Chapter 20: The role of morphology in Generative Phonology, Autosegmental Phonology and Prosodic Morphology

1 Introduction

The role of morphology in the rule-based phonology of the 1970's and 1980's, from classic GENERATIVE PHONOLOGY (Chomsky and Halle 1968) through AUTOSEGMENTAL PHONOLOGY (e.g., Goldsmith 1976) and PROSODIC MORPHOLOGY (e.g., McCarthy & Prince 1999, Steriade 1988), is that it produces the inputs on which phonology operates. Classic Generative, Autosegmental, and Prosodic Morphology approaches to phonology differ in the nature of the phonological rules and representations they posit, but converge in one key assumption: all implicitly or explicitly assume an item-based morphological approach to word formation, in which root and affix morphemes exist as lexical entries with underlying phonological representations. The morphological component of grammar selects the morphemes whose underlying phonological representations constitute the inputs on which phonological rules operate. On this view of morphology, the phonologist is assigned the task of identifying a set of general rules for a given language that operate correctly on the inputs provided by the morphology of that language to produce grammatical outputs.

This assignment is challenging for a variety of reasons, sketched below; as a group, these reasons helped prompt the evolution from classic Generative Phonology to its Autosegmental and Prosodic descendants, and have since led to even more dramatic modifications in the way that morphology and phonology interact (see Chapter XXX).

First, not all phonological rules apply uniformly across all morphological contexts. For example, Turkish palatal vowel harmony requires suffix vowels to agree with the preceding stem vowels (*paşa* 'pasha', *paşa-lar* 'pasha-PL'; *meze* 'appetizer', *meze-ler* 'appetizer-PL') but does not apply within roots (*elma* 'apple', *anne* 'mother'). The response to this lack of uniformity is either to morphologically condition the rules in question, or to alter the phonological representations of morphemes in a way that accounts for the (non)application of the phonological rules in question. The former approach reached full flower during the period covered in this article in the form of the theory of Lexical Morphology and Phonology (Kiparsky 1982a). The latter approach is seen in the evolution of autosegmental and prosodic representations, as well as in the increased use of underspecifiation during this era.

Second, not all morphemes are phonologically canonical, in the sense of consisting of a contiguous segmental string. Item-based theories of morphology operate transparently when morphemes adhere to what Bye and Svenonius (2012) describe as a 'concatenative ideal', as described by the following characteristics (among others):

(1)
a. Proper precedence: morphemes are linearly ordered (i.e. no overlapping
b. Additivity: morphemes are additive (i.e. no subtraction)
c. 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)
d. Morpheme preservation: morphemes are preserved when additional morphemes are added to them (i.e. no overwriting)

To this list one might add another ideal:

(2) e. Generality: namely that the phonological component be able to apply to the output of morphology in a fully general manner (i.e. no exception statements for individual morphological environments)

As with the canons of Corbett's (2005) Canonical Typology, actual morphological systems depart from these morphophonological ideals in almost every way. For example, the only phonological substance shared across the entries in a derivational Arabic verb paradigm is their consonants (e.g., McCarthy 1979, 1981); this unpronounceable collection of consonants (e.g. {k,t,b} for the verb meaning 'write') is identified as the root of the verb (see section 4.1). The only phonological substance associated with 3rd person masculine singular object agreement in Chaha is labialization of the rightmost (nonpalatalized) noncoronal consonant in the verb (*nækæs* 'bite', *nækʷæs* 'bite him'; *mækʲær* 'burn', *mʷækʲær* 'burn him' (McCarthy 1983:179) (see section 3.2). These phenomena violate Proper precedence, Autonomy — and if not those, then Generality. Yet they are not singularities. As the areal focus of morphology and phonology expanded in the 1970's and 1980's beyond European languages to the rest of the globe, the documented instances of phenomena like this multiplied correspondingly.

Retrospectively, one can see the 1970's and 1980's as a time in which phonological theory was driven by the impetus to solve these apparent problems for item-based morphology. This perspective that shapes the current chapter, which is structured as follows. Section 2 summarizes the key developments from classic generative phonology to its autosegmental and prosodic rule-based successors. Sections 3-5 discuss the role of morphology in inspiring an array of representational innovations in rule-based phonological theory. Section 6 addresses a residue of morphological processes that resist straightforward representational phonological solutions. Section 7 discusses phonological patterns that appear not to be fully general, i.e. which appear to have some morphological conditioning, and their implications for the structure of the phonological component of grammar. Section 8 concludes.

2 The trajectory from generative phonology

As outlined in *The Sound Pattern of English* and taught for decades in introductory classes in phonology and phonological theory, classic Generative Phonology makes three key assumptions that are relevant to our discussion. First is the GENERATIVE assumption that morphemes are stored as underlying representations and that the job of the phonological grammar is to map these underlying representations to surface representations. Second is the RULES assumption, namely that underlying representations are transformed into surface representation by means of the applications of phonological rules which actively alter representations. Third is the assumption that phonological REPRESENTATIONS, both underlying and surface, consist of (strings) of segments, which are themselves fully or partially specified matrices of distinctive features.

The GENERATIVE assumption underlies the term 'generative phonology' and persists through the representational evolutions from the eponymous Generative Phonology of the *Sound Pattern of English* into Autosegmental Phonology and Prosodic Morphology. (It even persists into Optimality Theory (see Chapter XX), though competes there with the assumption that all representations are surface-only.) The RULES assumption persists as well throughout most of this era, though the evolution toward a more constraint-based model of grammar does begin to

emerge in the era covered in this chapter, as in the Obligatory Contour Principle, discussed in sections 3.1.1 and 4.1. The wholesale rejection of RULES, however, reaches full flower only with the ascent of Optimality Theory in the 1990's.

The REPRESENTATIONS assumption is the main change that this chapter will focus on. Autosegmental theory and Prosodic Morphology are almost entirely representational innovations. Autosegmental theory, discussed in section 3, explodes the segment by introducing 'floating features' and featurally underspecified timing units; morphemes may consist of, and rules may operate on, either or both. Prosodic Morphology, discussed in sections 4 (on templatic morphology) and 5 (on reduplication), takes the representation of timing units to a new level, enabling a more insightful characterization of templatic morphological form. This new representational flexibility enables phonologists to posit underlying representations for morphemes which depart from the classical canon.

We turn next to more in-depth examination of these representational developments and their empirical motivations.

3 Morphemes as subsegmental units

Phonological theory was transformed by the development of autosegmental representations, which broke distinctive features out of segmental matrices and treated them, and the timing units they associate with, as independent entities in the grammar. Many excellent surveys of autosegmental phonology exist, including but not limited to Goldsmith 1976, 1979, 1990; Clements 1980; Halle & Vergnaud 1983; and Akinlabi 2011.

3.1 Tone

Phonologists working on African tone languages presented some of the strongest early arguments for decoupling features from the segments containing them.

3.1.1 Tone melodies

One of the strongest early elements for extracting tone out of segments was the need to characterize tonal melodies independently of the vowels bearing the tones. In the 1970's, discussion focused on languages like Mende (Leben 1973, 1978; though cf. Dwyer 1978, Conteh et al. 1983) in which the only available tonal melodies available to morphological roots in the system are H, L, HL, LH, HLH. The component tones of these melodies are distributed in highly predictable ways over the vowels (or, more precisely, 'tone-bearing units' of the words). A similar pattern applies in Kukuya stem (Hyman 1987). The Mende examples, below, are drawn from Leben 1978:

(3) Tone patterns on monosyllabic words

H	H	kɔ́	‘war’	pɛ́lɛ́	‘house’	háwámá	‘waist’
L	L	kpà	‘debt’	bɛ̀lɛ̀	‘pants’	kpàkàlì	‘three-legged chair’
Fall	HL	mbû	‘owl’	ngílà	‘dog’	félàmà	‘junction’
Rise	LH	mbǎ	‘rice’	fǎndé	‘cotton’	ndàvúlá	‘sling’
Rise-Fall	LHL	mbǎ̀	‘companion’	nyàhâ	‘woman’	nìkílì	‘peanut’

If 5 atomic tones existed, we might expect 25 possible tone patterns on disyllabic words and 125 patterns on trisyllabic words. Moreover, we would lack an explanation for why HHL contours do not contrast with HLL, why stretches of level tone are restricted to the ends of words, and why contour tones (Rise, Fall) are found only on the final syllable. These problems were solved with three major additions to phonological theory: an autosegmental tier for tone, the Obligatory Contour Principle, and a set of Universal Association Conventions. All three proposals (broadened to other features and known collectively as “Autosegmental phonology”) turned out to have much broader applicability within phonological theory.

Researchers such as Leben, Hyman, Williams (1976), Goldsmith (1976), and Pulleyblank (1986) posited an independent tonal ‘tier’ on which tones could exist autonomously with segments. Tone melodies thus take on an existence independent of the segmental makeup and syllable count of the stems they are lexically affiliated with; the association of these tones to tone-bearing units is predictable.

In order to explain why the melody inventory is so limited, and specifically why contrasts like HL vs. HLL vs. HHL were thought not to occur in systems like Mende, Leben (1973, 1978) invoked what Goldsmith (1976:36) later termed the Obligatory Contour Principle (OCP):

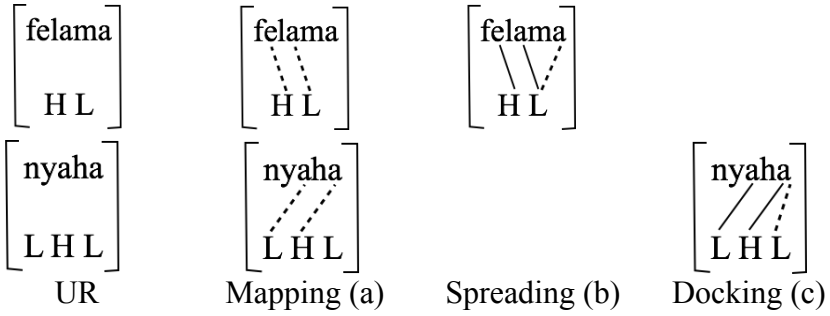
(4) Obligatory Contour Principle: Adjacent identical autosegments are prohibited

A striking early result of autosegmental work on tone was the emergence of seemingly universal conventions of autosegmental association which map tonal autosegments to potential tone-bearing units (Goldsmith 1976; the statement below is from Pulleyblank 1986):

(5) Association conventions for tone:
- a. Map a sequence of tones onto a sequence of tone-bearing units,
  - i. from left to right
  - ii. in a one-to-one relation
- b. A linked tone spreads rightward to any remaining unspecified tone-bearing units
- c. Leftover tones are assigned to the rightmost tone-bearing unit
- d. Association lines may not cross

Example (6) illustrates the conventions are showing applying below to two of the Mende words from (3):

(6)



This analysis captures a phonological generalization holding over morphemes — roots — in Mende. But it also extends to generalizations holding over complex words. In Mende, toneless suffixes such as *–ma* 'on' join into the domain of tone association, such that a disyllabic root with a LHL melody, in combination with *–ma*, surfaces with the same tones as a trisyllabic root with a LHL melody:[1]

(7) *nyàhá-mà* 'woman-on' (cf. *nyàhâ* 'woman')

This 'duplication' problem, in which root structure conditions are mirrored by conditions holding over words (see e.g. Kenstowicz & Kisseberth 1979:427), had a major influence on phonological theory, principally in the development of Optimality Theory (see Chapter XXX). Even during the era covered by the present chapter, however, the duplication problem was significant; it prompted cyclic analysis in which the same set of phonological rules could potentially apply to roots and (again) to affixed stems (section 7.3).

3.1.2 Tonal affixes

An even stronger argument from morphology for the postulation of floating autosegments is provided by featural affixes, whose only phonological content is manifested as the addition of or change to a feature. Morphological processes without clear segmental morphs to mark them are potentially problematic for item-based approaches to morphology (e.g., Chomsky 1957, Lees 1960, Halle 1973, Lieber 1980, and many others). Autosegmental phonology addressed this problem by permitting individual phonological features to be treated as autonomous objects.

Consider, for example, the genitive construction in Igbo. This construction juxtaposes two nouns and imposes a tonal change which is straightforwardly described by analyzing the genitive morpheme as a floating tone which associates to a nearby vowel (Williamson 1968, via Hyman 2011):

(8)	a.	Central Igbo	àgbà	+		+	èŋwè	→	àgbá èŋwè	'jaw of monkey'
			L L		H		L L		L H L L	

[1] Leben (1978) observes that LH melodies, in particularly, do not always display predicted linking behavior; in some roots, the H of the LH melody links to the last available vowel, leaving L to spread to the preceding vowels. This latter pattern is actually the norm in Kukuya (Hyman 1987). The behavior of these LH melodies was an early crack in the universality of the Linking Conditions. For discussion of this and other exceptions to tone mapping in Mende, see Dwyer 1978, Conteh et al. 1983.

b. Aboh Igbo ẹ̀gbà + + èŋwè → ẹ̀gbá èŋwè ‘jaw of monkey’
L L H L L L H L L

A similar phenomenon occurs in Bamileke-Dschang, where the associative morpheme is analyzed by Hyman (1985) as a floating L tone whose presence causes phonetic downstep, transcribed as a raised exclamation point:

(9) Bamileke-Dschang genitive marker: floating L (Hyman 1985)[2]

a. séŋ ‘bird’
H
séŋ ꜜséŋ séŋ ꜜséŋ ‘bird of bird of bird of bird’
H L H L H L H
b. kàŋ ‘squirrel’
L
kàŋ ꜜkàŋ ꜜkàŋ ꜜkàŋ ‘squirrel of…of squirrel’
L L L L L L L

In Hausa, a suffixed floating L tone produces a falling contour on a final H-toned syllable, as illustrated below by the verbal noun-forming *-(L)wá:* and the definite *(L)-r* (feminine) and *(L)-n* (masculine) suffixes (Newman 2000):

(10) a.

verb	verbal noun	
ká:wó:	ká:wô:-wá:	‘buy/buying’
káràntá:	káràntâ:-wà:	‘read/reading’
lí:ƙè:	lí:ƙè:-wà:	‘patch/patching’

b.

noun	definite noun	
gídá:	gídâ:-n	‘house/the house’
rì:gá	rì:gâ-r	‘gown/the gown’
ƌă:kì:	ƌă:kì-n	‘hut/the hut’

Hyman (1987) and Pulleyblank (1986) made the influential argument that the assignment of floating affixal tone follows from the Association conventions. One piece of evidence offered by Hyman are the tonal melodies in Kukuya verbs. Kukuya verbs exhibit the same five tone melodies as Mende nouns — but with the twist that the LHL melody occurs only with complex verbs, in which the L portion is supplied by the root and the HL portion by a suffix (the aorist, in the following examples).

[2] The floating L genitive marker alternates with an allomorph that has a fixed vowel.

(11) Realizations of L root melody + HL suffix melody in Kukuya (Hyman 1987:314)

a. (ndɛ́)-bvĭ̀ ‘(he) falls’
b. (ndɛ́)-kàầy ‘(he) loses weight’
c. (ndɛ́)-pàlî ‘he goes out’
d. (ndɛ́)-bàámɨ̀ ‘he wakes up’
e. (ndɛ́)-kàlə́gɨ̀ ‘he turns around’

Pulleyblank (1986)’s analysis of Tiv provided further support. As seen below, the Recent Past and General Past tenses in Tiv are encoded only by means of tone melody affixation. Recent Past suffixes a HL melody, while General Past prefixes a L:

(12)

	Underlying stem tone	Recent Past	General Past
‘come’	H	vé	ꜜvá
‘hear’	H	óngó	ꜜúngwà
‘flee’	H	yévésè	ꜜyévèsè
‘go’	L	dzé	dzà
‘refuse’	L	vèndé	vèndè
‘accept’	L	ngòhórò	ngòhòrò

Pulleyblank argues that the linking of the floating affixal tones follows from the universal rules of tone association. As seen below, floating tones associate in a left-to-right, one-to-one manner on each morphological cycle.

(13) Derivation of *ngòhórò* ‘accepted, Recent Past’ and ꜜ*yévèsè* ‘fled, General Past’

UR	[[ngohoro] H] L ‘accept, recent past’	[L [yevese]] H ‘come, general past’
Root cycle: association of underlying tone	ngohoro L	yevese H
Stem cycle: association of affix tone	ngohoro L H	yevese L H
Word level: association of default L tone	ngòhórò	ꜜyévèsè

The generalization that lexical stem tone is always realized on the first stem syllable, and that suffix tone is realized on the second stem syllable, follows from the first universal Association convention in (5). Note, however, that Tiv does not exhibit automatic left-to-right spreading. Instead, default Low is assigned to toneless TBU’s.

3.1.3 Universality of tone rules

The 1980's were a period during which phonologists tended to complicate representations in order to simplify rules, as characterized in this well-known quote from McCarthy 1988:84),

> "During the last 10 years or so, phonological theory has made great progress … by adhering to two fundamental methodological premises. The first is that primary emphasis should be placed on studying phonological representations rather than rules. Simply put, if the representations are right, the rules will follow."

Note, however, that even the meager set of morphologically sensitive tonal alternations seen so far is problematic for the universality of the Association conventions. In Bamileke Dschang associatives and in the Tiv General Past, floating L tones do not dock to form contours, thus violating Association convention (5c). Convention (5b) is flouted in Tiv, in which tone does not automatically spread rightwards to toneless TBU's. And even Association convention (5a) turned out to be language-specific. To take one example, Newman (1986) observed that Hausa tone patterns appear to associate from right to left. Example (14) shows that in Hausa, the imperative form of verbs replaces lexical tone with a uniform LH melody:

(14)

Declarative		Imperative (LH)	Gloss
HL	rúfè꞉	rùfé꞉	'close'
HLH	bíncìké꞉	bìncìké꞉	'investigate'
H	nánné꞉mó꞉	nànnè꞉mó꞉	'seek repeatedly'
LH	sò꞉yú	sò꞉yú	'be fried'

The fact that the LH imperative melody associates to trisyllabic words as L*H, rather than as H*L, suggests either right-to-left or what Yip (1988) terms 'edge-in' tone association, in which peripheral melodic elements associate to peripheral skeletal positions. Either way, the example shows the language particularity of tone association rules. The role of morphology in the development of the autosegmental approach to tone is thus twofold: providing evidence *for* autosegmental representations, and providing evidence *against* universal tone association principles.

3.2 Segmental features

Beyond tone, the 1980's saw a wave of support for autosegmentalization in a variety of areas. In this section we touch on evidence coming from morphology.

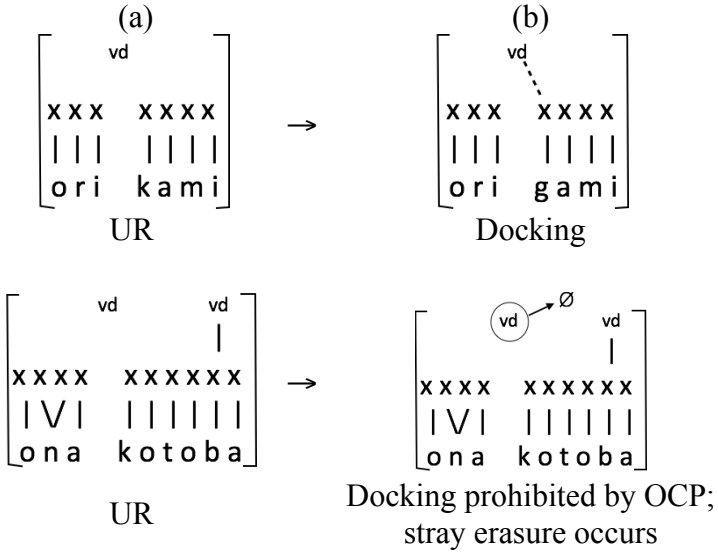
One of the most influential morphological arguments for autosegmental features other than tone is presented by Itô and Mester (1986) in their analysis of Japanese Rendaku voicing, which famously targets the initial obstruent of native Japanese lexical items serving as the second member of endocentric noun-noun compounds. Rendaku voicing is shown applying in (15a,b). In (15c), however, it is blocked by 'Lyman's Law', the prohibition against Rendaku voicing if the undergoer contains a voiced plosive in another position (data from Itô & Mester 1986):

(15)

a.	ori	kami	→	origami	
	‘fold’	‘paper’		‘paper folding’	
b.	kokoru	tsutai	→	kokorudzutai	
	‘heart’	‘usage’		‘consideration’	
c.	onna	kotoba	→	onnakotoba	*onnagotoba
	‘woman’	‘speech’		‘feminine speech’	

Itô and Mester’s influential analysis of Rendaku voicing posits a floating voicing ([vd]) feature which is introduced by the morphological compounding construction, much like the floating tones of the genitive and associative constructions in Igbo and Bamileke-Dschang, seen above. The [vd] feature docks to the first consonant of the second member (16a). Linking is blocked, however, if another [vd] feature exists on the same tier (16b):

(16)



The constraint responsible for Lyman’s Law is the Obligatory Contour Principle (4), the same constraint that prohibits two adjacent floating H tones in the melodies of Mende roots and Kukuya stems.

Rendaku voicing provided evidence for a further refinement to phonological theory, namely what Mester and Itô (1989) subsequently termed ‘contrastive underspecification’. Autosegmental representations already necessarily assume some degree of underspecification; Mende vowels, for example, are not underlyingly linked to tones. In Japanese, underspecification is crucially context-sensitive. Vowels and nasal consonants, though phonetically voiced, do not interfere with the application of Rendaku, as seen in (15a,b). Itô and Mester argue that sonorant segments lack a phonological [voice] feature in the lexical phonology; only obstruents may be lexically specified for voicing. The contextual underspecification of voicing on sonorants accounts for their invisibility to the OCP constraint enforcing Lyman’s Law.

Our next example, Chaha, played an important role in phonological theory in showing that inflectional morphology could be manifested solely by phonological featural changes — and that the association of those features is not only to edges. Example (17a) shows that 2nd person feminine singular is encoded on imperative verbs by End Palatalization, which targets the final

consonant. 3rd person masculine singular object marking is accomplished by Rightmost Labialization, targeting the rightmost noncoronal consonant (17b). Impersonal forms of the verb are marked by both End Palatalization *and* Rightmost Labialization (17c) (McCarthy 1983:179):

(17) a. *2nd person feminine singular realized by final palatalization:*

Imperative 2 masc sg	Imperative 2 fem sg	gloss
nəqəṭ	nəqəṭ^{y}	'kick'
g^{y}æk^{y}ət	g^{y}æk^{y}ət^{y}	'accompany'
nəmæd	nəmæd^{y}	'love'
nəkəs	nəkəs^{y}	'bite'
wəṭæq	wəṭæq^{y}	'fall'
fəræx	fəræx^{y}	'be patient'

b. *3rd person masculine singular object realized by labialization of rightmost noncoronal:*

	Perfective (no object)	Perfective (3 masc sg object)	gloss
i.	dænæg	dænæg^{w}	'hit'
	nækæb	nækæb^{w}	'find'
ii.	nækæs	næk^{w}æs	'bite'
	kæfæt	kæf^{w}æt	'open'
	qæṭær	q^{w}æṭær	'kill'
iii.	mæk^{y}ær	m^{w}æk^{y}ær	'burn'
iv.	sædæd	sædæd	'chase'

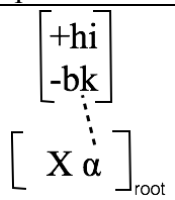
c. *Impersonal realized by both labialization and palatalization:*

	Personal	Impersonal	
i.	kæfæt	kæf^{w}æt^{y}	'open'
ii.	bænær	b^{w}ænær	'demolish'
iii.	nækæb	nækæb^{w}	'find'

McCarthy's (1983) analysis, carrying forward an earlier observation by Hetzron (1971), is that: "the feature complexes [+high, -back] and [+round] are morphemes marking various properties of the verb" (p. 178). These featural morphemes associate to root consonants by the autosegmental rules of Rightmost Labialization (18a) and End Palatalization (18b), which must be crucially ordered to account for Impersonal forms like (17ci,ii), in which Labialization applies first and potentially blocks Palatalization. No single consonant can be both labialized and palatalized.

(18)

a) Rightmost labialization:	
[+rd] ⋮ $[Q\ \alpha\ X]_{root}$	Condition: Q is maximal. Note: X represents a maximal final string of non-labializable segments

b) End palatalization:	
	(Applies only if α is a palatalizable consonant in Chaha)

McCarthy's analysis of Chaha dramatically converted an apparent case of process morphology to a clear case of regular affixation — albeit of abstract morphemic representations. Here again, autosegmental representations allow otherwise exiled nonconcatenative morphological processes to enter the large tent of item-based morphology.

A question at this juncture is whether the rules required to associate subsegments to skeletal positions are actually all that general — i.e., whether the representations do indeed do all the work. For example, the Chaha rules above target the rightmost skeletal position, not the leftmost, as the Universal Association Rules in (5) would predict.

This 'residue' of phonological rules which are not fully general but have to access specialized morphological information is addressed in Section 7.

4 Prosodic templates: morphemes as prosodic skeleta

Prosodic morphology is diagnosed when any morphological construction imposes a fixed phonological shape on the stem it creates, regardless of the varying shapes of the morphemes composing the stem. Prosodic templaticity (this section) and reduplication (section 5), in particular, played a major role in the development of phonological representations and the nature of phonological rules during the 1970's and 1980's.[3]

The most influential prosodic morphological templates in the literature are those of the Arabic verbal paradigm, as famously analyzed by McCarthy (1979, 1981); this work inspired many other analyses of templaticity in other languages. Initially templates were characterized in CV terms. The realization in the late 1980's and early 1990's that templates can be insightfully analyzed in terms of the prosodic hierarchy, namely mora, syllable, foot, prosodic word (McCarthy and Prince 1986), inspired a tidal change in phonological analysis, with more and more phenomena attributed to prosodic considerations. Whether templates are atomic lexical objects or compositionally constructed by grammatical rules or constraints is a question that also began to arise during this time; it has been taken much further in the era of Optimality Theory (Chapter XXX).

We begin our coverage of prosodic templates with Arabic, moving next to influential developments in Yowlumne and Japanese.

4.1 Paradigmatic templaticity: Semitic morphology

Most discussions of prosodic templates include a description of the verbal system of Arabic, in which each derivational category ('binyan') is associated with a fixed skeletal shape (McCarthy 1979, 1981; see also McCarthy & Prince (1990) on templatic patterns in Arabic plural nouns).

[3] Prosodic morphological templates are not to be confused with morphological templates whose purpose is to describe or control the order of affixes; on the latter, see e.g. Chapter YYY.

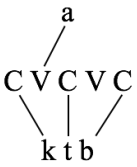
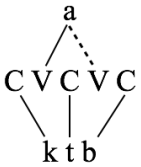
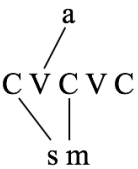
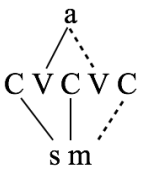
The root morpheme of each Arabic verb is purely consonantal, and the vocalic melody comes from a third morphological source. The partial examples below illustrates how skeletal shape varies across binyanim for the same consonantal root, and how vowel melodies vary by aspect/voice within a binyan:

(19)

		Perfective		Imperfective	
Binyan	# root consonants	Active	Passive	Active	Passive
I	3	katab	kutib	aktub	uktab
	3	kaðab			
	2	samam			
II	3	kattab	kuttib	ukattib	ukattab
	3	kaððab			
	4	daḥraj	duḥrij	udaḥrij	udaḥraj
III	3	kaatab	kuutib	ukaatib	ukaatab
	3	raasal			
IV	3	ʔaktab	ʔuktib	uʔaktib	uʔaktab
XI	3	ktaabab		aktaabib	
	4	dḥarjaj	dḥurjij	adḥarjij	udḥarjaj

McCarthy's foundational insight was that each binyan could be represented as a skeletal morpheme, a template defined in terms of C and V units. The association between these templatic positions and the consonants of the root and the vowels of the aspect/voice morpheme are determined by the Universal Association Conventions seen earlier in (5):

(20)

	UR	L-R, 1-1 association	Spreading	
a.	a C V C V C k t b			*= katab*
b.	a C V C V C s m			*= samam*

A striking prediction of this model is that, assuming the OCP is in force, the consonants of a bilateral root such as $\sqrt{\text{sm}}$ 'poison' will associate to a three-consonant template in left-to-right, one-to-one fashion, with the rightmost consonant spreading from the second to the third consonantal skeletal position (20b). This derives Greenberg's famous (1978) generalization to the effect that given a verb with three surface consonants of which two are identical, it is never the case that the first and second are identical (thus *samam*, but never **sasam*).

Cast in these prosodic and autosegmental representation terms, the templatic morphology of Arabic is brought more in line with canonical concatenative affixation. Templates, vocalic melodies and consonantal roots are all morphemes with fixed phonological substance. The fact that they combine 'vertically' instead of 'horizontally' is an effect of their representations: none of these morphemes can syllabify and be pronounced on its own.

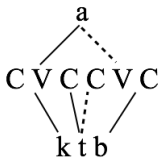
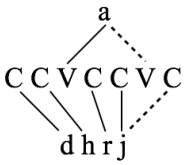
A question for this wildly successful analysis of Arabic is this: how fully general within the language (or universal grammar) are the association rules for Arabic? Clearly, capturing Greenberg's Generalization is a huge coup for the Universal Association rules. However, we have seen that in other languages those rules are not so exceptionless. And indeed, even in Arabic, McCarthy (1981) remarks that a number of special statements have to be made in order to fully account for the details of the system. For example, Binyan II and Binyan VII both contain 4 consonant slots. When roots with fewer than 4 consonants map to these templates, a consonant must double. The Universal Association conventions predict the last consonant to spread, as seen above for the root √sm → *samam* (Binyan I). But this is not the pattern seen in (21). Root √ktb 'write', in combination with template CVCCVC, is realized as *kattab*, not **katbab* as predicted by the Universal Association Conventions.

(21)

	Root	Predicted by UAC	Actual
Binyan II: CVCCVC	√ktb	**katbab*	*kattab*

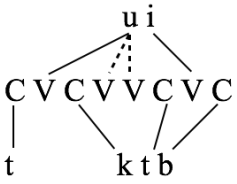
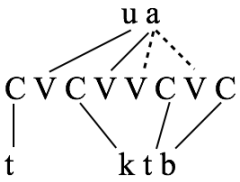
It is not the case that templatic association is prohibited from forming consonant clusters; compare Binyan XI with quadriliteral root √dhrj , which is realized as *dḥarjaj*, not **dḥarraj*. It appears that Binyan II invokes a different spreading convention than Binyan XI. McCarthy (1981) and McCarthy and Prince (1986) invoke a Binyan-specific internal gemination rule for this purpose; alternatively, it may be that Binyan II exhibits 'edge-in' association (e.g., Yip 1988).

(22)

Binyan II	cf. Binyan XI
	
'Edge-in' association or special internal gemination: *kattab*	Left to right association: *dḥarjaj*

The vowel /i/ also requires special association. In defiance of the Universal Association Conventions, a melody-final /i/ gravitates directly to the last vowel position:

(23)

Binyan VI, Perfective Passive	cf. Binyan VI, Passive Participle
	
'Edge-in' associationor special exception for /i/: *tukuutib*	Left to right association: *tukaatab*

The take-away point from this discussion is that highly advanced tools of phonological analysis make the Arabic templatic morphological constructions look more mainstream and additive than they might initially appear, capturing clear generalizations about Arabic verb stem shape and bringing Arabic verb combinatorics more into line with what is seen in concatenative affixing systems. However, it is still the case that the phonological component needs to perform some morphologically specific operations in order to account for every detail. It is not the case that the representations are so exactly correct that phonological rules (or constraints) can simply apply blindly. This caveat is relevant to the discussion of morphologically conditioned phonology in section 7.

4.2 Pervasive templaticity: Japanese minimality

In Arabic, it is the case that the entire verbal paradigm is characterized by closely related templates, but it is not the case that any one template applies to all words in the language. Japanese (as well as Lardil, another influential case discussed in the late 1980's and 1990's) is an example where bimoraic templaticity is truly pervasive and affects a diverse array of morphological constructions.

Detailed discussions of Japanese bimoraicity can be found in Itô (1990) and Poser (1984, 1990, as well as in the many sources cited therein. In Japanese, a short vowel is one mora, a long vowel is two moras, and a coda consonant contributes one mora. The bimoraic foot can therefore take three forms: a foot composed of two monomoraic syllables ($[CV]_{\omega}[CV]_{\omega}$), a bimoraic open syllable ($[CVV]_{\omega}$), and a bimoraic closed syllable ($[CVC]_{\omega}$):

As shown in a detailed study by Itô (1990), a bimoraic template is imposed on a variety of morphologically derived stems. Example (24) illustrates loanword clipping, which produces derived words of either one (24a) or two (24b,c) bimoraic feet:

(24)	a.	amachua	→	ama	'amateur'
		herikoputaa	→	heri	'helicopter'
	b.	furasutoreeshoN	→	furasuto	'frustration'
		asuparagasu	→	asupara	'asparagus'
	c.	hebii metaru	→	hebi meta	'heavy metal'
		paasonaru koNpyuutaa	→	paso koN	'personal computer'

Example (25) illustrates the imposition of a bimoraic stem template in tandem with the suffixation of /-tyan/, which form nicknames from proper girls' names. Names which are

trimoraic or longer shorten (25a-c), and names which are monomoraic will lengthen to conform to the bimoraic template (25d) (Poser 1984):

(25) a. megumi → megu-tyan
wa-sabu-roo → wasa-tyan
b. syuusuke → syuu-tyan
kinsuke → kin-tyan
c. midori → mii-tyan, mit-tyan, mido-tyan
d. ti → tii-tyan

An interesting wrinkle in the Japanese case is that bimoraic minimality is not imposed on monomorphemic words in Japanese, including verbs like *mi* 'look' and *ne* 'sleep' as well as nouns like *ki* 'tree', *e* 'picture', *no* 'field', *na* 'name', *su* 'vinegar' (Ito 1990:218).

Monomoraic CV roots do, however, undergo vowel lengthening when reduplicated or compounded, e.g. *mi* → *mii-mii* 'while looking', *ne* → *nee-nee* 'while sleeping'; cf. *tabe* 'eat' → *tabe-tabe* 'while eating' (Poser 1990, Itô 1990:226).

The immunity of monomoraic roots to the demands of the bimoraic template can be understood, as observed by Itô (1990), as a species of derived environment restriction, the topic of section 7.3.3.

4.3 Morpheme-specific templaticity: Yowlumne

While the Arabic and Japanese examples might give the impression that templaticity is a systemic trait of a language, other cases discussed in the 1980's revealed that templaticity can be highly morphologically particular. The prosodic templates specific to individual roots and affixes in Yowlumne (Yokuts, Penutian; known in the literature as Yawelmani (Newman 1944)) energized phonological theory when they were introduced into the generative literature by Archangeli (1983, 1984, 1991); see also Noske (1985).

Verb roots in Yowlumne consist of one distinctive vowel and two or three consonants. Each root is lexically associated with one of the three templates in (26).

(26) σ_{μ} (=CVC)
$\sigma_{\mu\mu}$ (=CVVC)
$\sigma_{\mu}\sigma_{\mu\mu}$ (=CVCVVC)

Root vowel and consonants map to the template in a predictable, left-to-right manner, modeled in autosegmental and prosodic phonology by Archangeli (1983, 1984, 1991:125). For example, the root $\sqrt{\text{yawl}}$ 'follow' is lexically associated with the $\sigma_{\mu\mu}$ template, to which its vowel /a/ and consonants /y,w,l/ map to produce the string *yawaal*.[4]

A root's lexical template characterizes the shape of the root when it combines with the non-templatic suffix, e.g. aorist *-hin (~ -hun)* Archangeli 1991:247):

[4]Cited Yowlumne forms follow the transcription convention of Archangeli (1983, 1991), who in turn follows Newman 1944 except for using vowel doubling rather than a raised dot to indicate vowel length.

(27)

		Root	Template	Root + aorist /-hin/
a.	‘shout’	√caw	σμ	**caw**-hin
	‘float’	√hogn	σμ	**hogin**-hin (< |hogn-hin|)
b.	‘devour’	√cum	σμμ	**c’om**-hun (< |c’oom-hin|)
	‘consent’	√cupn	σμμ	**coopun**-hun (< |cuupun-hun|)
c.	‘become quiet’	√ni	σμσμμ	**ninee**-hin (< |ninii-hin|)
	‘follow’	√yawl	σμσμμ	**yawaal**-hin

A number of Yowlumne suffixes are templatic, lexically associated with one or another of the three templates in (26). When a root combines with a template-selecting suffix, the root conforms to the template associated with the suffix, rather than to the template associated lexically with the root. In (28), we see three different roots combining with the consequent adjunctive suffix, which imposes the iambic template. Each of the three roots illustrated here is itself lexically associated with a distinct template. These root templates are irrelevant in the consequent adjunctive: each root conforms perfectly to the demands of the iambic template associated with the affix. Forms in (28) are based on Newman (1944:163):

(28) a. √t'ul **t’uloo**-ʔuy lit ‘burn-CONS.ADJ’ (< |t’uloo-ʔuy|)
(cf. lexical monomoraic root template, *t’ul*-)

b. √tan **tanaa**-ʔeey lit. ‘go-CONS.ADJ’ = ‘footprint’
(cf. lexical bimoraic root template, *taan*-)

c. √c'uy **c’uyoo**-ʔoy-nu lit. ‘urinate-CONS.ADJ-IND.OBJ’ (<|c’uyoo-ʔoy-nu|)
(cf. lexical iambic root template, *c’uyoo*-)

In (29), roots associated with three different lexical templates combine with the desiderative affix *-hatin*, which imposes a moraic template. The roots all conform to the affix-associated template, surfacing as monomoraic with a single short vowel. Data from Newman 1944:114:

(29) a. √linc' **linc’**-atin ‘speak-DESID’
(cf. lexical monomoraic root template, *linc’*-)

b. √wuʔy **wuʔy**-atin ‘go to sleep-DESID’
(cf. lexical bimoraic root template, *wooʔy*-)

c. √liʔ **liʔ**-hatin ‘sink-DESID’
(cf. lexical iambic root template, *liʔee*-)

Yowlumne is also a significant language in the development of phonological theory because of the high degree of phonological opacity it exhibits, for which the templatic morphology is partly responsible. Long high vowels shorten to mid in Yowlumne. Vowel length is provided by morphological templates. An underlying (short) high vowel may lengthen templatically, lower by rule, and then shorten again if, in the course of subsequent affixation, it

ends up being syllabified into a closed syllable. The result is an opaque short mid vowel, as in *c'omhun* in (27c).

Yowlumne opacity is mentioned in virtually every textbook and discussion of phonological opacity in the 1970's and 1980's (e.g. Kenstowicz and Kisseberth 1979), and also features in later theoretical developments seeking to eliminate rule ordering or to sharply delimit the range of opacity effects. See, for example, Lakoff 1993), arguing that rule ordering can be replaced in this instance by reference to three levels of representation, as well as Cole and Kisseberth 1995; McCarthy 1999, 2007; among many others.

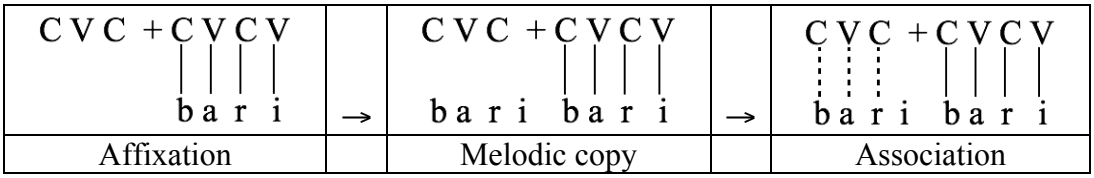
5 Reduplication

Reduplication, whether total or partial, poses a challenge to Bye and Svenonius's 'concatenative ideal' (1). The response to this challenge resulted in a number of developments in phonological theory during the 1970's and 1980's.

The greatest novelty of reduplication is the mysterious instruction of 'phonological copy'. While feature assimilation is a standard element of any phonological theory, the nature of reduplicative copying strained the ability of phonological theories of this era. Copying was not in the toolbox of standard generative phonology. How can reduplicative morphology be rationalized in an item-based approach to morphology?

The solution to this problem lay, first, with the realization that the same abstract structures used to characterize templates could also represent partial reduplicative morphemes (Marantz 1982, Broselow and McCarthy 1983). In a clarion call, Marantz (1982) proposed to rationalize reduplication as 'simply the affixation of a skeleton to a stem'. Example (30) illustrates CVC prefixing reduplication in Agta. Affixation of a CVC skeleton triggers full copy of all the segments in the base; these associate, by universal conventions, to the prefixal skeleton. Unassociated segments are deleted:

(30)



After some debate about whether the reduplicative skeleton should consist of C and V elements, as Marantz proposed, or instead simply of X timing units (Levin 1985), contemporaneous studies of reduplication by Steriade (1988) and McCarthy and Prince (1986) persuaded phonologists to convert to the same types of prosodic units that we saw above in the analysis of prosodic templates: moras, syllables, feet. This conversion was inspired by cases like Mokilese (Harrison & Albert 1976), in which the only way to give a consistent characterization of the shape of the reduplicative prefix is to say that reduplication adds a bimoraic syllable (McCarthy & Prince 1986). The nature of the segments in the added syllable, as well as the existence of extra copied segments outside that syllable to supply an onset to the following syllable, cannot be captured as succinctly or insightfully in a CV or X skeletal approach.

(31)

Skeletal shape	Prosodic shape	Stem	Progressive	Gloss
CVC	$\sigma_{\mu\mu}$	pɔdok	pɔd-pɔdok	‘plant’
VCC	$\sigma_{\mu\mu}$	andip	and-andip	‘spit’
CVV	$\sigma_{\mu\mu}$	pa	paa-pa	‘weave’

The power and elegance of this approach was tempered by two general concerns: more identity than expected (section 5.1), and less identity than expected (section 5.2), between base and reduplicant.

5.1 Identity effects

Wilbur noted in an early, seminal (1973) study that the application of phonological segmental rules to the output of reduplication is sometimes inhibited — or, conversely, catalyzed — in reduplication, in service of the maintenance of identity between the two copies.

In Tagalog, a famous and influential example of reduplicative ‘overapplication’ involves internal CV root reduplication which interacts with a rule of Nasal Substitution operative at the prefx-root boundary (Bloomfield 1933:122). Clements (1985) discusses the example of the Tagalog stem *sayaw* ‘dance’, which undergoes both the morphological processes of *maŋ-* prefixation and root-initial CV reduplication. The result is *ma-na-nayaw.* This form is derived by applying Nasal Substitution (*ŋ-s → n*) across the internal boundary; Nasal Substitution precedes and feeds reduplication. Assuming a morphological structure of *maŋ-CV_{Red}-sayaw*, this is an instance of ‘overapplication’ of fusion; ‘normal application’ would produce the incorrect *maŋ-sa-sayaw → *manasayaw.*

In Javanese, certain vowel-initial suffixes trigger the deletion of stem-final /h/ (32a), vs. (32b) (Horne 1961, Sumukti 1971, Dudas 1976; see McCarthy & Prince 1995 for discussion). A suffixed reduplicated stem undergoes normal /h/ deletion — but exactly when it does, the first copy loses its /h/ as well, even though no vowel follows (32c). Note, as in (32d), that reduplication itself does not cause /h/ deletion when no triggering suffix is present. (Data in (32a) are from Dudas 1976:164 and Sumukti 1971:92; data in (32b) are from Dudas 1976:133; data in (32c)-(32d) are from Dudas 1976:207.)

(32)

a.	aneh	‘strange’	ane-e	Demonstrative suffixation: h-deletion
	kokoh	‘rice in soup’	kɔkɔ-e	
	sarɛh	‘patient’	sarɛ-ɔ	Hortatory suffixation: h-deletion
b.	adɔh	‘far’	ng-adɔh-ake	Causative suffixation: no h-deletion
	akɛh	‘much, many’	ng-akɛh-ake	
c.	bəḍah	‘broken’	bəḍa-bəḍa-e	Root reduplication + suffixation: double deletion
	ḍajɔh	‘guest’	ḍajɔ-ḍajɔ-e	
d.	bəḍah	‘broken’	bəḍah-bəḍah	Root reduplication
	ḍajɔh	‘guest’	ḍajɔh-ḍajɔh	

Wilbur (1973) generalized over effects like these with a global Identity Principle stating that base and reduplicant tend to be identical even when phonological rules might change one but not the other. However, phonological theory of the time was not suited to the incorporation of such a principle, and it hung uncomfortably on the outskirts of the theory until its reification as a

correspondence constraint in McCarthy & Prince's (1995) Base-Reduplicant Correspondence Theory (see Chapter XXX).

Lacking a constraint-based theory in which to comfortably embed the Identity Principle, researchers in the 1970's and (especially) the 1980's sought representational solutions to the reduplicative identity problem. For example, both Clements (1985) and Mester (1986) developed analyses in which reduplicative association precedes the linearization of reduplicant and base. To account for the overapplication of Nasal Substitution in Tagalog, Mester (1986) proposed to do away with melodic copy and associate the reduplicative template directly to the segments of the base, on a separate skeletal tier (33a). On this account, nasal substitution applies once, to the shared segmental string (33b). A subsequent process of linearization, or what Mester termed 'Tier conflation', produces the copy effect (33c):

(33) Reduplication of /paN-takot/ (→ *pa-na-nakot*) in Tagalog (Mester 1986:183)

a. Morphemic representation:	C V | | p a N t a k o t | | | | | C V C V C
b. Nasal substitution:	C V | | p a n a k o t | | | | | C V C V C
c. Tier conflation (linearization):	p a n a n a k o t | | | | | | | | | C V C V C V C V C

Reduplicative overcopying of segmental alternations is a form of opacity. In the rule-ordering theory of the 1970's and 1980's, opacity was invariably handled by the ordering of operations, such that the later operations obscured the environments of the earlier operations. This is seen in the derivation, above, in Mester's (1986) analysis. Many instances of opacity arise through morphological combination, as in the case of reduplication or, in Yowlumne, templatic morphology. It is interesting to observe in hindsight that opacity was easy to handle and not viewed as particularly problematic in the 1970's and 1980's, but became much more of an issue for phonological theory in the surface-oriented, constraint-based theories of the 1990's and beyond.

5.2 Reduplicative reduction

Reduction is a striking characteristic of many cases of partial reduplication. It produces a *lack* of identity between base and reduplicant. Reduplicative reduction played an important role in the development of phonological theories of underspecification (Pulleyblank 1988) and, later, Unmarkedness (Steriade 1995). In an important early paper in the study of partial reduplication, Steriade (1988) noted that partial reduplicants were often reduced or unmarked versions of the bases that they copied. For example, prefixing partial intensive reduplication in Sanskrit does not

preserve onset clusters, reducing them to their initial (less sonorant) element (Marantz 1982:fn. 9, Steriade 1988:108):

(34) kan-i-krand 'cry out'
ban-i-bhranr- 'fall'
dhan-i-dhvans- 'sound'

This phenomenon is puzzling for phonological theory. Clearly Sanskrit tolerates onset clusters; only prefixed reduplicants lack them. How can this morphologically conditioned phonological generalization be insightfully captured?

As Marantz notes, preposing a CVC- (rather than CCVC) template could account for the reduction from two to one consonants, but would not predict *which* consonants associate, vs. delete. A major contribution of Steriade (1988) was to observe that reduplicants, when they differ in such ways from their bases, are relatively *unmarked*. Singleton onset are less marked than complex ones; obstruents are less marked (in onsets) than sonorants. Steriade's observations about unmarkedness shared with Wilbur's (1973) Identity Principle the property of being ahead of their time. Later, however, Steriade's insights were incorporated very straightforwardly into the ground-breaking Base-Reduplicant Correspondence Theory of McCarthy & Prince 1995).

Looking back on the phonological analysis of reduplication in the 1970's and 1980's, we can see two themes. The first is, as throughout this chapter, the attempt to rationalize apparently processual reduplication as straightforward affixation to which phonology applies in a regular manner. Despite the best attempts, however, it was still the case that the essential copying process is specific to reduplication. Unlike autosegments, CV skeleta or prosodic units, the copying devices above were not of broader, more general utility in phonological theory. In the current era, this problem has been mitigated by the introduction of Agreement by Correspondence theory, which uses the same formal apparatus to handle reduplication and phonological assimilation; see e.g. Hansson 2001, Rose & Walker 2004, Yu 2005, Inkelas 2008.

A second theme is the emerging need for phonological well-formedness constraints, in addition to phonological rules. Wilbur's (1973) Identity constraint, though clearly on the outer edges of the realm of phonology, nonetheless belongs to the same family of constraints that includes the Obligatory Contour Principle (Goldsmith 1976), itself motivated in part by the analysis of Arabic root morphemes (McCarthy 1979, 1981) and the tonal melodies characterizing morphemes in Mende, Kukuya and other languages (Leben 1978, Pulleyblank 1986, Hyman 1987). And the markedness parameters that Steriade elucidated in her 1988 analysis of Sanskrit reduplication paved the way for the theory of markedness in Optimality Theory (Prince and Smolensky 1993).

6 Truncation and subtraction

Some morphology cannot be analyzed as the addition of an affix because the outcome of the morphological operation is a subset of the phonological material present in the input. There are two subcases of this phenomenon, both of which grabbed the attention of researchers in the 1970's and 1980's. One is truncation, in which the input is mapped to an invariant prosodic template which happens to be smaller than the input. (Many cases of truncation actually flip and become augmentation in case the input happens to be smaller than the template; see Japanese,

discussed in section 4.2.) The other is true subtraction, arguably the very most problematic type of morphology for strongly item-based approaches.

Much of what there is to say about truncation was already covered above in the discussion of templates: studies of truncation flourished in the 1980's, inspired by McCarthy and Prince's (1986) observation that the prosodic units to which stems can be truncated as part of particular morphological constructions are the same units found in prosodic templates and in the metrical systems of the languages in question: mora, syllable, foot, and prosodic word. Morphological truncation can operate alone or in tandem with affixation, as in the Japanese hypocoristics in (25).

Truncation, like reduplication, can be handled as additive morphology as long as one accepts that the phonological component will 'stray erase' segments that can't be mapped to the template for lack of space. English nickname formation illustrates this process in (35). In one case, templatic truncation (to a heavy syllable) is accompanied by suffixation of *–y*; in the other case, it is unaccompanied:

(35) Daniel + $\sigma_{\mu\mu}$, *-y* → σ σ Daniel + $\sigma_{\mu\mu}$ → σ

μ μ μ μ μ

Dan ~~iel~~ –y Dan ~~iel~~

(stray erasure) (stray erasure)

Not all process morphology is readily amenable to analyses of template association and stray erasure. Subtractive morphology is particularly resistant to an additive analysis. Two cases that were frequently discussed during this period are Koasati and Tohono O'odham (known in the literature of this era as Papago). In Tohono O'odham, perfectives are formed by deleting the final segment of the imperfective root (36a) (Zepeda 1983:60-62). In Koasati, plurals are formed by deleting the final rime of the singular root (36b) (Martin 1988; see also Broadwell 1993).

(36) a.

Imperfective	Perfective	Gloss
ñeok	ñeo	'speak'
'apt	'ap	'walk'
he:lwuin	he:lwui	'slide'

b.

Singular	Plural	Gloss
pitáf-fi-n	pít-li-n	to slice up the middle
albití:-li-n	albít-li-n	to place on top of
iyyakohóp-ka-n	iyyakóf-ka-n	to trip
kawaɬ-ɬi-n	káw-wi-n	to snap something

Some languages delete word-final consonants; perhaps Tohono O'odham could be rationalized as a case of (morphologically-specific) final consonant deletion. However, Koasati rime deletion is not a process we would expect to occur word-finally as a general phonological rule in some language.

In the 1970's and 1980's, process morphology was discussed by morphologists because of the challenges it poses to item-based theories of morphology (see e.g. Anderson 1992).

Interestingly, process morphology did not typically feature in discussions of morphologically conditioned phonology. Thus its significant ramifications for the degree of morphological conditioning of phonological operations were not taken into account, making the level ordering picture (discussed in the next section) seem cleaner than it otherwise would have been.

7 Morphologically conditioned phonology

A theme of this chapter is that the aim of many of the modifications to phonological representations occasioned by subsegmental morphemes, templates, and reduplication during the 1970's and 1980's was to allow the rules of the phonological grammar to be as fully general as possible. Instead of a rule specific to causative verbs that geminated a medial consonant in Arabic, for example, the template itself carried the geminate representation; the phonology could simply apply universal rules of left-to-right, one-to-one association. If the morphology could just get its representations right, the job of the phonology should be simple.

Despite the advances of autosegmental and prosodic representations, the need still remained for some phonological rules to be morphologically conditioned, i.e. to require reference to specific morpheme boundaries, parts of speech, or even individual morpheme identities. These conditions motivated the positive and negative rule exception features of Lakoff 1965, Chomsky & Halle 1968, Lightner 1968, Lightner 1972, and Zonneveld 1978, among others. An oft-discussed example is trisyllabic laxing, in English, triggered by suffixes like *-ity*, *-ic, -ify, -itive* but not by suffixes like *-ious, -al* or *-ing*:

(37)

Suffixed form exhibiting laxing	Suffixed form not exhibiting laxing
divin-ity	divin-ing
ton-ic	ton-al
capac-ity	capac-ious
defin-itive	defin-ing

We observed earlier in this chapter a split in Javanese between morphological environments which trigger intervocalic stem-final /h/ deletion (32) and those which do not. In the 1960's and 1970's, such differences would have been handled either by associating the triggering suffixes with a minor rule feature [+ /h/ deletion], or by associating the suffixes *not* triggering the rule with an exception feature [-/h/ deletion], depending on whether the rule in question was perceived to be the exception or the general pattern.

In the 1980's, attention focused on the question of whether any principles could be brought to bear on the amount and nature of such conditioning. The theory of Lexical Morphology and Phonology (LMP; Kiparsky 1982a, Mohanan 1986, Pulleyblank 1986; see also Pesetsky 1979) arose in response.

The unique innovation of LMP was its modular analysis of grammar: the morphology consists of ordered modules ('levels', 'strata'), each associated with a unique set of affixes and a characteristic set of phonological rules. These modules differ from one another; as a set, they differ from postlexical phonology. In an early statement of the model, Kiparsky (1984) even ventured the ambitious aspiration that "lexical and postlexical phonology really are a single rule system operating in two modules of the grammar". While idiosyncratic differences among levels (as in Malayalam) subsequently made this strong vision difficult to support, the hypothesis of a

small number of ordered lexical levels persists to this day in the form of Stratal Optimality Theory (Kiparsky 2008).

7.1 Level ordering

The best known example of Level Ordering in the 1970's and 1980's is the analysis by Kiparsky (1982b) and Halle and Mohanan (1985) of the distinction between Class 1 and Class 2 suffixes in English (e.g., Chomsky & Halle 1968, Siegel 1974, Allen 1978, Selkirk 1982). Class 1 suffixes are those which are stress-shifting and trigger spirantization and Laxing; Class 2 suffixes are phonologically inert. The LMP analysis of this differences is that cyclic stress assignment, spirantization, Laxing (and other rules) apply in Level 1, where (largely Latinate) Class 1 suffixes reside; neither rule applies in Level 2, the home of (largely Germanic) Class 2 suffixes.

(38) Level 1 Class 1 ("+-boundary) derivation and inflection
Class 1: *-al, -ity, -ic, -ive, -ion, -ate, -ous, in-, con-, pre-, en-, de-, ...*
Level 2 Compounding , Class 2 ("#-boundary") derivation and inflection
Class 2: *-ness, -hood, -less, -ful, un-, non-, under-,...*

Some of the morphophonological differences between these classes are illustrated below:

(39)

	class 1 suffix		*class 2 suffix*		*isolation*	
a. TRISYLLABIC LAXING						
	seren-ity	[ɛ]	serene#est	[ij]	serene	[ij]
	divín-ity	[ɪ]	divíne#ing	[aj]	divíne	[aj]
	tón-ic	[a]	tóne#less	[ow]	tóne	[ow]
b. STRESS						
	parént+al		párent#hood		párent	
	orígin-al, origin-ál-ity		órigin#less		órigin	
	prósper, prospér-ity		prósper#ing		prósper	
c. SPIRANTIZATION						
	opác-ity	[s]	frólick-ing	[k]	opáque, frólic	[k]
d. CLUSTER SIMPLIFICATION						
	iamb+ic	[mb]	iamb#s	[m]	iamb	[m]
	prolong+ation	[ŋg]	prolong#er	[ŋ]	prolong	[ŋ]
	sign+al	[gn]	sign#er	[n]	sign	[n]
	malign+ant	[gn]	malign#ing	[n]	malign	[n]
	hymn+al	[mn]	hymn#s	[m]	hymn	[m]
	damn-ation	[mn]	damn#er	[m]	damn	[m]
e. NASAL PLACE ASSIMILATION						
	ir-resolute	[rr]	un-wrap	[nr]		
	il-legal	[ll]	un-lawful	[nl]		
	im-mobile	[mm]	un-moved	[nm]		

Despite the generalizations captured by level ordering, however, problematic areas remain (see e.g. Aronoff and Sridhar 1983, Giegerich 1999). One is rules which are exceptional even within the level. For example, the stress-shifting level 1 suffix *–al* fails to trigger Level 1 Laxing

(*tone, ton-al*; cf. Level 1 *–ic*, in *ton-ic*). Conversely, the stress-neutral level 2 suffix *–ist* exceptionally triggers Level 1 Spirantization (*classic-ist*).

If level ordering is applied at a level of granularity sufficient to capture all morphological and lexical conditioning, then suffixes like *–al* and *–ist* would require their own levels. The number of lexical levels might begin to approach the number of affixes, rather than being fixed at, say, two. This more expansive approach is taken later in cophonology theory (Orgun 1996, Anttila 2002, Inkelas & Zoll 2007). But for the theories of the 1970's and 1980's, which aim to reduce morphological conditioning of phonology to the bare minimum, the residue not covered by a small number of phonologically internally uniform levels was a serious problem.

7.2 Level nonordering: the loop

Languages with recursive morphology pose special challenges for the basic architectural assumption of Level Ordering theory that levels are always strictly ordered. The best known case of interleaving in a grammar with recursive morphology — Malayalam — was uncovered early in the development of LMP. As analyzed by Mohanan (1982, 1986, 1995) and Mohanan and Mohanan (1984), Malayalam has four levels or strata of morphology (Mohanan and Mohanan 1984:581):

(40) Stratum 1: Derivation (negative, unproductive causative, among others)
Stratum 2: Subcompounding, productive causative suffixation
Stratum 3: Cocompounding
Stratum 4: Inflection (case and tense)

Mohanan assigned Subcompounding and Cocompounding to different lexical strata because of their different phonological patterning. Subcompounds undergo internal junctural consonant gemination, while Cocompounds do not; Subcompounds are assigned tone and stress as a single unit, while members of Cocompounds undergo tone and stress assignment independently.

Subcompounding and Cocompounding are not extrinsically ordered in the way that Level Ordering theory predicts. Instead, either type of compound can be embedded within the other. Example (41a) illustrates Subcompounds embedded within a Cocompound (Mohanan 1986:111; transcriptions modified to match those of Mohanan 1995). Example (41b) illustrates a Cocompound embedded within a Subcompound (Mohanan 1995:52):

(41) a. moohanapaṯṯniiṯaarākaaṉṯanmaarə
[[[moohanan+ paṯṯni]$_{Sub}$ + [ṯaarā + kaaṉṯan]$_{Sub}$]$_{Co}$
Mohanan wife Tara husband
'Mohanan's wife and Tara's husband'

b. Cocompound within Subcompound
[[méeša + péṭṭi]$_{Co}$ + kasáala]$_{Sub}$ -kaḷ
table box chair -PL
'chairs made from tables and boxes'

To account for this free relative embedding of Subcompounding and Cocompounding, Mohanan proposed a 'loop' between Strata 2 and 3. While effective in accounting for the free ordering possibilities in Malayalam, the proposal clearly invalidates the claim that levels are strictly ordered. This worrying observation prompted several attempts to locate Subcompounding

and Cocompounding in a single level and recast their tone and stress differences in terms of prosodic structure (Sproat 1986, Inkelas 1989): on this view, a Cocompound consists of two prosodic words, while a Subcompound consists of one. Mohanan (1995) later argued against this analysis on the grounds that it fails to capture the gemination facts. In any case, prosodic differentiation of the two compounding types still undermines the essential claim that levels are internally phonologically uniform.

A question of interest in the early 1980's was the degree of difference a grammar can tolerate among different levels. The Strong Domain Hypothesis (Kiparsky 1984), the Stratum Domain Hypothesis (Mohanan 1986) and the Uniform Domain Hypothesis (Halle and Mohanan 1985) held that phonological rules had to apply in a contiguous set of levels; for example, a rule could not apply in Level 1 and postlexically, but not in Level 2. However, exceptions were found to these restrictions (see e.g. Hargus 1988, on Sekani, and Hualde 1988, on Basque). The possibility that levels are not strictly ordered undermined the validity of these hypotheses even further, and they ceased to be a major focus of discussion in the literature.

7.3 Interleaving

Work in LMP pointed clearly to the fact that phonology and morphology are interleaved. This interleaving sometimes goes by the term 'cyclicity'; analysts differ in their usage according to whether that term refers specifically to the situation in which exactly the same phonological rule applies every time a morphological operation takes place, or whether it refers simply to the situation in which some phonological rules apply to a word as it is being built. (Noninterleaving is the situation in which no phonological rules apply until a word is completely formed.) Compounding the terminological confusion is the possibility of building an entire word and the applying phonology from the bottom up in a cyclic fashion to successfully larger subconstituents of the word (as in Chomsky & Halle 1968); that is cyclicity, but it is not interleaving.

The significance of interleaving is that its existence requires the modules of morphology and phonology to coexist and interact, rather than existing in a strictly ordered fashion (first do all the morphology, then do phonology). In this respect, the morphology-phonology interface appeared in the 1970's and 1980's to be substantially different from the phonology-syntax interface. The assumption during this era was that all syntax took place before any phonology and could never be influenced by it (e.g., Pullum & Zwicky 1988). (That assumption started to change in the 1990's; see, e.g., the papers in Inkelas & Zec 1990).

Evidence for morphology-phonology interleaving assembled during the 1970's and 1980's) is of two kinds: rule interactions (including so-called 'aba' rule ordering, which can result in phonological opacity), discussed in section 7.3.1; and suppletive allomorphy of the kind that is conditioned by the output of applying phonological rules to the base of affixation on an earlier cycle, discussed in section 7.3.2.

7.3.1 Phonological rule interactions

Many cases of cyclic rule application were adduced during the 1970's and 1980's (see, e.g., Chomsky, Halle & Lukoff 1956; Chomsky & Halle 1968; Brame 1974; Kean 1974; Mascaró 1976; Harris 1983; Kiparsky 1982; and many others). The argument was straightforward: without cycles, with only one pass of rule application, the wrong outcome would result. Often-cited examples are pairs like *còndènsátion* vs. *còmpensátion* (see e.g. Kiparsky 1982:156). Unstressed vowel reduction applies to the second syllable in *còmpensátion* but not in

còndensátion. This is surprising since the metrical structure of the two words seems identical; unstressed vowel reduction ought to apply in the same way to both. A solution can be found in the cyclic application of the English stress rule. *Còndensátion* is constructed from *condénse*, whose second syllable receives cyclic stress. *Còmpensátion* is constructed from *cómpensàte*, whose second syllable is never stressed. The preservation of cyclically assigned stress across later cycles of affixation protects the syllable *dense* in *condensation* from undergoing unstressed vowel reduction.

Another famous example of cyclicity is Brame's (1974:43) analysis of stress and syncope in Palestinian Arabic. As see in (42), the *fhím ~ fihím* stem shape alternation is derived by the application of two rules: Stress Assignment and Syncope. Syncope deletes unstressed /i/ in nonfinal open syllables (42a). Why does Syncope not apply equally to the forms in (42b)?

(42)	a.	fhím-na	'we understood'	b.	fihím-na	'he understood us'
		fhím-tu	'you (pl) understood'		fihím-kum	'he understood you'
		smíʕ-na	'we heard'		simíʕ-na	'he heard us'
		smíʕ-nu	'you (pl) heard'		simíʕ-kum	'he heard you (pl)'

Brame's answer is that the suffixes in (42a) are within the first cycle of Stress Assignment, while the suffixes in (42b) are outside the first cycle. Because forms in (42b) undergo two applications of Stress Assignment, the vowel in (42b) that corresponds to the syncopating vowel in (42a) is protected from undergoing Syncope by the stress assigned to it on the first cycle.

7.3.2 Phonologically conditioned suppletive allomorphy

Another argument for interleaving is evidence that suppletive allomorphy can be conditioned by derived phonological properties due to the application of cyclic phonological rules to the base of affixation, prior to suppletive allomorphy selection. A compelling case of this phenomenon is discussed by Hargus 1993, citing Hall 1990 and earlier sources. The nominalizing suffix illustrated in (43) has two allomorphs: *-erei*, found on verb stems with final stress, and *–ei*, found on all other verb stems (data from Hargus 1993:49-50):

(43)		Infinitive (=base + *en*)	Nominal (=base + *ei/erei*)	base gloss
	a.	báck-en	Back-eréi	'bake'
		spion-íer-en	Spion-ier-eréi	'spy'
		trompét-en	Trompet-eréi	'trumpet'
	b.	ségel-n	Segel-éi	'sail'
		pláuder-n	Plauder-éi	'chat'

Verb stress is (largely) predictable in German, and by hypothesis is assigned by rule. *-ei/-erei* suffixation shifts stress to the suffix. Clearly, then, stress rules must apply to the base before the suffix allomorphy is determined (and again after suffixation).

7.3.3 Derived environment effects

Derived environment effects show that morpheme boundaries, or at least some encoding of morphological complexity, are properties of words that phonology must be able to access. The most famous case discussed in the 1970's and 1980's is undeniably Finnish assibilation (e.g. Kiparsky 1973:60, Kiparsky 1973b:93, Keyser and Kiparsky 1984, Kiparsky 1993), an alternation by which underlying /t/ neutralizes to /s/ before the vowel /i/. Assibilation applies to sequences that are heteromorphemic (44a,b), but not to those wholly contained within a root (44b, c).

(44)	a.	/halut-i/	→ halusi	'want-3P.SG.PRET'	
		/halut-a/	→ haluta	'want-INF'	
	b.	/tilat + i/	→ tilasi	'order-3P.SG.PRET'	(*silasi)
		/tilat-a/	→ tilata	'order-INF'	(*silata)
	c.	/æiti/	→ æiti	'mother'	(*æisi)

Morphologically derived environment effects of this kind — often termed 'strict cyclicity' in the literature — were handled with meta-grammatical restrictions on rule application, like the Revised Alternation Condition of Kiparsky 1973:65; the Strict Cycle Condition of Kean 1974, Mascaró 1976, Hualde 1989; and the Elsewhere Condition of Kiparsky 1982, Iverson and Wheeler 1988. These effects show that phonological grammars are sensitive to word-internal structure, an important point in debates over whether morphology is item-based or, to use Anderson's (1992) term, 'A-morphous', such that words lack internal constituent structure. If derived environment effects require reference to morpheme boundaries, they support the former view. However, as with so many aspects of the morphology-phonology interface, derived environment effects have been reassessed in later theories; see, in particular, proposals to attribute derived environment effects to underspecification (e.g., Poser 1993, Kiparsky 1993) as well as the parallelist, transderivational 'Comparative Markedness' approach of McCarthy 2003.

8 Conclusion

In retrospect, the role of morphology in the era of Generative Phonology, Autosegmental Phonology and Prosodic Morphology can be seen as addressing two fundamental questions. Both tacitly pervade the literature of this era. It is only after the fact that they become particularly clear:

1. Is morphology amenable to an item-based analysis, as syntax is?
2. How sensitive to morphological information does phonology need to be — or, conversely, how much light does phonology shed on the internal morphological structure of words?

We have seen in this chapter that the aspiration to answer Question #1 with "yes" inspired and fueled many exciting representational developments in phonological theory. With the increased focus on phonological representations came a growing acknowledgment that static phonological constraints on representations play a major role in capturing phonological generalizations. This realization paved the way for the subsequent constraint-based era of phonology that began in a serious way in the 1990's and continues to this day. Interestingly, the introduction of constraint-

based approaches actually reduced the need to rely on highly technical and abstract underlying representations of morphemes. But that development is the topic of another chapter in history and in this volume.

Question #2 also inspired major developments in phonological theory, and played a role in reimagining the modularity of grammar. Evidence from cyclicity showed that phonology could interpret morphological structures either from the bottom up or in tandem with their morphological construction. Work in level ordering theory sought broad cross-linguistic generalizations about the limits of morphological conditioning of phonological patterns. The need for cyclicity started to be challenged in the 1990's and still fuels a contentious analytical debate. The question of morphological conditioning of phonology remains open, both on an empirical and a theoretical level.

In sum, the role of morphology in phonology is undeniable and was an important factor in the phonological theorizing of the 1970's and 1980's. The interaction must be well understood in order to develop any successful theoretical model of morphology or of phonology.

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