present, the perfect, and the volitional. All three are formed on the First Stem, by suffixation, and combine with finite verb agreement (what Freeland calls ‘verbal’ agreement). There are two related series of finite verb agreement, one for the two declarative tenses (present and perfect), and another for the volitional, as illustrated in (104) for the verb-final stem *yíli-* ‘bite’ (the forms in the first two columns are from Freeland 1951: 43, while those in the third column are constructed on the basis of the description in Freeland 1951: 40–98).

<sup>34</sup>In common with many iambic languages, Sierra Miwok appears to disallow final iambs, which would rule out  $\text{CVC}\acute{\text{V}}\text{V}$  in isolation without a suffix. This does not help us much, though, because we are still left with the absence of  $\text{CVC}\acute{\text{V}}\text{V}$  from the underlying inventory, as well as the absence of the other three types.

(104)		Present	Perfect	Volitional
	1sg	yílli-m	yíll-aa-k	yíll-ee-mà?
	2sg	yílli-š	yíll-aa-š	yíll-e?
	3sg	yílli	yíll-aa	yíll-ee-niš
	1plexcl	yílli-màaš	yíll-ak-màaš	yíll-ee-màaš
	1+2	yílli-tùì	yíll-ak-tùì	yíll-ee-tùì
	1plincl	yílli-tùìč	yíll-ak-tùìč	yíll-ee-tùìč
	2pl	yílli-tòòš	yíll-ak-tòòš	yíll-ee-tèèč
	3pl	yílli-p	yíll-aa-p	yíll-ee-niš-kòò
		‘I bite’ (etc.)	‘I have bitten’ (etc.)	‘let me bite’ (etc.)

We will take as a starting point the assumption that all Sierra Miwok main clauses are FinPs and contain a T node for Tense; furthermore, we will assume that TAM features are arranged in a hierarchy like the one identified by Cinque (1999). Not all sentences use one of these three tenses, and so we posit a feature Mood, which we abbreviate Mod, distinguishing these three tenses from others. Semantically, perfect and present are declarative while the volitional is a non-declarative mood, and we posit a feature Decl absent in the volitional. The second person volitional is used as an imperative, and imperatives are often reduced structures (Jensen 2003). However, the volitional in Sierra Miwok has more semantic content, being also used in a range of modal contexts. To represent this, we posit a marked Vol feature present only in the volitional. To distinguish the present from the perfect, we posit another feature Pfct, with a perfect semantics. We have no evidence that Pfct and Vol can combine, but we will assume that this is because the compositional meaning is not useful (“let me have bitten”), and do not rule it out formally.

The syntactic structures for the three tenses can be then represented as in (105), using the head-movement representation, with a non-projecting Agr node on Mod and omitting the Fin\* at the top.



All three sets of forms show the first stem *yílli-*, with a heavy first syllable, because of the consonantal mora spelling out *v*.

Pfct and Vol are spelled out by {-a} (with an allomorph {-ak} before a heterosyllabic consonant) and {-e?} respectively (the latter reducing to -e before consonants), with T null (or, alternatively, {-a}~{-ak} spells out <Pfct,T> and {-e?} spells out <Vol,T>, but there is a null T in the present in any case). There is a systematic lengthening of the final vowel of the stem (phonologically blocked before glottal stop), which might be a moraic exponent of Fin, but may also be purely



phonological.<sup>35</sup>

- (106) *Finite tenses in Sierra Miwok*
- |               |                            |                     |  |
|---------------|----------------------------|---------------------|--|
| $\emptyset$   | $\Leftrightarrow$          | $\langle T \rangle$ | (present)                                    |
| $/a/$         | $(/ak/ \mid \_\text{[C]})$ | $\Leftrightarrow$   | $\langle \text{Pfct}, T \rangle$ (perfect)   |
| $/e\text{?}/$ | $(/e/ \mid \_\text{C})$    | $\Leftrightarrow$   | $\langle \text{Vol}, T \rangle$ (volitional) |

We posit an Agr probe on Mod, and the agreement suffixes which are parsed out in (104) are exponents of Mood plus  $\phi$ -features, as in (107).

- (107) *Finite agreement in Sierra Miwok* (present tense, intransitive or third singular object)
- |                         |                   |  |
|-------------------------|-------------------|--|
| $/m/$                   | $\Leftrightarrow$ | $\langle \text{Decl}, \text{Mod}, 1 \rangle$               |
| $/\check{s}/$           | $\Leftrightarrow$ | $\langle \text{Decl}, \text{Mod}, 2 \rangle$               |
| $/ma\check{s}/$         | $\Leftrightarrow$ | $\langle \text{Decl}, \text{Mod}, \text{Pl}, 1 \rangle$    |
| $/\check{t}i/$          | $\Leftrightarrow$ | $\langle \text{Decl}, \text{Mod}, 1, 2 \rangle$            |
| $/\check{t}i\check{c}/$ | $\Leftrightarrow$ | $\langle \text{Decl}, \text{Mod}, \text{Pl}, 1, 2 \rangle$ |
| $/\check{t}o\check{s}/$ | $\Leftrightarrow$ | $\langle \text{Decl}, \text{Mod}, \text{Pl}, 2 \rangle$    |
| $/p/$                   | $\Leftrightarrow$ | $\langle \text{Decl}, \text{Mod}, \text{Pl} \rangle$       |

In the Declarative tenses, the agreement suffixes also spell out Decl. In the Volitional, there is no Decl and so they do not. At this point, for explicitness we will take a stand on the Subset versus Superset issue. We will assume that semantically interpretable features (like Decl) are overspecified on lexical entries, hence subject to Superset, as proposed by Starke (Caha 2009b: 55), except that we assume that Match matches features preserving relative dominance relations, not subtrees. This allows the same entries in (107) to be used in the volitional, even though there is no Decl projection there.<sup>36</sup>

- (108) Superset (our version)  
 Given a lexical entry L and a contiguous structure S in a spell-out domain, Match associates L to S iff S has a subset of the features specified in L (respecting dominance relations)

Now we briefly address the places where the perfect and the volitional show different suffixes from what is given in (106) and (107), for example the  $\{-k\}$  of the first person singular in the perfect, and the  $\{-ma\text{?}\}$  in the first person singular in the volitional. Neither one can be phonologically motivated; there is no general phonological process which would cause an  $/m/$  after  $/a/$  or  $/aa/$  to be deleted; and even if for some reason the  $/ak/$  allomorph were selected in the first person singular of the perfect, on the basis of Sierra Miwok phonology more generally, we would expect epenthesis.

Since these follow the regular tense suffixes, they suggest that spelling out of Mod can be sensitive to what features are nearby. One way of modeling that would be to posit an agreement probe in Mod which copies tense. Another way would be to allow allomorph selection to be sensitive to syntactic features on neighboring nodes.

<sup>35</sup>These affixes also have allomorphs which are sensitive to the conjugation class of the verb. If conjugation classes have no syntactic interpretation, then they are not categories and do not project, on our assumptions. They might be treated as uninterpretable features, like gender, but if they cannot be copied by agreement probes then they might alternatively be treated as part of the phonological representation of the lexical entry, hence visible to Insert.

<sup>36</sup>Alternatively, if we wanted to use underspecification, then we would make sure that Decl could fail to be spelled out in the tree, by redefining Exhaustive lexicalization, and adjusting lexical entries accordingly.

We will handle the situation by exploiting the power of overspecification and spanning. If  $\{-k\}$  is specified as first person and also Perfect ( $\langle \text{Decl}, \text{Mod}, 1, \text{Pfct} \rangle$ ), then all else being equal, it should preempt the regular perfect suffix by Minimize Exponence. But the regular perfect morpheme also spells out T, so if the special agreement suffix doesn't, then there has to be a distinct spell-out of T anyway. This means there are two morphemes in both cases. The associations considered by Match include the following:

- (109) Possible matches for  $\langle \text{Decl}, \text{Mod}, 1, \text{Pfct}, \text{T} \rangle$
- a.  $\{-\emptyset\} \langle \text{T} \rangle + \{-aa\} \langle \text{Pfct}, \text{T} \rangle + \{-m\} \langle \text{Decl}, \text{Mod}, 1 \rangle$
  - b.  $\{-\emptyset\} \langle \text{T} \rangle + \{-k\} \langle \text{Decl}, \text{Mod}, 1, \text{Pfct} \rangle$
  - c.  $\{-aa\} \langle \text{Pfct}, \text{T} \rangle + \{-m\} \langle \text{Decl}, \text{Mod}, 1 \rangle$
  - d.  $\{-aa\} \langle \text{Pfct}, \text{T} \rangle + \{-k\} \langle \text{Decl}, \text{Mod}, 1, \text{Pfct} \rangle$

We set aside associations with superfluous features in the lexical entries (e.g. 1pl suffixes), since those will be ruled out by Elsewhere. Match discards associations which fail to match features in the tree, as before. As before, spanning entails that single lexical items can associate with multiple nodes in the structure. Now, we also consider the inverse, that single nodes in the structure can be associated with multiple lexical items.

Suppose that Match sends all four of these associations to Insert. Insert then starts from the bottom of the tree, selecting the morpheme with the most associations to higher structure, and respecting phonological conditions. Starting at the bottom, this favors  $\{-aa\} \langle \text{Pfct}, \text{T} \rangle$  over  $\{-\emptyset\} \langle \text{T} \rangle$ , eliminating the first two candidates. Moving up the tree, the evaluation then hinges on whether to select  $\{-m\} \langle \text{Decl}, \text{Mod}, 1 \rangle$  or  $\{-k\} \langle \text{Decl}, \text{Mod}, 1, \text{Pfct} \rangle$ . Pfct is already spelled out by  $\{-a\}$ , so  $\{-m\}$  is the more parsimonious. But on the other hand  $\{-k\}$  is better linked to the structure, if multiple association lines are tolerated. If we assume that they are, and that multiple association is better than parsimony (at least in agreement systems), then the correct candidate is selected by Insert (compare Ramchand's 2008 discussion of underassociation and agree).

The special forms of agreement in the volitional can be handled even more simply by specifying lexical entries which lack the Decl feature.

- (110) Agreement suffixes specific to the volitional
- $/ma?/ \Leftrightarrow \langle \text{Mod}, 1 \rangle$
  - $\emptyset \Leftrightarrow \langle \text{Mod}, 2 \rangle$
  - $/teč/ \Leftrightarrow \langle \text{Mod}, \text{Pl}, 2 \rangle$

These will be preferred by Match over their more fully specified counterparts by the general principle of avoiding unmatched features.

Finally, there are special suffixes in the third person forms of the volitional. There are a number of ways to handle these. As a starting point, consider the entries in (111).

- (111) Additional suffixes appearing only in the third person
- $/niš/ \Leftrightarrow \langle \text{Mod}, \text{Vol} \rangle$
  - $/ko/ \Leftrightarrow \langle \text{Mod}, \text{Pl} \rangle$
  - $\emptyset \Leftrightarrow \langle \text{Decl}, \text{Mod} \rangle$

The idea is that if there are non-third person agreement features, then Mod and Pl will be spelled out by those, and Vol will always be spelled out by  $\{-e?\}$ , so these morphemes will never appear in those cases, by Minimize Exponence. The suffix  $\{-niš\}$  will only appear if there is no non-third

person agreement to spell out Mod; it will be preempted by  $\{-\emptyset\} \langle \text{Decl}, \text{Mod} \rangle$  in the declarative third person singular, and so will be restricted to Vol.

Since Match targets categories, not features, the plural agreement feature is not expected to spell out separately from Mod. This is why  $\{-niš\}$  must be additionally specified as being able to lexicalize Vol, so that  $\{-ko\}$  can be the sole exponent of Mod. However, this seems to render  $\{-niš\}$  unnecessary, since  $\{-eʔ\}$  already lexicalizes Vol, so that  $\{-eʔ\} \langle \text{Vol}, \text{T} \rangle + \{-ko\} \langle \text{Mod}, \text{Pl} \rangle$  should preempt  $\{-eʔ\} \langle \text{Vol}, \text{T} \rangle + \{-niš\} \langle \text{Mod}, \text{Vol} \rangle + \{-ko\} \langle \text{Mod}, \text{Pl} \rangle$  by Minimize Exponence. At this point there are many different possible alternatives, including separating the person and number agreement probes onto separate nodes, or treating third person as a feature (rather than the absence of person features). Instead, we will posit an additional feature in the Volitional, one which is lexicalized by the non-third person agreement suffixes and *niš*, leaving  $\{-eʔ\}$  as the obligatory exponent of Vol.

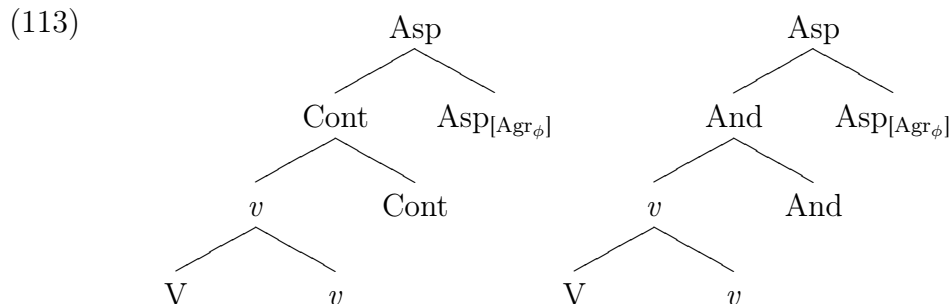
## 11.4 Participles

Now we turn to two additional forms which are constructed on the basis of the first stem but which take a different set of agreement suffixes, a nominal series used on nouns. These are the continuative and the andative (the forms on the left of (112) are from Freeland 1951: 52–53; the forms on the right are constructed on the basis of the description in Freeland 1951: 40–69).

(112)	Continuative	Andative
1sg	náyyɪ-šak-tè-ʔ	náyyɪ-yyii-t
2sg	náyyɪ-šak-nì-ʔ	náyyɪ-yyii-n
3sg	náyyɪ-šaak	náyyɪ-yyii
1pl	náyyɪ-šak-mè-ʔ	náyyɪ-yyii-m
2pl	náyyɪ-šak-tòon	náyyɪ-yyii-tòon
3pl	náyyɪ-šak-koo	náyyɪ-yyii-k
	‘I was scolding’ (etc.)	‘I go to scold’ (etc.)

These nominal agreement suffixes have long forms after a consonant (used with the continuative) and short forms after a vowel (used with the andative). The long forms may be followed by a case suffix (here, nominative -ʔ).

We assume that these forms are participles, following Freeland. In (113) we posit a feature Asp to distinguish participles from other verb forms, and assume that Asp has its own Agr probe to copy the phi-features of the subject. The Continuative represents the least marked expression of Asp, while the Andative includes another feature, And. These might be cumulative (i.e. Andative is built on top of Continuative) but to keep the trees simple we will just posit two different incompatible features.



In the tree on the left, *v*P will spell out as the first stem, as before. The aspectual suffixes are as follows.

- (114) *Continuative and Andative participles in Sierra Miwok*  
 {-šak} ⇔ <Cont> (Continuative)  
 {-yyii} ⇔ <And> (Andative)

The agreement suffixes have to be specified with special short forms, only possible when the preceding participle is vowel final and there is no following case suffix, but are otherwise unremarkable. For the third person singular, we either posit a null Asp or else assume that Cont and And can spell out Asp when it has no agreement features.

We assume there is a null auxiliary which spells out Fin and T together, used with the participles. The null auxiliary does not allow the expression of perfect or volitional. Since the Mood projection is absent, there is no agreement on the null auxiliary, and so participles appear unsupported, to function as the main verb in main clauses.

## 11.5 The Second Stem

Two important tenses are formed on the second stem, the future and the recent past. They are participial like the andative and continuative, showing the nominal agreement series. Here are three examples showing the distinctive form of the second stem (recall that the Second Stem ends in a moraic consonant and has stress on the final syllable).

- (115)
- | Gloss    | Recent Past | Future     |
|----------|-------------|------------|
| ‘dance’  | kaláŋŋ-e-   | kaláŋŋ-ik- |
| ‘put’    | wíkk-e-     | wíkk-ik-   |
| ‘appear’ | lakíšš-e-   | lakíšš-ik- |

Since these forms take nominal agreement, we assume that they contain the same Asp node as we saw in the Andative and Continuative. In addition to Asp, they contain a low inner aspectual feature Perfective, which we abbreviate Pfiv, whose semantics introduces a boundedness which implies non-overlap with the present and whose exponent causes the distinctive shape of the second stem (compare the use of the perfective aspect to express future tense in Russian). Since the future and recent past affixes are between Asp and Pfiv, we assume that they reflect the Retrospective and Prospective heads identified by Cinque (1999) (compare the ‘going to’ future of English, and the use of the perfect to express past tense in German). Trees for the recent past and the future are given in (116).

- (116)
- ```

graph TD
    Asp1[Asp] --- Retr1[Retr]
    Asp1 --- AspA1[Asp[Agr_φ]]
    Retr1 --- Pfiv1[Pfiv]
    Retr1 --- Retr2[Retr]
    Pfiv1 --- v1[v]
    Pfiv1 --- Pfiv2[Pfiv]
    v1 --- V1[V]
    v1 --- v1a[v]

```

```

graph TD
    Asp2[Asp] --- Pros2[Pros]
    Asp2 --- AspA2[Asp[Agr_φ]]
    Pros2 --- Pfiv3[Pfiv]
    Pros2 --- Pros3[Pros]
    Pfiv3 --- v2[v]
    Pfiv3 --- Pfiv4[Pfiv]
    v2 --- V2[V]
    v2 --- v2a[v]

```

The second stem is not derived from the first. Therefore, we posit a portmanteau morph which spells out Pfiv and *v* together. Since the form of the first stem was caused by a morpheme spelling out *v*, the existence of the Pfiv-*v* portmanteau will prevent the first stem pattern from appearing in the context of Pfiv. As with the participles discussed above, these participles will occur with the null auxiliary lexicalizing Fin and T.

We suggest that the lexicalization of the second stem involves suffixing a consonantal root node (C) which is associated with a mora. If the verb stem ends in a consonant underlyingly, the consonantal root node coalesces with it. If it ends in a vowel, the featureless consonantal root node may be dealt with in one of two ways. Either it attracts one of the consonants of the stem into it, resulting in metathesis, or it is realized as a default consonant [ʔ]. In the interests of keeping lexical representations simple we might entertain the possibility of dispensing with the moraic consonant, given the inviolable requirement in Sierra Miwok that a stressed syllable be heavy. Suppose the weight of the stem-final syllable is simply the result of this requirement. This would leave the association of the mora undetermined, since a heavy syllable may be CVV or CVC. This would thus not account for the alternation found in stems ending in a CVVC syllable, which alternate with CVCC. The lexical entry is formulated in (117) below.

$$(117) \quad \text{SECOND STEM} \\ \mu \\ | \\ \text{C} \Leftrightarrow \langle v, \text{Pfiv} \rangle$$

If the underlying stem lacks a final consonant, there is either metathesis of the final C◌V sequence, as in (99-b), or insertion of a glottal stop /ʔ/, as in (99-c). The choice between the two is left to the interaction of independently motivated phonological constraints to sort out. Consider the Second Stem of the first and fourth lexical stem classes (CVCVVC and CVVC). The most expedient way of satisfying the final consonant requirement is by using existing material. These interactions are illustrated in the tableau (119). The empty consonant of the suffix must surface faithfully on the right edge (high-ranked RIGHT-ANCHOR(C)). High-ranked SPEC requires that the empty consonant be filled featurally in one way or another. By ranking DEP(C) above UNIFORMITY (McCarthy and Prince 1995) in (118), coalescence of the empty consonant and the final consonant of the stem is preferred over epenthesis to render the empty consonant interpretable. Realizing C as, say, a glottal stop, would also necessitate vowel epenthesis, which would also violate DEP(V).

$$(118) \quad \text{UNIFORMITY} \\ \text{No element of the output has multiple correspondents in the input.}$$

In the interests of space, only candidates that satisfy SPEC are shown in the tableaux. Epenthetic segments are indicated with Greek letter indices. Note that, although the moraic consonant of the suffix coalesces with the epenthetic glottal stop, UNIFORMITY is not violated, since the consonant still only has one input correspondent.

$$(119) \quad \text{tuyaŋ ‘jump 2.STEM’}$$

|                                                             |     |            |
|-------------------------------------------------------------|-----|------------|
| $\mu$<br> <br>tuya $\eta_1$ +C $_2$                         | DEP | UNIFORMITY |
| a. $\mu$<br> <br>tuyá $\eta_1$ i $_{\alpha}$ ? $_{\beta,2}$ | *!* |            |
| b. $\mu$<br> <br>tuyá $\eta_1$ ? $_{1,2}$                   |     | *          |

Now let us turn to vowel-final stems of the form CVCCV and consider how they behave under suffixation of a moraic consonantal root node. In this case there are two possibilities, metathesis and epenthesis. Which of these we get depends on whether the medial CC is a cluster or a geminate. When it is a cluster, it is preferable to metathesize than epenthesize. The constraint ranking that enforces this preference is DEP[F]»LINEARITY. This is shown in (120).

(120) /čelku/ ‘quit 2.STEM’

|                                                   |     |            |           |
|---------------------------------------------------|-----|------------|-----------|
| $\mu$<br> <br>čelk $_1$ u $_2$ +C $_3$            | DEP | UNIFORMITY | LINEARITY |
| a. $\mu$<br> <br>čelk $_1$ ú $_2$ ? $_{3,\alpha}$ | *!  |            |           |
| b. $\mu$<br> <br>čelú $_2$ k $_{1,3}$             |     | *          | *         |

Metathesis is ruled out in CVCV stems like /hame/ because attraction of the medial C into the final position would create a vowel hiatus (a), in violation of ONSET, which is inviolate in Sierra Miwok. Candidate (b) evinces metathesis and repairs the resulting hiatus through insertion of a glottal stop, but is harmonically bounded by the winning candidate (c).

(121) /hame/ ‘bury 2.STEM’

|                                                     |       |     |            |           |
|-----------------------------------------------------|-------|-----|------------|-----------|
| $\mu$<br> <br>ham $_1$ e $_2$ +C $_3$               | ONSET | DEP | UNIFORMITY | LINEARITY |
| a. $\mu$<br> <br>ha.é $_2$ m $_{1,3}$               | *!    |     | *          | *         |
| b. $\mu$<br> <br>ha.? $_{\alpha}$ é $_2$ m $_{1,3}$ |       | *   | *!         | *         |
| c. $\mu$<br> <br>ham $_1$ é $_2$ ? $_{3,\alpha}$    |       | *   |            |           |

## 11.6 The Third Stem

The Third Stem is characterized by a heavy closed first syllable and ends in a consonant. It appears in two tenses, the habitual and the ‘venitive’ (coming to do). It is also the basis for



the most frequently used negative form in the language, which is based on the habitual, and it is selected by some aspectual or ‘adverbial’ operators, including a continuative, a discontinuous iterative, and one which is glossed ‘here and there’.

- (122) *Third stem tenses*  
kállaŋ-i:- ‘dance-HAB.AG’  
kállaŋ-wa:- ‘dance-NEG.HAB.AG’  
šíyyeŋ-i:-t̩ ‘see-VEN.AG-1SG.APPOS’
- (123) *Third stem aspectual forms*  
wíkkiš-puttu- ‘go.along-CTN’  
héllek-i:- ‘peep-ITER’

We can take the third stem to represent Impf, a feature with imperfective semantics. As with Pfiv, its presence causes agreement to be expressed using the nominal paradigm.

The Third Stem differs from the Second in that it apparently requires positing a disyllabic template. The evidence is the behaviour of CVC stems, which remain monosyllabic in the Second Stem, but in the Third Stem are augmented with a syllable. The disyllabicity requirement poses problems for the view that templates emerge from the prosodic system of the language. Downing (2006) argues that stems are morphologically complex, comprising a root and an affix (Morphological Binarity Theory, MBT). In many languages, she argues, stems are subject to a minimal disyllabicity, PROSODICSTEM. The problem with applying this theory to Sierra Miwok is that disyllabicity is only a property of the Third and Fourth Stems. There is no disyllabicity requirement on the Second Stem, and it is not clear why it should be exempt. We have seen that the Second Stem, although lacking a prosodic template, requires that the stem end in a consonant. We dealt with this requirement in the morphology not by invoking a template but by concatenation — suffixation of a consonantal root node. We then left it to the phonology to determine how this empty root node was to be filled with content. The template effect ‘must end with a consonant’ is thus an emergent effect of underspecification and phonological constraint interaction.

We adopt the same approach to the Third Stem; it is a portmanteau exponent of Impf and *v* together. We assume no disyllabicity requirement as such (whether construed in terms of Generalized Template Theory or Downing’s MBT), but suggest that disyllabicity, like consonant-finality in the Second Stem, emerges from phonological constraint interaction. First let us determine what lexicalization of the Third Stem entails. To begin with, there must also be a moraic consonant that attaches to the first syllable. The Third Stem must end in a consonant, this time non-moraic. These will coalesce respectively with the stem-final and post-nuclear consonants under the same assumptions discussed above. The empty consonantal root node must be immediately preceded by an empty vowel, as in the lexical entry in (124). Where the lexical entry has a second vowel, the empty vowel will coalesce with it. Otherwise, the empty vowel will receive its featural content by epenthesis.

- (124) THIRD STEM
- $$\begin{array}{c} \mu \\ | \\ C ; \sigma_1 , C \Leftrightarrow \langle v, \text{Impf} \rangle \end{array}$$

Tableaux (125) to (127) show how the new input fares in the phonology. To simplify the exposition, we only show candidates where the first half of the Third Stem exponent, the moraic consonant, is correctly attached to the first syllable. We focus instead on how the phonology deals with the

second half, the suffixal bare consonant. The tableau in (125) shows using the constraint hierarchy already established that it is preferable to coalesce than to epenthesize to fill an empty root node. In candidate (a), the bare C linearizes after the root material (facilitated by epenthesis), while (b) coalesces C with the last consonant of the root.

(125) túyyaŋ- ‘jump 3.STEM’

| $\mu$<br> <br>tuya <sub>1</sub> ŋ <sub>2</sub> +{C;σ <sub>1</sub> }, C <sub>3</sub> | DEP | UNIFORMITY |
|-------------------------------------------------------------------------------------|-----|------------|
| a. túyya <sub>1</sub> ŋ <sub>2</sub> i <sub>α</sub> ? <sub>β,3</sub>                | *!* |            |
| b. ➞ túyya <sub>1</sub> ŋ <sub>2,3</sub>                                            |     | **         |

Our previously motivated ranking also derives the preference for metathesis (d) over epenthesis (a–c) in (126).

(126) čélluk- ‘quit 3.STEM’

| $\mu$<br> <br>čelk <sub>1</sub> u <sub>2</sub> +{C;σ <sub>1</sub> }, C <sub>3</sub> | ONSET | DEP   | UNIFORMITY | LINEARITY |
|-------------------------------------------------------------------------------------|-------|-------|------------|-----------|
| a. čelk <sub>1</sub> u <sub>2</sub> i <sub>α</sub> ? <sub>β,3</sub>                 | *!    | **    |            |           |
| b. čelk <sub>1</sub> u <sub>2</sub> ? <sub>α</sub> i <sub>β</sub> ? <sub>γ,3</sub>  |       | *!*** |            |           |
| c. čelk <sub>1</sub> u <sub>2</sub> ? <sub>α,3</sub>                                |       | *!    |            |           |
| d. ➞ čéllu <sub>2</sub> k <sub>1,3</sub>                                            |       |       | *          | *         |

Now consider (127). Candidate (a) is again eliminated on grounds of syllable well-formedness. Candidates (b–d) all violate the next highest ranked constraint DEP, but (b) fares worse here than either (c) or (d). Candidates (c) and (d) fare equally on DEP, and so the task of deciding between the two is passed down to constraints further down in the hierarchy. Candidate (c) is harmonically bounded by (d), scoring additional marks on both UNIFORMITY and LINEARITY.

(127) hámmē?- ‘bury 3.STEM’

| $\mu$<br> <br>ham <sub>1</sub> e <sub>2</sub> +{C;σ <sub>1</sub> }, C <sub>3</sub> | ONSET | DEP  | UNIFORMITY | LINEARITY |
|------------------------------------------------------------------------------------|-------|------|------------|-----------|
| a. hámm <sub>1</sub> e <sub>2</sub> i <sub>α</sub> ? <sub>β,3</sub>                | *!    | **   |            |           |
| b. hámm <sub>1</sub> e <sub>2</sub> ? <sub>α</sub> i <sub>β</sub> ? <sub>γ,3</sub> |       | **!* |            |           |
| c. há? <sub>α</sub> e <sub>2</sub> m <sub>1,3</sub>                                |       | *    | *!         | *         |
| d. ➞ hámm <sub>1</sub> e <sub>2</sub> ? <sub>α,3</sub>                             |       | *    |            |           |

The atemptatic analysis we have been developing faces a challenge in the monosyllabic CVC stems. If coalescence is permitted, why do we not find coalescence of the suffix with the stem in this case? This would result in homophony between the Second and Third Stems of CVC root, e.g. we<sub>1</sub>k<sub>2</sub>+C<sub>μ,3</sub>, C<sub>4</sub>→[we<sub>1</sub>kk<sub>2,3,4</sub>]. In disyllabic roots such as /tuyaŋ/ and /čelku/, the two

consonant root nodes in the affixal material coalesce with different consonants in the stem. With a monosyllabic root such as /wek-/, on the other hand, both consonant root nodes would have to coalesce with the root-final consonant, resulting in a segment that was the result of two instances of coalescence. Adopting a proposal by Smolensky (1993, 1995, 1997), this may be analyzed as an instance of local constraint self-conjunction: UNIFORMITY may not be violated more than once in the same segment. Ranking the locally self-conjoined constraint  $\text{UNIFORMITY}_{\text{seg}}^2$  above DEP will force epenthesis, even though coalescence is preferred to epenthesis in the general case. This is shown in (128). The monosyllabic candidate (c) scores a fatal violation of  $\text{UNIFORMITY}_{\text{seg}}^2$ , which leaves the disyllabic candidates (a) and (b), both of which fare equally on DEP (2 violation marks each) and UNIFORMITY (1 mark each). Candidate (a) has a subset of candidate (b)'s marks, however, which incurs an additional violation of LINEARITY.

(128) wékki?- ‘dodge 3.STEM’

| $\mu$<br>we <sub>1</sub> k <sub>2</sub> +{C <sub>3</sub> ;σ <sub>1</sub> }, C <sub>4</sub> | $\text{UNIFORMITY}_{\text{seg}}^2$ | DEP | UNIFORMITY | LINEARITY |
|--------------------------------------------------------------------------------------------|------------------------------------|-----|------------|-----------|
| a. $\text{we}_1\text{kk}_{2,3}\text{i}_{\alpha}\text{i}_{\beta,4}$                         |                                    | **  | *          |           |
| b. $\text{we}_1\text{i}_{\alpha}\text{i}_{\beta,3}\text{k}_{2,4}$                          |                                    | **  | *          | *!        |
| c. $\text{we}_1\text{k}_{2,3,4}$                                                           | *!                                 |     | **         |           |

## 11.7 The Fourth Stem

The Fourth Stem is characterized by a heavy closed first syllable and ends in a vowel. Freeland identifies it as a kind of nominalization, and we assume that is correct.

The fourth stem turns up with suffixes indicating states, including prospective (‘wish to, be on the point of’), desiderative (‘wish to, be ready to’), and resultative (describing ‘a state that is the result of previous activity’, p. 130;§52.4).

(129) *Fourth stem*

|            |                                                    |
|------------|----------------------------------------------------|
| ʔíwʔi-     | ‘eat-INF’                                          |
| pólŋa-yɲi- | ‘fall.down-PROS (be on the point of falling down)’ |
| ʔíwʔi-ksi- | ‘eat-DES (be ready to eat)’                        |
| púšti-mši- | ‘become.dark-STAT (be in the dark)’                |

The fourth stem is also used to form what Freeland (p. 80, §35.1; p. 149, §58.I.A) terms the ‘first infinitive’. This form is a verbal noun that may be used as the object of certain verbs, e.g. *čélkum tɛyʔeɣ-y* ‘I am quitting sleeping’, *kučíkkim tɛyʔeɣ-y* ‘I like sleeping’.

We suggest that the Fourth Stem is a nominalization formed on the Third Stem. The Fourth Stem entails the suffixation of an empty vowel root node to the Third Stem. The existing ranking is sufficient to account for the Fourth Stem form across all classes, as shown in (130). Again, metathesis is preferred to epenthesis, this time of a vowel.

(130) tuyŋa- ‘jump 4.STEM’

|    | tuyya <sub>1</sub> ŋ <sub>2</sub> +V <sub>3</sub>  | DEP | UNIFORMITY | LINEARITY |
|----|----------------------------------------------------|-----|------------|-----------|
| a. | tuyya <sub>1</sub> ŋ <sub>2</sub> i <sub>α,3</sub> | *!  |            |           |
| b. | ☞ tuyŋ <sub>2</sub> a <sub>1,3</sub>               |     | *          | *         |

On our approach, then, the stem-forming morphology is importantly just like any other inflectional formative. Our approach is supported by the fact that templatic effects are not restricted to the basic stem categories, as prosodic effects are observed in many places in Sierra Miwok; several suffixes cause lengthening of the stem-final vowel, e.g. *čikilla-* ‘stick’ vs. *čikilla:-ši-* ‘with a stick’. The adverbial suffix {-teyni-} ‘around’ seems to require a CVVCVC template. Part of the lexical specification of this suffix would therefore require a moraic vocalic root node specified as attaching to the first syllable. Some of the apparent templates fall outside the four-stem system. Thus, Sierra Miwok is simply a language which makes more use of certain kinds of underspecified affixes than other languages, and there is no special distribution of the templatic effects.

## 12 Conclusions

As we mentioned at the outset, the rubric of non-concatenative morphology covers a heterogeneous range of phenomena, including autosegments, infixes, subtraction, overwrite, and templates. The very existence of such phenomena is sometimes taken to show that morphology is not morpheme-based. However, we have outlined a morpheme-based approach which we think handles the challenges while simultaneously capturing the fact that morphology in the default case is concatenative.

Specifically, we have argued that exponence can be more than a mapping of structure to a unique shape; it must sometimes include a specification of the place of exponence. Stipulating that individual morphemes linearize in marked ways allows us to capture infixes as well as second-position clitics and other edge-sensitive phenomena. We agree with the syntactic literature that many affixes and second position clitics are placed by syntax, but find a residue of cases which motivate the use of place attributes. These place attributes may further specify a particular pivot (e.g. in the case of infixes), attachment site (in the case of overwrite), or even overwrite the edge orientation given by universal linearization algorithms. Not all non-concatenative effects imply a place attribute, however. The examples of autosegmental affixes discussed in this paper may be seen as inheriting their linearization from the syntax in the normal way. The non-concatenative effects they give rise to may be understood as a result of their phonological deficiency. To summarize, minimally enriching the theory of Spell-Out with position attributes, and formally detailing the procedure of Spell-Out and its interaction with listed allomorphs of different kinds, allows us to pursue the goal of a purely morpheme-based theory of morphology, free of destructive morphological processes like morphological subtraction and metathesis, and morphological output conditions (templates). Subtraction, we additionally suggest, is caused by the addition of a feature which renders a segment unpronounceable, forcing the phonology to delete it.

On the phonological side, the new division of labour we envision drastically reins in the proliferation of constraints in the OT grammar, not least because language-specific and morpheme-specific requirements of place in structure are reassigned to Spell-Out. Rather than allowing essentially lexical requirements to compete alongside phonological constraints in an extrinsically ranked hierarchy, lexical entries compete intrinsically via the Minimize Exponence and Elsewhere Principles. Once lexicalization has taken place, phonological modifications may be made after Spell-Out in the OT grammar relying only on well-motivated constraints. The division of labor thus allows us

to pursue OT's original goal of grammar plus 'inherent typology.'

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