

Contemporary Views on Architecture and Representations in Phonology

edited by Eric Raimy and Charles E. Cairns

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1 Architecture and Representations in Phonology

Charles E. Cairns and Eric Raimy

1.1 Introduction

The essays in this volume address foundational questions in phonology: What sorts of phenomena comprise the explananda of the field? How should phonological objects be represented? What is the optimal architecture for phonological theory? These questions cut across different schools of thought within the discipline, and they remain largely open after a half century of research.

A main theme is that to study phonology productively, one must ask what modules are necessary, how these modules interact with each other and with other components of linguistic theory, and what the representational and computational resources of each module are. Computation and representation are inherently linked; as John McCarthy sagely remarked, “Simply put, if the representations are right, then the rules will follow” (1988:84).

The modular approach seems natural simply because phonology is a component of human cognition, ultimately a biological object; all biological entities more complex than viruses are arguably best understood in a modular framework. The modular approach also enables us to break the larger questions of phonology into smaller ones. We can ask of apparently bewildering arrays of complex surface phenomena: What components are responsible for the facts at hand? Which aspects of the behavior are directly due to operations within components and which emerge from interactions between components? Rough answers to these questions help develop more precise questions about the individual components and the architecture that houses them.

The following sections introduce three examples showing how the modular approach advances our understanding of phonology. The first example (section 1.2) illustrates the benefits of a modular perspective by showing that advances in the understanding of phonetic modules allow us to remove from phonology’s purview a classic and formerly vexing problem, the North American English vowel length alternations before voiced and voiceless obstruents. The efficacy of modularity within the phonology proper is shown in the next example (section 1.3), where we argue that

the interaction among stress, syllabification, and vowel devoicing in Southern Paiute suggests distinct internal modules, one for stress and another for syllable structure. The third example (section 1.4) shows that positing three distinct modules for morphology, syllable structure, and “segmental” phonological processes (e.g., assimilation, vowel reduction) resolves the challenging problem of an apparent lexical syllabic contrast in Sinhala. The organization of the volume is described in section 1.5.

1.2 Phonetics and Phonology as Distinct Components

Keyser and Stevens (2001, 2006; KS) propose a theory of the phonetic component consisting of an interacting set of devices that transform representations produced by the phonology into articulatory instructions. Some of these phonetic modules are sensitive to language-particular information.

In his famous 1941 paper “Phonemic Overlapping,” Bloch introduced the theoretical problem of the North American English vowel length alternations that occur before voiced and voiceless consonants. He pointed out that “the pairs of words *bit bid*, *bet bed*, *bat bad*, *but bud*, *bite bide*, *beat bead*, etc., have respectively the same vowel phoneme, but exhibit a regular and fairly constant difference in the length of the vowel allophones” (1941:283). He went on to identify the vowel in *pot* as the same phoneme in *bomb*; the vowel in *balm* is phonemically longer, but identical in quality. So, except for *bomb balm*, all the length alternations are allophonic.

The length alternations cited above would lead the rational phonologist to conclude that *pot* should have the same phoneme as in *pod*, just as the vowel pairs in *bit bid*, *bet bed*, *but bud* all share respectively the same phoneme. However, Bloch objected that “in the sentence *Pa’d go (if he could)*, the utterance fraction *pa’d* must be analyzed . . . as containing the phoneme of *balm*. In the sentence *The pod grows*, the utterance fraction *pod* must be analyzed . . . as containing the phoneme of *pot*” (1941:283–284). But if *Pa’d* has the long phoneme, homophonous *pod* cannot have the short phoneme because there would be no taxonomic procedure that could reliably assign the vowel of *Pa’d* to the long phoneme and of *pod* to the short one. Therefore, *pod*, *Pa’d*, and *balm* all have the same vowel, which is different from the vowel in *pot*, which of course has the same vowel phoneme as *bomb*. The insistence on taxonomic procedures destroys the parallelism between *pot pod* and *bit bid*, *bet bed*, *but bud*. Bloch admits that “the resulting system is lopsided; but the classes it sets up are such that if we start from the actual utterances of the dialect we can never be in doubt of the class to which any particular fraction of utterance must be assigned” (1941:284).

Chomsky (1964:90ff.), mentioning Bloch’s forfeiture of a linguistically significant generalization, proposed to capture the length alternations with a rule of generative phonology that lengthens vowels before voiced obstruents. Although this rule is

descriptively adequate, it lacks any explanatory force. The rule seems to somehow reflect a phonetically “natural” process of some kind, yet an otherwise identical rule that had just the opposite effect would be as easy to formulate in his system. So the generative solution is as unsatisfactory as was the taxonomic one, albeit for different reasons.

According to KS, it turns out that the length alternations are not handled in the phonology at all. They are due to a phonetic effect known as enhancement (a topic also discussed in Clements’s chapter 2 in this volume). *Enhancement* refers to a set of phonetic processes that add salience to phonological contrasts. For example, the perceptibility of the contrast between [ʃ] and [s] is enhanced by rounding the lips for the former; lip rounding produces resonance in the frequency region typical of nonanterior sounds (KS 2006:50). This rounding is a phonetic phenomenon, not a phonological one, as shown by its variable nature and its inertness with respect to any purely phonological process. It is handled by a distinct *phonetic* module responsible for enhancement.

KS (2001) say that the length alternation at the heart of the Bloch-Chomsky dispute is also an example of phonetic enhancement. A glottal constriction gesture accents the salience of the voicelessness of the final obstruent, which results in a shortening of the vowel. The length reductions produced by this phonetic process never serve as focus, trigger, or blocker of any known phonological rule or constraint. Chomsky’s rule becomes unproblematic because it ceases to exist.

We have sketched how the development of an explicit, modular theory of the phonetic component has enabled phonologists to get on with building a phonological theory with one niggling problem safely withdrawn from its domain of explananda. As KS recognize and address, any theory of the phonetic component raises the same questions as does a theory of phonology in Universal Grammar (UG): What modules are involved? What are their computational and representational resources? How do they interact? We now turn to a discussion of these questions within phonology.

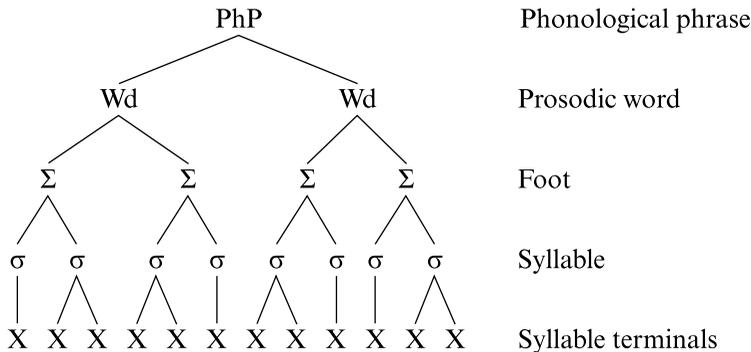
1.3 Modularity within Phonology: The Syllable and the Foot

What is the modular structure of the phonology proper? This topic is illuminated at length in chapters 13–15, but here we demonstrate the efficacy of the modular approach by asking whether all prosodic categories are generated by the same mechanism, or whether some categories may require unique mechanisms. We will focus in particular on the categories “syllable” and “foot” and on whether each has its own dedicated module or whether they are both produced by one. (We will not deal with the internal structure of the syllable in this chapter, as that is discussed in chapters 5–8.)

At least some sort of syllable structure is apparently present at a variety of phonetic, phonological, and morphological levels. Phonetically, KS have shown that the glottalization typical of syllable-final coronal consonants in American English is an enhancement phenomenon (KS 2006:54–55), so phonetic theory must define at least “syllable-final.” The syllable is well known to be active in the phonology, where it is crucial for understanding constraints on sequences of segments, a variety of epenthesis and deletion facts, and a host of other phenomena. As illustrated in chapters 8 and 19, the morphology also needs syllable structure in order to spell out morphemes. Therefore, syllables appear to be formed in some module that interacts with phonetic, phonological, and morphological components in interesting ways.

Are syllables produced by a unique mechanism, or are they part of something larger? The theory of the prosodic hierarchy (e.g., Selkirk 1980, Selkirk and Shen 1990) claims that syllables are part of a larger hierarchical plane, the prosodic plane, (1), that contains prosodic feet, prosodic words, and higher-level constituents (Blevins 1995:210). “Prosodic foot” is a key prosodic hierarchy notion in accounting for word stress.

(1) *The prosodic plane showing the universal prosodic hierarchy*



To restate the hypothesis of the prosodic hierarchy theory in modular terms, it asserts that one module is responsible for producing representations like those in (1) on the prosodic plane. Stress, sequential constraints, deletion, and epenthesis—in fact, all foot-based and syllable-based generalizations—can be deduced from a single two-dimensional plane as in (1), the output of a single module of UG.

The one-module versus two-module question is an empirical one. Are there cases where the constituents needed for stress phenomena conflict with those needed for syllable-based facts? The nub of the issue is whether or not the syllable is the inviolable unit for bearing stress (e.g., Hayes 1995 and much recent work). If it were, one would expect syllables to nest neatly within feet; but if some languages were to employ vowels as the stress-bearing unit, then the possibility would exist that the constituents needed for stress might conflict with those needed for syllabic facts.

Recall the hypothesis that syllables and feet are the responsibility of different modules, each drawing graphs on distinct planes. These planes intersect along a line, known as the segmental tier; because such representations require three dimensions to be depicted, they are known as three-dimensional theories (Halle and Vergnaud 1980, 1987; see chapter 6). We will comment briefly at the end of this section on the alignment among the planes of 3-D phonology. Chapters 10–12 present theories of a module responsible for stress, all of which assume that syllables are generated by a mechanism distinct from the one that produces metrical feet. Such theories are typically known as metrical theories of stress, and the constituents corresponding to word stress are known as metrical feet. Metrical and prosodic feet result from conflicting theories, so they are difficult to compare. Nevertheless, they are very different, as we will show below and as Cairns shows in chapter 6.

The prosodic hierarchy and 3-D theories make contrasting predictions about how the edges of feet and of syllables align. A prosodic foot cannot split a syllable, for the straightforward reason that syllables are constituents of feet. No such restriction applies to metrical feet, however; syllables and metrical feet are created in independent modules and their alignment is orthogonal to their generation. This raises the issue of Syllable Integrity (Everett 1998), the principle that supposedly prevents a foot from bisecting a syllable; see (2). Violations of Syllable Integrity are formally prohibited in prosodic hierarchy theory but freely predicted in 3-D phonology.

(2) Syllable Integrity prohibits . . . (v)v[v] . . . , where syllable boundaries are shown by square brackets and foot boundaries by parentheses. Equivalently: no language may make a contrast between tautosyllabic $\dot{v}v$ and $v\dot{v}$.

Southern Paiute, a Shoshonean language, provides compelling evidence of violations of Syllable Integrity. The feet required to account for stress clearly bisect the syllables required to account for distributional and other phonological phenomena. Cairns (2002) uses a version of metrical theory known as the simplified bracketed grid model of prosody (Idsardi 1992, this volume, Halle and Idsardi 1995) to show that Southern Paiute may assign adjacent, tautosyllabic vowels to separate feet, a clear violation of Syllable Integrity. Southern Paiute counts vowels, not syllables, in its stress system, yet syllables are necessary to account for phonotactics and some morpheme alternations. Cairns demonstrates that the syllables needed to account for these phenomena do not always respect the foot structure that is part of the stress system, resulting in violations of Syllable Integrity.

The strongest evidence that Southern Paiute violates Syllable Integrity is the interaction between stress and a vowel-devoicing rule. Even-numbered, nonfinal vowels, counting from the left edge of a word, are stressed; in metrical terms, the grammar constructs iambic feet from left to right, and the word-final vowel is extrametrical. Unstressed vowels that immediately precede a geminate obstruent are devoiced (as

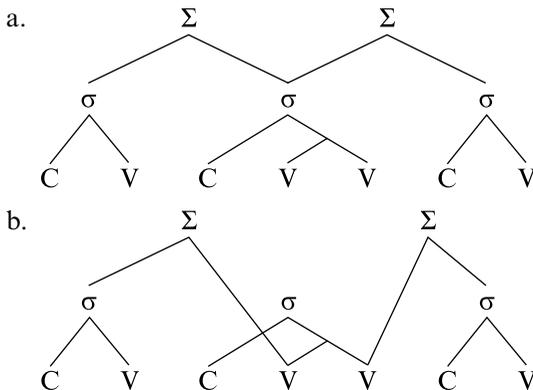
(3a) and (3b) show the metrical and syllabic analysis of /papàpààppapàa/ and /nampàpapààppàpaa/, respectively. Syllable structures are depicted below the strings of phonemes, which represent the segmental tier. The syllable structures for (3a) and (3b) are identical, except that (3b) has the added syllable from the prefix.

The metrical planes are above the strings of phonemes. Line 0 of the metrical plane has an asterisk for every potentially stress-bearing unit, which is every nonfinal vowel in Southern Paiute. The brackets on line 0, which define metrical feet, are inserted by a rule of a form described in greater detail in chapters 9–12. The marks on line 1 (also inserted by rule) represent the heads of the iambic feet defined on line 0. Notice that the metrical structure in (3b) is similar to that in (3a) (except for an extra asterisk on the right in (3b)), but it is shifted over one vowel because of the prefix /nam/.

Observe that the second metrical bracket in (3a) is immediately to the right of the asterisk that is projected from the underlined /a/, which is the final vowel of the syllable in which it resides. This bracket conforms to Syllable Integrity, because it does not bisect a syllable. In (3b), however, the second metrical foot is terminated by a bracket that occurs between the first and second vowels of a tautosyllabic vowel sequence. This is a violation of Syllable Integrity.

(4) presents two possible representations for (3b) in a prosodic hierarchy–type model.

(4) *Violations of Syllable Integrity in a prosodic hierarchy–type model*



Since the prosodic hierarchy theory produces syllables as constituents of feet, it may be mathematically impossible for it to produce objects like those presented in (4). One might propose an “ambifooted syllable” analysis, as shown in (4a). The problem with (4a) is that it does not clearly specify that the left vowel of the shared syllable is the head of the left foot and that the right vowel in the same syllable is the weak member of the right foot. (4b) overcomes these infelicities of (4a) but has other serious problems. For example, each of the two feet directly dominates one syllable and

one vowel, and they do so just when there is a syllable not parsed into a foot also dominating those same vowels. While this representation does not have the problems associated with the ambifooted syllables in (4a), the syllable in (4b) that requires stress is not contained in a foot and thus cannot be stressed in the prosodic hierarchy theory.

One possible response to this problem for the prosodic hierarchy theory is the derivational approach adopted by Hayes (1995:121–122), who posits a level of representation where long vowels are syllabified into two distinct syllables. This early syllabification makes each vowel a syllable so stress can be calculated on syllables alone. The vowel-devoicing rule also applies at this stage. A second syllabification rule then converts CV.V sequences into a single syllable. This solution to the mismatch between syllables and feet is ad hoc and should be rejected.

One might alternatively try to turn Syllable Integrity into a violable constraint as in Optimality Theory (Prince and Smolensky 2004), as Everett (1998) suggests. This would license the incoherent representations shown in (4) as possibly optimal outputs. However, these presumably cannot be generated in a prosodic hierarchy-based theory of representation. A 3-D model of representation must be assumed by any theory that tolerates violation of Syllable Integrity.

The Southern Paiute facts show that phonology contains at least two modules, one for syllables and the other for metrical feet. These modules operate independently of each other, and each has its own computational and representational resources, as discussed later in this volume. Each creates graphs on its own two-dimensional plane. The 3-D proposal is that these planes intersect at the segmental tier. What constraints there are on how representations from these two planes may align with respect to each other on the segmental tier remains an open and important question. Whatever these constraints are, they clearly do not preclude violations of Syllable Integrity.

1.4 Modularity Producing Emergent Phenomena

If syllabification and stress are calculated in separate modules, what is the role of phonological rules of the sort that account for assimilation, vowel reduction, and other segmental phenomena? Do such rules inhabit a distinct module that interacts with the stress and syllabification modules? And what about morphological rules that situate affixes with respect to roots and are responsible for true allomorphy? Are they also in a dedicated module?

An example from Sinhala throws some light on these questions.

(5) *A Sinhala contrast (syllable boundaries supplied)*

- a. ka.ⁿdə ‘trunk, sg. def.’
- b. kan.də ‘hill, sg. def.’

These examples appear to show a lexical contrast between a prenasalized stop and a heterosyllabic nasal-stop sequence. If this were valid, it would be the only such contrast attested in the world. Cairns and Feinstein (1982) and Feinstein (1979) show that this is a surface contrast between a tautosyllabic and a heterosyllabic nasal-stop sequence, also unattested as a lexical contrast. As we will show, this contrast emerges from the interaction among three modules: one for morphology, one for syllable structure, and one dedicated to phonological rules.

We first digress into a brief examination of the data in (6) (from Cairns and Feinstein 1982:217), illustrating causative formation in Sinhala.

(6) *Some Sinhala verbs, all in the present indicative*

	<i>Noncausative</i>		<i>Causative</i>		<i>Root</i>	<i>Gloss</i>
	<i>Phonetic</i>	<i>Lexical</i>	<i>Phonetic</i>	<i>Lexical</i>		
a.	yənəwa	ya na waa	yawənəwa	ya wa na waa	ya	‘go’
b.	kəpənəwa	kapa na waa	kappənəwa	kap wa na waa	kapa	‘cut’
c.	a ⁿ dənəwa	anda na waa	andənəwa	and wa na waa	anda	‘put on’

Note the alternation between the supposedly prenasalized stop and the heterosyllabic nasal-stop sequence in (6c); this is parallel to the alternation between the singleton and geminate stops in (6b). Because such parallel alternations are common in Sinhala paradigms, a single set of generalizations must be responsible for both of these alternations. Note that we are in fact dealing with an alternation between a tautosyllabic and a heterosyllabic sequence, as in (7).

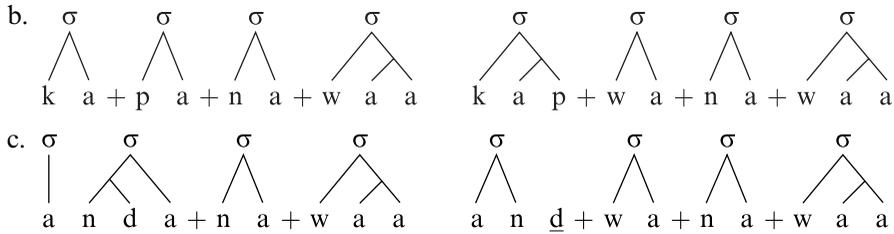
(7) *Geminates and prenasalized stops in Sinhala*

- a. ka.pə... kap.pə...
 b. a.ndə... an.də...

To understand these facts, we must delve into the morphological structure of the forms in (6). To quote Cairns and Feinstein (1982:217), “The morphological structure of these forms is *Root (+ Causative) + Present + Indicative*.” The underlying form of the causative is /wa/ for the forms in (6) (Feinstein 1979). The causative suffix is added after the last consonant of the root, entailing deletion of any stem-final vowel; however, if the stem is monosyllabic, the suffix is added after the final vowel. The present tense, indicated by the morpheme /na/, is added after the last segment of the stem. The indicative suffix is /waa/. These morphological rules, coupled with the syllabification process mentioned below, produce the structures in (8).

(8) *Structure of Sinhala present indicative verbs in (6)*

	<i>Noncausative</i>			<i>Causative</i>			
a.	σ	σ	σ	σ	σ	σ	σ
	∧	∧	∧	∧	∧	∧	∧
	y	a + n	a + w	y	a + w	a + n	a + w
			a				a
			a				a



Sinhala analyzes an intervocalic nasal-stop sequence as a tautosyllabic onset; see the noncausative in (8c). Observe that Sinhala also allows nasals in coda position, as the causative of (8c) indicates; this will prove crucial in our analysis. Sinhala does not allow complex codas, nor may onsets consist of a /dw-/ sequence. Therefore, the /d/ in the causative of (8c) ends up being unsyllabified, which we indicate both by underlining it and by representing it as unaffiliated with a syllabic node. These brief comments about Sinhala syllabification suffice for present needs.

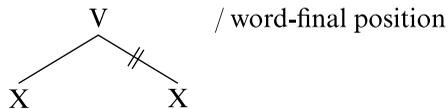
The morphological and syllabification modules interact to produce the representations in (8), which are in turn handed over to a module that contains phonological rules. One such rule reduces all occurrences of the vowel /a/ to [ə] in open, nonstressed (= noninitial) syllables in Sinhala. Feinstein (1977) argues that long vowels in unstressed, word-final position in Sinhala are shortened and unreduced, so /waa/ always surfaces as [wa]. (Shortening and reduction are counterfeeding.) Note that the surface forms of the noncausative examples are all generated simply by the rules of Vowel Reduction and Vowel Shortening, applied in that order. Sinhala also has a productive rule of Glide Assimilation, which renders a glide identical to a consonant to its left (Feinstein 1977, 1979, Cairns and Feinstein 1982); it is unordered with respect to Vowel Reduction and Vowel Shortening. The three rules are shown in (9).

(9) *Some Sinhala phonological rules*

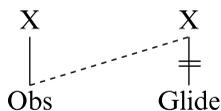
a. *Vowel Reduction*

/a/ → [ə] / open, nonstressed (noninitial) syllables

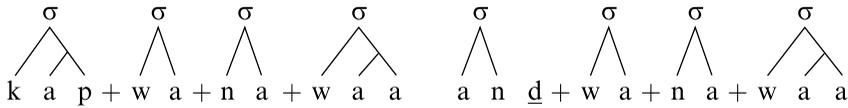
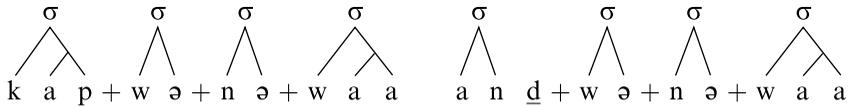
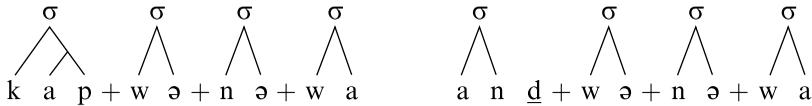
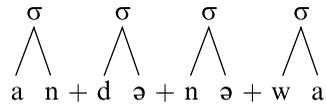
b. *Vowel Shortening*



c. *Glide Assimilation*



The rules of Glide Assimilation, Vowel Reduction, and Vowel Shortening apply to the forms in (8) to produce the surface forms in (6). (10) shows the derivations of the causative forms of (8b) and (8c).

(10) *Derivations for kappənəwa and andənəwa*a. *Underlying representation*b. *Vowel Reduction*c. *Vowel Shortening*d. *Glide Assimilation*e. *Unsyllabified Consonant Deletion*

Glide Assimilation assimilates the underlying /w/ to the consonant to its left, /p/ in the causative of (8b) and /d/ in the causative of (8c). The root-final /d/ then deletes because it is unsyllabified. (Note that the /p/ and /d/ become root-final as a result of the morphological rule adding the causative suffix.) Without making a firm theoretical statement regarding how the unsyllabified segment is eliminated, it is commonplace in phonology to invoke deletion as one of the strategies for handling unsyllabified segments. (The examples in (5) are treated in a way similar to those in (6): Cairns and Feinstein (1982) argue that $ka^n d\partial$ and $kand\partial$ (better, $ka.nd\partial$ and $kan.d\partial$) are underlyingly /kand + a/ and /kand + wa/.)

It can now be seen that the heterosyllabic nasal-obstruent sequence is the result of Glide Assimilation followed by the deletion of unsyllabified consonants. Both the heterosyllabic and the tautosyllabic nasal-obstruent sequences are licit in Sinhala, so there is no need for resyllabification to apply. Therefore, the derivations in (10) are complete. The parallelism between the geminate/singleton and the heterosyllabic/tautosyllabic alternations is explained, and there is no question of a lexical contrast based on syllabification.

Note that this problem is easily understood with minimal and uncontroversial assumptions about the nature of each of the three relevant modules, as well as of their mode of interaction. These facts are troubling to most other perspectives in phonology because they appear to demonstrate contrastive syllabification in the lexicon.

1.5 Organization of the Volume

This volume has five main parts, four dealing with core aspects of phonology and the fifth dealing with interactions within and among modules. Parts I–IV each consist of a main chapter followed by two or three shorter commentaries; part V contains four freestanding chapters.

1.5.1 Phonological Features

Part I deals with the status of phonological features. In the lead chapter of this part (chapter 2), Clements argues for general principles underlying phonological features that make up the segmental inventory of specific languages. He describes several principles governing segment inventories, including Feature Bounding, which determines an upper bound on how many segments and contrasts may occur in an inventory. Another principle is Feature Economy, which favors the maximum use of feature combinations. A distinct theory of markedness can be developed from these principles. Clements uses the expanded UPSID (UCLA Phonological Segment Inventory Database) as his source of data.

Two commentaries follow, both agreeing with Clements on the primacy of distinctive features in phonological theory. In chapter 3, Halle stresses the importance of the details of distinctive feature theory; he points out that the distinctive feature [\pm palatalized] is profitably replaced with [\pm back], and that [\pm slack vocal cords] should substitute for [\pm voiced]. He questions the validity of conclusions based on an outmoded theory of features. Halle's chapter also contains an important cautionary tale based on the history of feature theory.

Vaux, in chapter 4, asks exactly where Clements's principle of Feature Economy resides in the overall cognitive capacities of human beings. Is this principle unique to the language component of the human brain? Is it a general property of the human brain and not specific to human language? Are this and other principles merely the result of the interaction of other cognitive functions? Vaux also questions those of Clements's conclusions that are based on faulty data from UPSID.

1.5.2 The Syllable

Part II focuses on contemporary theories of syllabification in phonology. Chapter 5 by Vaux and Wolfe is the lead chapter of this part. In Vaux and Wolfe's view, all segments must be prosodically licensed by association with some syllable, foot, pro-

sodic word, or other level of the prosodic hierarchy, as in (1). Segments are typically associated with syllables, in strict conformity with the Sonority-Sequencing Principle (SSP). An appendix is any segment that cannot be associated with a syllable in accordance with the SSP. Such segments are instead associated with some higher prosodic structure.

In the first commentary on syllables, chapter 6, Cairns suggests that prosodic licensing has no content, because all possible responses to prosodically unlicensed segments (epenthesis, deletion, no action) are attested. He also argues that the SSP is not useful in understanding syllabification. Cairns splits Vaux and Wolfe's appendices into either plain stray segments (i.e., not associated to any prosodic structure) or members of more richly conceived syllables.

In the second commentary on syllables, chapter 7, Clements argues that the main phonetic correlate of phonological sonority is resonance within the phonetic signal, consistent with a salient formant structure. This explains why low vowels are the most sonorous (have the strongest formant structures) and obstruent stops are the least sonorous (completely lack formant structures). Clements also explains what sonority is and is not supposed to account for, and differs from Cairns regarding the utility of the SSP.

In the final commentary on syllables, chapter 8, Raimy seeks to demonstrate that many of the distributional arguments based on reduplication and infixation to support Vaux and Wolfe's idea of an appendix are actually irrelevant. He also presents a case of reduplication from Thao that requires an abstract syllabification that Vaux and Wolfe deny.

1.5.3 Metrical Structure

Part III deals with metrical structure and begins with chapter 9, Idsardi's revision of the simplified bracketed grid (SBG) approach to stress patterns using finite state automata as the computational basis of the formalism. This revision of the SBG approach abandons avoidance constraints and adds ternary counting as a parameter. The previous distinction between edge marking and iterative constituent construction is replaced with a parameter governing whether or not a rule is iterative. These new parameters, plus an account of the finite state automata that constitute the mathematical underpinning of the rules, produce an exhaustive listing of the basic metrical rules.

Dresher's comments on Idsardi's proposals, in chapter 10, are based on an SBG analysis of "metrical incoherence" found in Tiberian Hebrew. Dresher argues in favor of a well-known feature of the SBG approach, that constituents are defined with unmatched brackets. This allows the analytical possibility of building part of the stressed foot with a rule that inserts an unmatched bracket and then completing it later in the derivation with a rule that inserts a bracket delimiting the original constituent. Dresher suggests that the derivational approach and the possibility of

unmatched brackets renders the SBG approach unique among theories of stress in its ability to provide a satisfactory analysis of the Tiberian Hebrew facts.

In chapter II, van der Hulst presents an alternative view of the nature of stress systems by discussing the main-stress-first model. This contribution provides the opportunity to evaluate current understanding of metrical systems. Van der Hulst also questions the utility of attention to formalisms and finite state automata, as does Reiss in chapter 12.

Reiss attempts to simplify representational aspects of the SBG approach by his *Separator Theory*, where left and right brackets are replaced by a single symbol, the separator symbol “[.” This approach is conceptually simpler than the SBG approach because it reduces the number of primitives, but it requires empirical argumentation, as Reiss discusses.

1.5.4 Architecture

Part IV addresses the overall architecture of the phonological component. Calabrese, in chapter 13, argues that a model of phonology must account for both natural and conventional aspects of phonology. By “natural,” Calabrese means those aspects accounted for more or less directly by the phonological components of UG, which include various aspects of markedness, constraints, repairs, and natural rules. “Conventional” aspects of phonology are those that require idiosyncratic rules and extrinsic ordering; these are frequently vestiges of diachronic processes. Calabrese’s theory of the overall architecture attempts to capture the ways in which the natural and the conventional aspects of phonology interact. As is consistent with the theme of this volume, Calabrese proposes a concrete and detailed theory of the modules within phonology, the representations appropriate for and the computations within each module, and the interaction among these modules.

Calabrese also suggests that language change occurs primarily through lexical and social diffusion. This point is disputed by Kaisse, who in chapter 14 points out that roughly 30 years of Labovian sociolinguistics provide evidence against the view that lexical diffusion is the main vector of language change. She suggests that gradient phonetic changes are part of language change.

Rice, in chapter 15, who along with Kaisse generally agrees with Calabrese’s approach, compares her view of markedness as a substantive part of UG with Hale and Reiss’s (2000) model of substance-free phonology. She suggests that the presence or absence of phonological contrast is a key factor in sorting out these issues. Markedness appears to be “substance-free” in the absence of contrast, but it is productive to apply contentful markedness principles in the presence of contrast.

1.5.5 Interactions

Part V contains four chapters about various sorts of interaction among components of phonology. Blevins, in chapter 16, begins this part by discussing the relationship

between phonological and phonetic knowledge; she argues against models of phonology that incorporate strong models of phonetic knowledge (such as Hayes, Kirchner, and Steriade's (2004)) because an adequate theory of language change would remove any explanatory role for phonetic knowledge in a phonological grammar.

In chapter 17, Purnell also makes the case that phonetic knowledge has no predictive power in phonology. He argues that the lack of any universal one-to-one mapping of acoustic characteristics to or from phonological features shows that phonetic knowledge does not perform any work in phonology.

Halle and Nevins, in chapter 18, investigate the interaction among individual rules. They invoke the Principle of Morphological Consistency, which states that all the surface representations of a given morpheme are derived by means of phonological rules from a single underlying form. This principle severely limits possible mappings between surface forms and underlying representations. Halle and Nevins's proposal for marking exceptionality, coupled with the Principle of Morphological Consistency, provides the basis for an analysis of verbal forms in Russian, Czech, and Serbo-Croatian that have eluded successful explanation in frameworks that do not accept these proposals.

Raimy, in chapter 19, argues that the principles of modularity lead to a new understanding of reduplicative templates. The interaction between the morphology and phonology components, a theory of computation in the phonology component, and a theory of language acquisition all interact in ways that remove the need for any explicit constraint requiring reduplicative templates to be an authentic unit of prosody. Because of this result, Raimy suggests that surface-oriented, prosodically based analyses of reduplicative templates should be abandoned.

1.5.6 Conclusion

In conclusion, each chapter in this volume can be profitably viewed within a modular view of phonology. Each either directly investigates interactions among distinct modules or develops specific aspects of representation within a particular module. It is evident that there are many places where understanding of phonology can be improved by considering points of disagreement in this volume. On the whole, this lack of unanimity is positive because of the questions that it raises. Understanding progresses when the field comes up with better questions.

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