15

The Independent Nature of Phonotactic Constraints

An Alternative to Syllable-Based Approaches

Juliette Blevins

15.1. Introduction

This chapter questions one of the most basic assumptions within syllable theory: namely that phonotactic constraints are largely syllable-based.[1] In this chapter I argue that segmental and feature-based phonotactic constraints on consonant sequencing are most profitably viewed as syllable-independent statements. Evidence for the syllable-independent nature of phonotactics comes from three domains. First, it can be demonstrated that, language-internally, the syllable-based view of phonotactics is, in many cases, empirically inadequate. Second, cross-linguistic comparisons demonstrate that languages with arguably distinct syllabifications have identical phonotactic constraints. Third, emergent phonotactic universals on consonant sequencing are only evident when phonotactics are stated independent of syllable structure.

Three important points need to be made at the outset. First, though I present evidence that phonotactics are to a large extent independent of syllable structure, I am not denying the existence of syllables. On the contrary, in many of the languages examined in this study, evidence for phonological syllables exists in the form of syllable-sensitive rules of stress assignment, syncope, vowel reduction, reduplication, and consistent judgments of syllabifications across speakers. Second, in languages where phonotactic statements and other arguably syllable-based statements do not converge on a single syllable structure, one might argue for "basic" and "derived" syllabifications for distinct phonological domains. However, if two distinct syllabifications are

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needed for many of the world's languages precisely where phonotactics are involved, then one alternative strategy is to consider the possibility that phonotactics are not syllable based. This is the strategy adopted here. Third, though native speaker intuitions regarding word-internal syllabifications will be used as evidence where available, there is a growing body of literature suggesting that these judgments are variable across speakers in many languages and that this variability reflects inference strategies based on word-edge phonotactics (see Steriade 1999).

The chapter is organized as follows. In section 15.2, I highlight certain empirical inadequacies of the syllable-based view of phonotactics. I present examples of languages in which the syllable structure required for phonotactic constraints does not converge with that required for metrical structure, native speaker syllabifications, or other aspects of phonotactics. In addition, identical or parallel phonotactic constraints are adduced in languages with distinct syllabifications, providing cross-linguistic evidence for the independence of consonant phonotactics and syllable structure. Finally, I present phonotactics that defy syllabic statements altogether. Section 15.3 provides motivation for the approach in the form of emergent cross-linguistic phonotactic universals that reveal themselves only when phonotactics are liberated from syllable-based statements. These phonotactics include the distribution of contrastive laryngeal features, the distribution of contrastive place features, and the distribution of medial CCC and/or word-edge CC clusters. In section 15.4 I briefly comment on the nature of the phonotactic constraints identified. While these constraints may have clear phonetic origins, their synchronic statement is purely phonological, with no reference to phonetic features. Finally, in section 15.5 the implications of these findings for Optimality Theory (OT) are discussed.

Though this volume is primarily devoted to studies of the syllable within OT, I have tried to remain relatively theory neutral in presentation and analysis, since the major finding of this study is to a great extent theory independent. Given the existence of syllables, some means of representing them, and some means of representing string-based phonotactic constraints, the conclusion that phonotactic constraints are best expressed as string-based statements without reference to syllables is easily adapted to a variety of theoretical frameworks.

15.2. Where Syllable-Based Phonotactics Fail

The strongest empirical support for theories of syllable structure lies in their potential to simultaneously generate predictions in three distinct empirical domains: word-based phonotactics; the stress-attracting or tone-bearing properties of V and VX sequences in distinct cluster environments; and native speaker intuitions as to where syllable breaks fall. If phonotactics are stated with reference to syllable structure, as in (1), then this syllable structure should be the same as that referred to by other arguably syllable-sensitive processes. Studies supporting this approach include Kahn 1976 for English, Broselow 1979 for Cairene Arabic, and Harris 1983 for Spanish.

(1) Syllable-based phonotactics
Phonotactics are determined by phonotactic constraints of the sort
  [αF] is/is not licensed in P(σ)
where [αF] is a set of feature values and P(σ) is a syllabic position (e.g., syllable-initially, syllable-finally, in the Onset, in the Coda, in the same Onset as [βG]).

(2) String-based phonotactics
Phonotactics are determined by phonotactic constraints of the sort
  [αF] is/is not licensed in K[2]
where [αF] is a set of feature values and K is a description of a string of features, segments, and identifiable (word, morpheme) boundaries.

However, cases in which rhythmic patterns, phonotactics, and speaker intuitions fail to converge on one set of syllabic structures suggest the need to explore alternatives. This study explores an alternative approach in which syllabifications necessary for phonotactic statements may diverge from those necessary for other phonological statements precisely because these phonotactics are defined independent of syllable structure, as shown in (2).[3]

The phonological literature contains many examples of ostensibly syllable-sensitive phonotactic patterns. A common cross-linguistic case is word-final laryngeal neutralization (devoicing, deglottalization, deaspiration), which also commonly occurs in preobstruent position. To generalize over these two seemingly disparate environments, syllable structure is invoked. The claim is that neutralization occurs syllable-finally (or in the coda). However, detailed studies of these phonotactic patterns demonstrate that not all patterns of laryngeal feature distribution can be stated in terms of syllable structure because the syllable structure necessary for phonotactic constraints is distinct from that required for other phonological patterns (Blevins 1993, Steriade 1997).

A well-studied case of this kind is Klamath. Blevins (1993) argues that the Klamath facts strongly support a syllable-independent statement of laryngeal feature distribution, as in (2). This is because in one and the same language, identical VTRV sequences (T an oral stop, R a plain sonorant)[4] must be analyzed sometimes as VT.RV and other times as V.TRV (where a period indicates a syllable boundary). In particular, distinctive aspiration and ejection on obstruents are licensed only before plain (nonlaryngealized) sonorants, never before obstruents. Syllable-based accounts of this neutralization have been proposed (e.g., Steriade 1982, Kingston 1985, 1990, Lombardi 1991), all requiring that VTRV sequences be syllabified as V.TRV. However, the stress rule in Klamath allows vowels in _CCV to attract stress, where CC includes TR.[5] This is also the context for reduction of /a/ to schwa, which also applies word-finally before a consonant or consonant cluster. A rule of vowel syncope applies under prefixation, just in case the vowel is in the context _CV. This rule never applies in _TRV. Finally, the pattern of preobstruent neutralization observed word-medially is paralleled in word-initial CC clusters. In this case, the syllable-based accounts are forced to treat word-initial TT clusters as sequences of coda + onset, despite the fact that under reduplication all CC clusters are copied, independent of their featural content.

(3) Divergent syllabifications in Klamath (where [,] are word boundaries)

Syllable-based laryngeal neutralization	V.TRV	VT.TV
	[.TRV	[T.TV
Stress	VT.RV	VT.TV
Vowel reduction	VT.RV	VT.TV
Syncope	VT.RV	VT.TV
Reduplication	[.TRV	[.TTV

Assuming syllable-based neutralization, we are faced with the divergent and problematic syllabifications shown in (3). Four independent processes refer to syllabifications that are distinct from those necessary for a syllable-based account of laryngeal neutralization. Instead of insisting on a syllable-based account of laryngeal neutralization, and proposing two levels of syllabification for a single language, Blevins (1993) suggests a syllable-independent constraint on Klamath laryngeal feature distribution, as in (4). With this constraint, VC.CV syllabification can be viewed as exceptionless and follows from a simple constraint ranking where *Complex Onset dominates *NoCoda.

(4) Laryngeal phonotactics [L-O1] (an inviolable synchronic constraint)
An obstruent with specified laryngeal features must be followed by a plain sonorant:
[-son, LAR] is licensed only /_[+son, ØLAR]

A similar pattern is found in Lithuanian (Steriade 1997: 16–20), where native speaker intuitions are available. In Lithuanian, as in Klamath, an obstruent voicing contrast is present only in presonorant environments. At the same time, speakers break all VCCV sequences into VC.CV (despite the existence of certain word-initial TR clusters). The situation is entirely parallel to Klamath. A syllable-based statement of neutralization, where devoicing occurs in the coda, requires V.TRV syllabifications to block neutralization.

But native speakers syllabify these strings as VT.RV, just like all other VCCV sequences. Again, by proposing the syllable-independent statement in (4), we can adopt the convergent intuitions of VC.CV syllabification without compromise. Among Indo-European languages, what makes Lithuanian somewhat unique is not its overall pattern of laryngeal feature distribution but its regular splitting of consonant sequences C.C (including T.R) between syllables.[6] The parallel distribution of laryngeal features in Lithuanian and German constitute additional evidence for syllable-independent phonotactics. In both languages, obstruent voicing contrasts are found in presonorant position only, despite the fact that intervocalic VTRV can be tautosyllabic in German (e.g., *pl, bl, kl, gl, pr, br, kr, gr tr, dr*) but not in Lithuanian. Compare Lithuanian *res.pùb.li.ka* 'republic' with German *Re.pu.blik*.[7]

The Klamath and Lithuanian examples both involve laryngeal features, but the same sorts of divergent language-internal syllabifications are necessary in syllable-based analyses of place-of-articulation phonotactics. Consider Manam (Lichtenberk 1983) where, nonfinally, the only codas are nasals homorganic with following Cs: *embeʔi* 'sacred flute', *lunta* 'moss', *uŋ guma* 'person from a village other than one's own', *m-panana* 'I will run', *n-doʔ-i* 'I will take them', *ŋ -ŋ ara* 'I will swim' (/m/ 1 sg. irr.), and so on. Word-finally, the only codas are nasals. In absolute word-final position, that is, before pause, *m* and *ŋ* occur (but not *n*), and these two nasals are in free variation (Lichtenberk 1983: 30). Syllable-based analyses of nasal-stop homorganicity constraints (Ito 1986, Goldsmith 1990) take the form of coda constraints. These constraints typically prohibit major place features licensed solely by association with coda position (e.g., *PLACE in the coda); surface place features in the coda are licensed only by their association with the following syllable onset position. While it is clear that nasal place of articulation is noncontrastive in all Manam codas, what the syllable-based analysis cannot handle straightforwardly is the occurrence of labial or dorsal place features in word-final codas only.[8] On the other hand, a syllable-independent analysis invokes *[+nas, COR] word-finally, and *[+nas, PLACE] before all obstruents. Compare this with a coda-based licensing account, where word-final codas are treated as extrametrical or as onsets of degenerate syllables.[9] The problem with these syllable-based accounts is that stress in Manam is attracted to word-final VN]; stress falls on a final "heavy" syllable, otherwise on the penultimate. Here again, a syllable-based phonotactic constraint results in divergent syllabifications of word-final VN sequences, while a syllable-independent approach does not.

Manam is not unusual in barring place contrasts before obstruents. Many languages show this pattern for nasal-place, obstruent-place, or both. In Japanese, /p, t, k/ contrast in presonorant position (intervocalically and word-initially before a vowel), but no place contrast is possible word-finally, where obstruents are absent, or in preobstruent position, where an obstruent is always homorganic to the following consonant forming the first half of a geminate. Woleaian (Sohn 1984, Tawerilmang and Sohn 1984, Harrison 1995a), a Western Trukic language, shows exactly the same distribution of place features as Japanese but allows (tautosyllabic) word-initial geminates as well: *kkii* 'spicy', *ttoo* 'deep', and so on. And in Saipan Carolinian (Jackson 1984a, 1984b), a Trukic language closely related to Woleaian, with the same distribution of place features, word-final voiceless vowels have been lost, resulting in word-final consonants with contrastive place features (*sææt* 'sea', *arap* 'next', etc.) and word-final tautosyllabic geminates as well (*takk* 'finished', *xacc* 'good', etc.). My account of these languages (and many others; see 15.3.2) is that major place features are licensed only prevocalically: [+cons, PLACE] is licensed only /_V. Syllable-based analyses of the Japanese pattern (Ito 1986, Goldsmith 1990, Ito and Mester 1993) take the form of coda constraints, as for Manam. In the case of Japanese, a constraint disallows major place features licensed solely by association with coda position; surface place features in the coda are licensed only by their association with the following syllable onset position. A problem arises when we attempt to extend this analysis to Woleaian and Saipan Carolinian, since the syllable-based analysis requires that all geminates constitute heterosyllabic clusters. We are forced to adopt *k.kii*, *t.too*, and so forth for Woleaian and *sææ.t*, *ara.p*, *tak.k*, *xac.c* for Saipan Carolinian, though Trukic phonology supports the analysis of word-initial and medial geminates as complex onsets (Harrison 1995a: 915, Churchyard 1991).[10]

Finally, certain phonotactic patterns defy even the cleverest syllable-based treatment. Consider, for example, a common pattern for the distribution of laryngeal features on sonorants. In Yowlumne (Yokuts) (Newman 1944, Archangeli 1984, Archangeli and Pulleyblank 1994, Steriade 1997), the contrast between glottalized (or laryngealized) sonorants and nonglottalized sonorants is limited to postvocalic position: VR'V, VR'CV, and VR']. In intervocalic position, the glottalized sonorant is arguably an onset, while postvocalically before another consonant or word-finally, it is a coda. Looking at positions of neutralization, we can compare word-initial position, where the consonant is an onset, to postconsonantal position, where the sonorant is also an onset. However, *[+son, LAR]/Onset is too strong, since this will incorrectly predict neutralization of intervocalic sonorants. No syllable-based account is possible, and to my knowledge, none has been proposed. I suggest that the Yowlumne constraint be formulated as in (5).[11]

(5) Laryngeal phonotactics [L-S1] (an inviolable synchronic constraint)
A sonorant with specified laryngeal features must be preceded by a vowel:
[+son, LAR] is licensed only /V_

A similar pattern of distribution is evident for the contrast between apicoalveolar and apicopostalveolar coronal consonants in many Australian Aboriginal, Indic, and Dravidian languages (Dixon 1980, Hamilton 1995, Steriade 1998). For example, in Gujarati (Indo-European), Toda (Dravidian), and Diyari (Pama-Nyungan), the alveolar/postalveolar contrast is distinctive only after vowels. The argument for syllable-independent phonotactics for Australian languages goes back at least to Dixon (1980: 159) in his discussion of words of the form ($C_1VC_2C_3V(C_4)$: "It is thus not possible, for an Australian language, to give a structure $C_1V(C_2)$ for syllables, and then to describe a word as a sequence of these syllables. The possibilities at C_3 may be similar to those at C_1, but they never coincide; similar remarks apply to C_2 and C_4. . . ." Simply put, the apical contrast is licensed postvocalically. For many languages then, the phonotactic constraint in (6) is motivated.

(6) Place phonotactics [AP-1] (an inviolable synchronic constraint)
Contrastive [anterior] for apicals is licensed only after a vowel:
[COR,αant] is licensed only /V_

In sum, syllable-based phonotactics are unable to account systematically for languages where the syllable structures they necessitate differ from those required for other syllable-based processes in those languages. Syllable-based phonotactics are also unable to account for the fact that identical phonotactics occur across languages with seemingly distinct syllabifications. Finally, there are inviolable phonotactic constraints in many languages that defy a syllabic characterization. The alternative I propose is that phonotactics are defined by syllable-independent constraints like those suggested in (4)–(6). These constraints are inviolable, allow unique language-internal syllabifications, and permit cross-linguistic differences in syllabification for languages exhibiting the same phonotactic patterns. In the following section I explore further cross-linguistic evidence for general statements of the sort schematized in (2).

15.3. Phonotactic Patterns and Emergent Universals

Steriade (1997), in her survey of laryngeal neutralization, shows not only that certain patterns of neutralization defy syllable-based statements but also that cross-linguistic universal patterns emerge only when syllable-independent string-based contexts are examined. Building on Steriade's (1997) conclusions for laryngeal feature distribution, this section demonstrates how phonotactic patterns involving laryngeal and place features can be viewed as instances of the same string-based phonotactic constraints, independent of syllable structure.

15.3.1 Laryngeal Features

The distribution of distinctive laryngeal features on consonants is severely limited in many languages. As documented by Steriade (1997) and summarized in Table 15.1 for obstruent voicing, a universal implicational hierarchy is in evidence: if a laryngeal contrast on obstruents is possible in environment *n*, then it is also possible in environment *n* + 1.[12]

For example, in all languages where voicing is neutralized word-finally, it is also neutralized postsonorantly before obstruents, initially before obstruents, and finally after obstruents. Notice that the string-based environments in Table 15.1 make no reference to syllable structure. For example, the presonorant environment, 4, could be an instance of a tautosyllabic cluster or a heterosyllabic cluster, and within a single language could have distinct syllabifications depending on segmental content. In French, German, and many other Indo-European languages TR (T an oral stop; R a consonantal sonorant) is syllabified as VT.RV if it is a stop-nasal cluster or an alveolar-lateral cluster, but elsewhere, the (presumably unmarked) syllabification is V.TRV. The most common patterns cross-linguistically are those exemplified by Lithuanian, where laryngeal contrasts are licensed by a following (plain) sonorant, and French, where laryngeal contrasts are absent in obstruent clusters.[13] Less common patterns are those of Tamazight Berber, where voicing is present only when a sonorant precedes or follows, and Nhanta, where a voicing contrast for obstruents is found only intervocalically. The Khasi

Table 15.1. *Worst-to-Best Environments for Laryngeal Obstruents Contrasts: Is There a Voicing Contrast in Environment n?*

Environment	Nhanta	Lithuanian	French	Tamazight Berber	Khasi
1 [_O, O_], O_O	no	no	no	no	yes
2 R_O	no	no	no	yes	(n.a.)
3 R_]	no	no	yes	yes	yes
4 _R	no	yes	yes	yes	yes
5 R_R	yes	yes	yes	yes	yes

Note: R = plain sonorant; O = obstruent; [,] = phonological word boundaries

More languages and data sources (Steriade 1997 and references therein) is abbreviated (S97):
Lithuanian pattern (S97): German (S97); Kiowa (Watkins 1984); Klamath (Blevins 1993); Sanskrit (S97); Russian (S97); Dinka (Nebel 1948); Afar (Bliese 1981); Korean (Kim-Renaud 1974).

French pattern (S97): Hungarian (S97); Kolami (S97).

Tamazight Berber pattern (Saib 1976, 1978): English (Kahn 1976, S97), Maithili, Lamani (S97), Syrian, Eastern, Moroccan, and Iraqi Arabic (S97).

Nhanta pattern (Blevins 1999b): Totontepec Mixe (S97), Lac Simon (S97) pattern, where a voicing contrast is possible even in obstruent clusters, appears to be the rarest of all.

An obvious question that arises is how the implicational hierarchy apparent in Table 15.1 is to be captured grammar-internally. I suggest the inviolable constraints in (7).[14] Notice that all of the constraints in (7) are stated with respect to well-recognized phonological categories (sonorant, obstruent) and adjacency ("precedes," "follows," or for Tamazight Berber "is adjacent to"), and all are claimed to be inviolable for the relevant class of languages. Where statement of phonological position of neutralization is simpler than that of contrast (e.g., 7-[Vd-O2]), the phonotactic constraint is negative, while the default statement is one of positive licensing constraints.

(7) Voiced phonotactics for oral stops (inviolable synchronic constraints)
Table 15.1

Envir.	Index	Phonotactic constraint	Language
1–5		None	Khasi
2–5	[Vd-O4]	Contrastive voicing is licensed only /R: [-son, αvd] is licensed only /[+son]	Tamazight
3–5	[Vd-O2]	Contrastive voicing is not licensed in _O: [-son, αvd] is not licensed /_[-son]	French
4–5	[Vd-O1]	Contrastive voicing is licensed only in _R: [-son, αvd] is licensed only /_[+son]	Lithuanian
5 only	[Vd-O3]	Contrastive voicing is licensed only in R_R: [-son, αvd] is licensed only /[+son]_[+son]	Nhanta

Steriade (1997) details similar recurrent patterns for ejective/nonejective contrasts and postaspirated/nonaspirated contrasts for obstruents. She also demonstrates that languages allowing postconsonantal laryngealized sonorants also allow postvocalic sonorants, but that the reverse is not true. Steriade (1999) complements her earlier study by illustrating distinct cross-linguistic generalizations for preaspiration and postaspiration. Postaspiration follows the general constraint hierarchy in (7), while preaspiration is often limited to postvocalic or postsonorant contexts (cf. (5)).

In sum, recurrent patterns of laryngeal feature distribution and implicational universals reveal themselves when phonotactics are stated independent of syllable structure. What determines positions of contrast or neutralization is the presence/absence and quality (sonorant, obstruent, etc.) of the immediately following or preceding segment.

15.3.2 Place Features

The distribution of contrastive place features for obstruents is also severely limited in many languages, as shown in Table 15.2.

Table 15.2. *Best-to-Worst Environments for Major P, T, K Place Contrasts in Obstruents: Is There a Major Place Contrast in Environment n?*

Environment	Japanese	Saipan Carolinian	Tamazight Berber	Klamath
1 [_O, O_O	n.a.	n.a.	no	yes
2 R_O	no	no	yes	yes
3 R_]	no	yes	yes	yes
4 _R	yes	yes	yes	yes

Note: R = sonorant; O = oral stop; [,] = phonological word boundaries
More languages and data sources:
Japanese pattern (Ito 1986): Italian (Ito 1986); Woleaian (Sohn 1984, Tawerilmang and Sohn 1984, Harrison 1995a); Selayar, Konjo, Makasar, Bugis, Uma (Mills 1975a, 1975b, Sneddon 1993); Minangkabau (Moussay 1981, Adelaar 1995).
Saipan Carolinian pattern (Jackson 1984a, 1984b): Acehnese (Durie 1985); Diola Fogny (Sapir 1965); Arctic Quebec and Greenlandic Eskimo (Dorais 1976, 1985, Creider 1981).
Tamazight Berber pattern (Saib 1976, 1978): Toba Batak (van der Tuuk 1971, Adelaar 1981, Nababan 1981); Lake Miwok (Callaghan 1963); Yokuts (Newman 1944); Western Canadian Eskimo (Dorais 1976, 1985, Creider 1981). (N.B. none of these languages have initial OO or medial OOO, so they could be of the Klamath type.)
Klamath pattern (Barker 1964): English (Kahn 1976, *Oxford English Dictionary* 1971); Leti (van Engelenhoven 1995).

As with laryngeal contrasts, a string-based universal implicational hierarchy is in evidence: if a major (labial/coronal/dorsal) place contrast on obstruents is possible in environment *n*, then it is also possible in environment $n + 1$.[15] For example, in all languages where major place contrasts are neutralized word-finally after sonorants, they are also neutralized postsonorantly before obstruents, initially before obstruents, and finally after obstruents and between obstruents. Conversely, there are many languages where major place of articulation for obstruents is contrastive word-finally, but not word-medially before another obstruent. As in Table 15.1, the string-based environments in Table 15.2 make no reference to syllable structure.

The languages chosen to illustrate limitations on the distribution of major place contrast in Table 15.2 all have geminate obstruents; this is the case where, in an oral stop cluster T_1T_2, no major place feature contrast is possible in T_1. In Japanese, /p, t, k/ contrast in presonorant position (intervocalically and word-initially before a vowel), but no place contrast is possible word-finally, where obstruents are absent, or in preobstruent position, where an obstruent is always homorganic to the following consonant forming the first half of a geminate.[16] While all medial geminate obstruent sequences in Japanese are heterosyllabic, Woleaian, a Western Trukic language, shows exactly the same distribution of place features as Japanese but allows (tautosyllabic) word-initial geminates as well: *kkii* ‘spicy’, *ttoo* ‘deep’, and so on. In Saipan Carolinian, a Trukic language closely related to Woleaian with the same distribution of place features, word-final voiceless vowels have been lost, resulting in word-final consonants with contrastive place features (*sææt* ‘sea’, *arap* ‘next’, etc.), and word-final tautosyllabic geminates as well (*takk* ‘finished’, *xacc* ‘good’, etc.) In Tamazight Berber, the maximal syllable shape is CVCC, but the only possible (nonfinal) coda clusters are geminates. In heterosyllabic T_1. T_2, however, there are no constraints on major place for T_1. For major place features, I propose constraints identical in form to those limiting the distribution of voicing in (7). The constraint set is shown in (8). Note that languages with contrastive place only in the R_R environment are missing from this table. As far as I am aware, there are no languages in which /P, T, K/ contrast in V_V, but not word-initially.[17]

Interestingly, identical environments of minimal contrast to those in (8) are found in languages that fall midway between the extreme neutralization of Japanese and the freely occurring place contrasts in Tamazight Berber (simple) codas.

(8) Place phonotactics for oral stops (inviolable synchronic constraints)
Table 15.2

Envir.	Index	Phonotactic constraint	Language
1–4		None	Klamath
2–4	[PL-O3]	Contrastive place is licensed only in /R: [-son, PL] is licensed only /[+son]	Tamazight
3–4	[PL-O2]	Contrastive place is not licensed in _O: [-son, PL] is not licensed /_[-son]	Saipan Carolinian
4 only	[PL-O1]	Contrastive place is licensed only in _R: [-son, PL] is licensed only /_[+son]	Japanese

Consider the consonantal phonotactics of Toba Batak (van der Tuuk 1971, Adelaar 1981, Nababan 1981). The full consonant inventory of Toba Batak is /p, b, m, t, d, s, n, l, r, j, k, g, ŋ/. In Toba Batak, as in Saipan Carolinian, word-final (postvocalic) consonants occur with contrastive place features (*ulak* ‘come back’, *surut* ‘retreat’, *tarup* ‘roof’). However, unlike Saipan Carolinian, place is contrastive preconsonantally, but minimally so. In medial $C_1.C_2$, C_1 can be the first half of a geminate or one of the set /s, l, r, k, ŋ/.[18] In heterorganic clusters then, C_1 may be a fricative, lateral, trill, oral stop, or nasal, but place contrasts among these manner classes are absent. With respect to the distribution of major place features for oral stops, Toba Batak is almost identical to Saipan Carolinian, except that in preconsonantal position there is a minimal contrast between stops homorganic with the following consonant and stops that are not homorganic but whose place is predictable. Toba Batak, with intervocalic obstruent sequences /pp, tt, kk, kp, kt/ falls between Tamazight Berber, which allows /pp, tp, kp, tt, pt, kt, kk, pk, tk/, and Saipan Carolinian, which allows only /pp, tt, kk/. I suggest that this aspect of Toba Batak phonotactics be accounted for by the same constraint evident in Saipan Carolinian [PL-O3] of (8): Contrastive place is not licensed in _O: [-son, PL] is not licensed /_[-son]. Because contrastive [PL] is not licensed in preobstruent position, a place feature will either be shared with the following obstruent (a homorganic cluster), or the default (noncontrastive) place feature, dorsal, will emerge.[19] The phenomena of "minimal contrast," then, is the consequence of phonotactic statements like the one in [PL-O3] of (8), combined with two distinct phonological implementations of nondistinctiveness: for a given segment, a feature can be nondistinctive when it is predictably shared with a neighboring segment or when it is predictable (by default). Once it is recognized that general phonotactic constraints are independent of syllable structure, the pattern of minimal contrast in Toba Batak can be shown for other phonotactic positions. Word-finally, a similar continuum is found. Languages like Toba Batak allow the full range of place contrasts, while related Minangkabau (Moussay 1981, Adelaar 1995), where historical final **p*, **t*, and **k* have neutralized to glottal stop, allows none. Between these extremes, there are languages like Fúzhōu (Norman 1988: 235–239), where, among nonnasal consonants, the only contrast found word-finally is that between /k/ and glottal stop. Both Minangkabau and Fúzhōu arguably instantiate the same constraint as Japanese (see (8)-PL-O1): Contrastive place is licensed only in _R. The significant difference between these languages is the existence of place-neutral obstruents (/k/ in Fúzhōu) or placeless stops (glottal stop in Minangkabau and Fúzhōu). An additional implicational universal emerges from these patterns: if a maximal major place contrast on oral stops is possible in environment *n* in Table 15.2, then a maximal contrast is also possible in environment *n + 1*.

The discussion has centered on major place of articulation for oral stops, but similar constraints hold for nasals as well, as shown in Table 15.3. Again, an implicational hierarchy emerges: if a major place contrast on nasal stops is possible in environment *n* in Table 15.3, then it is also possible in environment *n* + 1.

In Japanese, nasal place contrasts between /m/ and /n/ are found only in prevocalic position; word-finally a nasal glide occurs, and place is neutralized. In Ponapean (Rehg 1981), place is contrastive for nasals before vowels and word-finally, but not before obstruents, where NC clusters are homorganic and occur word-finally (*emp* 'coconut crab'), intervocalically (*tempel* 'kava pounding rhythm'), and word-initially (*mpe* 'next to it'). In many Australian languages, nasal place is contrastive before vowels and (to a lesser extent)

Table 15.3. *Worst-to-Best Environments for Major Place Contrasts in Nasals: Is There a Major Place Contrast for Nasals in Environment n?*

Environment	Japanese	Ponapean	Mbabaram	Arrernte
1 [_O, O_O	n.a.	no	no	yes
2 R_O	no	no	yes	yes
3 R_]	no	yes	yes	yes
4 _R	yes	yes	yes	yes

Note: R = sonorant; O = oral stop; [,] = phonological word boundaries

before consonants word-medially (where apical nasals contrast with nasals homorganic to the following consonant). For example, in Mbabaram (Dixon 1991), with contrastive nasals /m, n̪, ɲ, n, n^w, ŋ/, all nasals are found word-initially before a vowel, and all except *n*^{w} are found word-finally. Intervocalically *n.g* contrasts with *ŋ.g*, and *n.b* with *m.b*. But word-initially, only homorganic NC clusters are found. The distribution of contrastive nasal place in Mbabaram then follows stepwise the contrastive hierarchy shown in Table 15.3: in environment 4, there is a maximal contrast among place features for nasals; in environment 3, the maximal contrast is diminished with the /n, n^w/ contrast neutralized; in environment 2, a minimal contrast is found between *n* and a nasal homorganic with the following C; and in environment 1, word-initially before a stop, no place contrasts are possible. In Arrernte (Henderson and Dobson 1994), another language of Australia, the distribution of place contrasts in nasals is even freer, with word-initial nonhomorganic NC clusters as well: compare *mpe* ‘come on!’ and *(r)npernpe* ‘yellow-throated miner’. Suggested phonotactic constraints for nasal place are given in (9). These constraints make use of the same string-based environments suggested in (7) and (8).[20]

(9) Place phonotactics for nasals (inviolable synchronic constraints)
Table 15.3

Envir.	Index	Phonotactic constraint	Language
1–4		None	Arrernte
2–4	[PL-N3]	Contrastive place is licensed only in /R: [+nas, PL] is licensed only /[+son]	Mbabaram
3–4	[PL-N2]	Contrastive place is not licensed in _O: [+nas, PL] is not licensed /_[-son]	Ponapean
4 only	[PL-N1]	Contrastive place is licensed only in _R: [+nas, PL] is licensed only /_[+son]	Japanese

15.3.3 Extensions of Place Distribution

Section 15.3.2 shows that major place features are limited in distribution in many languages in a highly structured and predictable way. In a position where no place contrast between /p, t, k/ is possible, there are three basic patterns: (i) a place-neutral segment occurs, such as word-final glottal stop in Minangkabau; (ii) a segment homorganic with the following segment occurs, such as the medial geminate obstruents of Japanese; or (iii) no segment at all occurs, as is the case for Japanese word-finally, where obstruents are prohibited.[21] If the third "no-segment" option is one instantiation of general limitations on the contrastiveness of major place features, then certain widespread phonotactic patterns of segment distribution may be viewed as extensions of the hierarchies seen in Tables 15.2 and 15.3.

Consider that many languages disallow initial and final biconsonantal clusters and/or medial triconsonantal clusters. If geminate structures are not possible in a given language, then these general anticluster constraints could be viewed as extensions of the constraints on place proposed in (8). String-based formulations of these general constraints are given in (10).

(10) String-based cluster constraints
 a) *CCC
 b) *[CC
 c) *CC]

If we limit consideration to vocalic environments,*VC**C**CV, *[**C**CV, and *VC**C**], it is clear that the bold **C** in each string is a potential target of place-licensing constraint (8)-[PL-O3]: contrastive place is licensed only in /R. Given this, it is not difficult to see how the string-based constraints in (10) could arise from original place-licensing constraints.

Compare the constraints in (10) with syllable-based approaches making use of *Complex Onset and/or *Complex Coda. Under these accounts, no constraint *CCC is posited, since the prohibition of CCC clusters is claimed to follow from the ill-formedness of complex onsets, complex codas, or both. The syllable-independent constraints in (10) make very different predictions from the syllable-based approach incorporating *Complex Onset and *Complex Coda. The strictly segmental appoach predicts the existence of languages that allow complex onsets and/or complex codas but still bar triconsonantal sequences by the independent *CCC. At the same time, in languages in which *CCC is inactive, the segmental approach allows triconsonantal CCC independent of the occurrence of complex onsets or codas elsewhere in the language.

A range of facts supports the string-based approach over a syllable-based model. First, there are languages that allow initial and/or final CC clusters but that do not allow medial *CCC clusters. Second, there are languages in which word-initial and word-final CC clusters are not permitted but medial CCC is. Finally, in languages that allow medial CCC clusters but do not exhibit word-edge clusters, homorganicity constraints are in evidence, suggesting a relationship between whole-segment and place-based constraints.

In Lenakel (Lynch 1978), initial and final CC clusters occur, but there are no medial CCC clusters. When morpheme concatenation yields a medial CCC cluster, epenthesis occurs to break up the sequence. Similarly, in Leti (van Engelenhoven 1995), word-initial CC clusters occur, and word-final single consonants are found, but no word-medial CCC clusters are found. Phonological vowel loss is regular in Leti, unless it would create a CCC cluster. Formally, one could simply dictate that *Complex holds in both languages and that initial and final consonants within CC clusters are extrasyllabic (or exceptionally licensed by their word-peripheral position). But why do such patterns exist? Why is special word-edge licensing a necessary ingredient of so many syllabic analyses? I return to these questions in section 15.5. Here, I simply mean to demonstrate that languages with *CCC include those with word-initial and word-final CC clusters.

Many Australian Aboriginal languages exhibit medial CCC clusters, but independent of these, show no evidence of complex codas or onsets. Pama-Nyungan languages with medial CCC clusters include Umpila, Gugu-Yalanji, Guugu Yimidhirr, Djabugay, Wargamay, Yidiny, Dyirbal, Wembawemba, and Woiwurrung. None of these languages allow word-initial or word-final CC clusters. Hamilton (1995) provides the key to understanding these phonotactic patterns: intervocalic triconsonantal clusters have the same place contours as biconsonantal clusters. In all of the Pama-Nyungan languages listed here, the situation is parallel: intervocalic $C_1C_2C_3$ clusters contain at most two place specifications, and all consist of an initial sonorant C_1 followed by a homorganic NC sequence for C_2C_3. O'Grady and Fitzgerald (1995) show that many of these clusters have been inherited from Proto-Pama-Nyungan, which also excluded initial and final CC clusters but allowed $C_1C_2C_3$ clusters provided that C_2C_3 was a homorganic NC cluster. The maintenance of this general phonotactic pattern in so many daughter languages illustrates not only that is it a possible type, but also that it is relatively stable. Despite the existence of medial triconsonantal clusters, there is no pressure to reanalyze strings in terms of complex onsets or complex codas.[22]

15.4. The Nature of Phonotactic Constraints

The explanation for phonological patterns can reside in synchronic analysis or diachronic evolution, and the appropriate locus of such explanations is an empirical issue. Originally, syllables were invoked in synchronic accounts of phonotactics for their explanatory value. However, I have summarized in sections 15.2 and 15.3 evidence that many phonotactic patterns are independent of syllable structure.[23] In what way do string-based phonotactics themselves have explanatory value? What are their origins?

Steriade (1994, 1997, 1998, 1999) presents plausible phonetic explanations for the evolution of many of the phonotactic constraints discussed in sections 15.2 and 15.3.[24] The guiding principle is that positions of neutralization are those where the phonetic (acoustic/perceptual) cues for a specific feature contrast are least salient, while positions of contrast are those where phonetic cues for the same features are most robust. An important finding is the existence of directional asymmetries in contexts for feature distribution. Steriade argues persuasively that these directional asymmetries have phonetic origins, origins that have no direct account in syllable-based statements of laryngeal or place phonotactics.

However, it is well known that phonetic systems change over time and that phonological systems may represent fossils of once-regular phonetic patterns. Given this, we should not be surprised to find synchronic counterexamples to Steriade's general cue-based model of phonotactic constraints. Phonetic cues for a feature like glottalization or aspiration may shift temporally over time; preaspiration may shift to postaspiration, postglottalization may shift to preglottalization, and so on. Diachronic changes of this sort can result in systems where phonotactic constraints are no longer representations of phonetic optimality. Though in many cases, as documented by Steriade (1997, 1998, 1999), the phonetic optimality approach finds synchronic support, counterexamples force us to accept that phonological statements like those in (4)–(9) are statements about the distribution of phonological features independent of their synchronic phonetic instantiation or diachronic phonetic origins.

Howe and Pulleyblank's (2001) survey of glottalization in a number of Amerindian languages of the Northwest Pacific Coast presents just such a counterexample. In Ahousaht, as in Yowlumne, Klamath, and many other Pacific Coast languages, obstruents produced with glottal constriction are realized as ejectives, while glottalized sonorants are normally preglottalized. If the position of phonetic cues is the sole factor determining the nature of phonological constraints on distribution, then we expect neutralization of ejectives in preconsonantal position where release cues are least salient, and neutralization of laryngealized sonorants in postconsonantal position, where preceding VC transitional laryngealization is least salient. However Howe and Pulleyblank (2001) demonstrate that Ahousaht ejectives and laryngealized sonorants have the same distribution: both sets occur word-initially (before a vowel) and intervocalically, but not word-finally or preconsonantally. The relevant constraint is similar to that for Lithuanian voicing:

contrastive glottalization is licensed only /_V. In other words, the general synchronic phonological pattern is that expected for release features, even though sonorants are clearly preglottalized.

Counterexamples like this one are still amenable to cue-based phonetic explanations in the diachronic dimension. Imagine that, in pre-Ahousaht, laryngealized sonorants were the result of sonorant-glottal stop clusters and were all postlaryngealized. Alternations in pre-Ahousaht would result in pre-V and pre-C environments for ejectives and postlaryngealized sonorants, and the weaker release cues in pre-C environments would result in laryngeal neutralization for obstruents and sonorants. Over time, sonorant laryngealization would shift to its "optimal" position (Kingston 1990), resulting in the current Ahousaht system.[25]

A weaker version of Steriade's proposal is, then, that phonotactic constraints on feature distribution are the result of phonetic optimality in the diachronic dimension. Within synchronic phonologies, these constraints are necessarily expressed in terms of phonological primitives (distinctive features, prosodic constituents, etc.) and given the course of sound change, may not transparently reflect their phonetic origins. A synchronic constraint that licenses voicing before sonorants only (as proposed for Lithuanian, Klamath, and many other languages) is transparent, while one that licenses contrastive glottalization on ejectives and preglottalized sonorants before vowels only in Ahousaht is not. Given that the phonological alternations involved are productive and robustly cued, there is no poverty of the stimulus. Both statements are simple and easily learned.

Now consider that the Ahousaht generalization permits both a string-based and syllable-based formulation. Given that C_1 of all C_1C_2 clusters is a coda (Howe and Pulleyblank, 2001), we can compare the statements in (11).

(11) Ahousaht laryngeal neutralization
  a. Contrastive glottalization is licensed only /_V.
  b. Contrastive glottalization is neutralized in the coda.

The arguments for (11a) over (11b) are not internal to Ahousaht, because these two statements are equivalent. Rather, following Steriade (1997, 1999), the argument in favor of (11a) centers on the fact that there are many recurrent patterns that must be stated independent of syllable structure, as in (4)–(9), and that, in many cases, these syllable-independent statements directly reflect underlying phonetic explanations.

In some cases, underlying phonetic explanations are not forthcoming. For example, in Catalan intervocalic heterosyllabic clusters include all T.T and T.N clusters and *t.l*.[26] (The sequence *dl* is absent in underlying and surface forms within and across morphemes, so neutralization of /d/ before /l/ cannot be assessed.) Well-formed onsets include intervocalic and word-initial clusters: /*pl*, *bl*, *kl*, *gl*, *pr*, *br*, *kr*, *gr*, *tr*, *dr*/. Catalan is similar to Lithuanian with respect to its general distribution of distinctive voicing, though there are important differences. Distinctive voicing is only found preceding a following sonorant, provided the sonorant is nonnasal. A syllable-base account is straightforward: voicing is prohibited in syllable codas. An alternative to a syllable-based account is to refine further the set of relevant environments in Table 15.1. A subcategorization of the class of sonorant consonants (R) into nasals and the more sonorous liquids, glides, and vowels will suffice. The Catalan variant of constraint [Vd-O1] in (7) is then [-son, αvoiced] is licensed only /_[+son,-nas]. The question is why nasals pattern with obstruents. The operative generalization appears to be that the more vowel-like the formant structure of the neighboring segment, the stronger the perceptual cues for voicing. However, this generalization awaits confirmation in the form of experimental evidence.

Finally, a note is in order regarding a fairly eclectic class of phonotactic constraints not yet mentioned. These are purported constraints on coda elements that do not refer specifically to laryngeal features, nor to place of articulation, and often involve manner or major class features. For example, in the Yecuatla dialect of Misantla Totonac (Mackay 1994), nonnasal sonorants /w, y, l, h/ are not possible codas, but glottal stop, nasals, fricatives, and oral stops are.[27] The restriction on /h/ is arguably a constraint on the laryngeal feature [spread glottis], so let us focus on the phonotactics of /w, y, l/.[28] As in Ahousaht, a syllable-independent statement ((12a)) and a syllable-based statement ((12b)) are both possible, as both are consistent with language-internal evidence.

(12) Misantla Totonac constraint on /w, y, l/
a. [+son,-nas] is licensed only /_V.
b. *[+son,-nas]/Coda.

We are left to ask whether there is any reason to prefer one over the other. Until we have more cases of this type and understand the phonetic conditioning factors for fortition and lenition in similar contexts, a choice between the two phonotactic constraints seems arbitrary.

In contrast to the Misantla Totonac case, where high-sonority codas appear to be disfavored, syllable-based statements involving restrictions of codas to high-sonority segments have been motivated by their instantiation of the general constraint that high-sonority codas are preferred over low-sonority codas (Hooper 1972, Murray and Vennemann 1983, Clements 1990). However Blevins (1999a) demonstrates that few, if any, languages show pure instantiations of sonority-based coda constraints and that, in most languages where codas are limited to high-sonority segments, the mora is the significant determinant of phonotactics. This follows from Zec's (1988, 1995) sonority principle stated in (13).

(13) Mora sonority principle
If Q is a possible mora (i.e., a weight- or tone-bearing unit), then all segments of equal or greater sonority than Q are also possible moras.

For example, in Gilbertese (Harrison 1995b, Blevins 1997, Blevins and Harrison 1999), moraic consonants are restricted to the class of nasals and constitute the only occurring syllable codas. If we adopt the constraints in (14), which are independently necessary, then there is no need for an independent syllable-based constraint restricting codas to the class of [+nasal] segments; this distributional fact follows from the fact that all codas will be moraic, and only [+nasal] consonants can be moraic in Gilbertese.[29]

(14) Deriving Gilbertese nasal codas
a. Possible mora = [+nasal].
b. Weight-by-position: if X is rhyme-internal, then X is moraic.

Finally, if phonotactics are stated independent of syllable structure, why are there languages like Ahousaht, Catalan, Totonac, and Gilbertese where phonotactic constraints and syllable structure appear to converge? I suggest this is because syllabifications are derivative of phonotactics, not vice versa. Word-initial and word-final consonants and clusters are taken as attested onsets and codas respectively; when a medial cluster cannot be parsed into these attested constituents, other ranked phonological constraints come into play. If none of these is decisive, word-medial syllable divisions can remain ambiguous. A detailed investigation of this hypothesis, along with supporting experimental evidence, can be found in Steriade 1999.

In sum, the phonotactics discussed in sections 15.2 and 15.3 involve recurrent cross-linguistic patterns with fairly transparent phonetic origins. Syllable-independent statements of these phonotactics allow direct comparisons across languages and reflect underlying phonetic explanations, where relevant, though their synchronic statement is purely phonological. The syllable-independent nature of phonotactics is not restricted to laryngeal and place features. Manner-based phonotactics are also amenable to syllable-independent statements, or, where sonority based, more appropriately represented as constraints on possible moras.

15.5. Phonotactic Constraints in Optimality Theory

The primary finding of this study is that the majority of phonotactic constraints are string-based statements, as schematized in (2). The implications for OT are straightforward. Wherever a syllable-based phonotactic constraint of the form in (1) has been proposed in an OT analysis, it should be examined closely and weighed against the alternative constraint types illustrated here.

Two additional issues are raised by the string-based constraints suggested in (4)–(9). One is constraint violability and interaction; the second is the extent to which a theory of phonotactic markedness can be extracted from an OT grammar. I address each of these issues in turn.

15.5.1 Constraint Violability

An important observation concerning the phonotactic constraints suggested in (4)–(9) is that they are all inviolable. Within OT, where it is generally assumed that all constraints are violable, particular syllable-based analyses of phonotactic patterns examined in sections 15.2–15.3 can only be accounted for with violable constraints. Consider, for example, the distribution of voiced obstruents in French, Hungarian, and Kolami as described in Table 1: they occur word-finally, but not syllable-finally before another obstruent. The constraint proposed in (7) is [-son, αvoiced] is not licensed /_[-son]. Any syllable-based analysis of this phenomenon will require a way of excluding word-final obstruents from examination. However, there is ample evidence that word-final consonants are codas (Steriade 1997). Here, I consider OT approaches in which the exclusion of word edges follows from particular constraint rankings. In the case of French-type languages the syllable-based constraint can be stated either in terms of syllabic markedness (e.g., Steriade 1997) or syllabic faithfulness (e.g., Beckman 1997).

(15) OT approaches to French-type languages
  a. Syllabic markedness approach
    IDENT [α voiced]-WDFIN > *[voiced]-IN-CODA > IDENT [α voiced]
  b. Syllabic faithfulness approach
    IDENT [α voiced]-IN-ONSET, IDENT [α voiced]-WDFIN > *[+voiced]

The two general approaches are compared in (15). One problem arising under both approaches is that once phonotactics are viewed as violable constraints, predictions are made involving unattested systems.

Consider the very simple case of four constraints with a syllabic markedness approach: ONSET, *COMPLEX ONSET, NOCODA, and a syllable-based phonotactic constraint prohibiting distinctive voicing in the coda, *[voiced]-in-Coda (*VD/CODA). Of interest is the ranking where ONSET is undominated, and *VD/CODA dominates *COMPLEX ONSET, with NOCODA ranked lowest. The constraint ranking and predicted syllabifications are shown in (16).

(16) Defeasible phonotactic constraints: syllabic markedness
a. constraint ranking:
Onset > *Vd/Coda > *Complex Onset > NoCoda
b. resultant syllabifications:
V.dCV V.bCV V.gCV
Vt.CV Vp.CV Vk.CV

The significant feature of this ranking is the ability of a coda constraint to force segments into a complex onset, just in case the coda segment/feature is ruled out. A similar case can be made for faithfulness approaches, as shown in (17), where IdentVd/Ons abbreviates Ident [α voiced]-in-Onset, and *Vd abbreviates *[+voiced].

(17) Defeasible phonotactic constraints: syllabic faithfulness
a. constraint ranking:
Onset > IdentVd/Ons > * Vd, NoCoda > *Complex Onset
b. resultant syllabifications:

Input:	/VdCV/	/VbCV/	/VtCV/	/VpCV/
Output:	Vt.CV	Vp.CV	V.tCV	V.pCV

Significantly, in all the work on syllable-based phenomena and syllabification, there are no reported cases where laryngeal features of C_1 in VC_1C_2V regularly determine coda versus onset, as in (16), or where the presence versus absence of neutralization determines distinct syllabifications, as in (17).[30] The same is true of place features of C_1. A general argument, then, against phonotactics of the sort examined in sections 15.2–15.3 as violable syllable-based constraints is that the introduction of violable phonotactic constraints predicts unattested systems of syllabification. Given this, the introduction of potential subsystems of inviolable constraints within OT should be considered.

15.5.2 Toward a Theory of Markedness

The syllable-independent statement of phonotactics is one component of a theory of phonotactic markedness in which unmarked constraints directly reflect phonetic origins, while marked constraints do not. Unmarked constraints have the widest distribution cross-linguistically, while marked constraints (e.g., the distribution of sonorant laryngealization in Ahousaht) are rare. Most important, perhaps, the implicational universals in feature distribution seen in Tables 1–3 are incorporated directly into phonotactic constraints, such as those proposed in (4)–(9).

Within OT syllable-based approaches to phonotactics, active constraints like *[F]/Coda suggest (along with NoCoda) that the best syllables are open and that syllables are more marked as their codas acquire more distinctive features. Similarly, active faithfulness constraints like IDENT [F]-IN-ONSET (along with ONSET) suggest that onsetless syllables are marked, and that as an onset acquires more distinctive features, it is less marked. However, as demonstrated in Steriade (1994, 1997, 1998, 1999), positions of neutralization relate directly to phonetic conditioning environments that are entirely independent of syllable structure. An initial step in establishing a theory of phonotactic markedness within OT, then, is to attempt to restate syllable-based markedness and faithfulness constraints in string-based terms. If this is done and if these constraints are inviolable as suggested here, constraint ranking will be shown to be irrelevant to the assessment of cross-linguistic phonotactic markedness in consonant clusters.[31]

The real challenge, then, is not to describe common and rare cross-linguistic phonotactics solely as the output of a ranked set of markedness and faithfulness constraints but to discover principles underlying these phonotactics, their roles within individual grammars, and any consistent or recurrent relationships that exist between phonotactics and syllable structure.

NOTES

1. The syllable-independent nature of phonotactic constraints is proposed in Blevins 1993 for Klamath and further supported by the studies of Steriade (1994, 1997, 1998, 1999).
2. Or "[αF] is/is not contrastive in K," or both. See Steriade 1994, 1997 for further discussion. Note that in contrast to standard OT approaches, I admit the possibility of positive licensing/markedness constraints like "[+voiced] is licensed only before sonorants." Indeed, reference to positions of contrast is often straightforward, whereas reference to positions of neutralization is not. For example, in languages like Gujarati, where an alveolar vs. postalveolar contrast is distinctive only after vowels (Steriade 1998), reference to the postvocalic context is simpler than reference to the disjunction "word-initial or postconsonantal" where the contrast is neutralized.
3. I do not rule out the possibility that some phonotactic statements are syllable based. Inviolable syllable-based constraints are possible for the Ahousaht dialect of Wakashan and Catalan, as discussed in section 15.4. However, such cases are rare and can always be stated in independent string-based terms. As noted in section 15.1, syllable-based generalizations concerning stress and vowel distribution are also common. (Note that processes like closed-syllable laxing are not pure phonotactics of the kind examined here: segmental statements of these processes demand reference to nonadjacent segments.) I also accept that higher-level prosodic categories (foot, prosodic word, etc.) may play a role in phonotactics. However, the range of constraints examined in this chapter do not lend themselves to such alternatives.

   The constraints in (1)–(2) are phrased within OT positional markedness approaches. However, the criticisms against syllable-based statements of phonotactics hold for both positional markedness and positional faithfulness accounts. See section 15.5 for further discussion.

4. Plain sonorants in Klamath are nonlaryngealized, nonbreathy ones, i.e., those without specified laryngeal features.
5. Klamath stress is described in Barker 1964: 35–38, and confirmed by study of his field tapes (Blevins 1993: 237, note 1, and 256–257). Main stress falls on the last long vowel in the word and, where there is no long vowel, on the penultimate syllable if it is heavy (i.e., closed) and elsewhere on the antepenult.
6. The Lithuanian pattern could well be inherited. Other Indo-European languages where VT.RV is a possible syllabification, but where a voicing contrast is maintained for T in this context and neutralized before obstruents and word-finally, are Sanskrit, Attic Greek, Russian, and Polish (Steriade 1997: 23–31). In Gujarati, where distinctive aspiration is also neutralized in preobstruent position, native speakers syllabify VORV clusters as VO.RV. See Steriade 1999 for further discussion of the Sanskrit, Homeric Greek, and Gujarati cases.
7. Even the descriptive generalization that obstruents are devoiced syllable-finally in German meets with counterexamples within the native vocabulary. Consider *A[d]ler* 'eagle' (cf. *A[t]las* 'atlas; silk'). At least some German speakers syllabify this as *A[d].ler*. In this case then, native speaker intuitions diverge from the syllabification required for coda devoicing. Other counterexamples to surface syllable-final neutralization involve morphologically complex forms: *Han[t]* 'hand', *Hän[d]e* 'hand, pl', *han[t]-lich* 'handy' vs. *han[d]el-n* 'to act', *Han[d]l-ung* 'plot; act'. (See Rubach 1990, Hall 1992, Wiese 1996, and Steriade 1997 for accounts of these and other cyclic effects.) None of these are counterexamples to the statement in (4), which, as far as I am aware, is exceptionless in German as well.
8. If only one place feature occurred, the syllable-based licensing account could argue that this was the default place of articulation for Manam, inserted in the absence of a phonologically licensed feature.
9. An additional strategy is to propose a general *Place/Coda account, dominated by a word-final faithfulness constraint leading to violation of this phonotactic constraint word-finally. General problems with this strategy are discussed in section 15.5.
10. Again, see section 15.5 for a critique of the general OT strategy of accounting for divergent word-edge effects by incorporating word-edge faithfulness constraints that dominate general syllable-based phonotactic constraints. Comparison of Manam and Woleaian is instructive: in Manam, a word edge shows an unexpected violation of an otherwise inviolable constraint, while in Woleaian, a word edge shows adherence to a phonotactic constraint in an unexpected position. Constraint violations are of an entirely different sort in the two languages, with both types exhibited word-finally in Saipan Carolinian.
11. See Steriade 1999 for a discussion of left- vs. right-anchored contexts for feature distribution. She argues persuasively that these directional asymmetries have phonetic origins, origins that have no direct account in syllable-based statements of laryngeal phonotactics.
12. In Table 1 R stands for sonorant. However, in some languages, only a subset of sonorants will be involved due to independent aspects of phonotactics. For example, in a language that lacks CC clusters altogether, the only relevant intersonorant environment for the obstruent voicing contrast is V_V. Environments involving preceding

and following fricatives are not included in this survey, so that O is more properly interpreted as “oral stop or affricate.”

13. Dell (1995: 12–13) notes that in terms of pronunciation, regressive voicing in obstruent clusters is highly preferred; however, “in careful pronunciation it is possible to pronounce a voiceless obstruent immediately before a voiced one (e.g., in *anecdote, aqueduc*). . . .” These clusters contrast phonetically with [kt] of *actif* and [gz] of *exacte*. However, despite this pronunciation, there is no apparent phonological contrast between word-internal [kd] and [gd], representing /kd/ and /gd/ respectively.
14. Again, as in Table 15.1, R stands for sonorant, though in some languages, only a subset of sonorants will be involved due to independent aspects of phonotactics.
15. Environments involving preceding and following fricatives are not discussed here for reasons of space. Pre- and postfricative environments appear to be favored over pre- and poststop environments in many languages. For example, in Finnish (Karttunen 1970) /p, t, k/ may precede /s/, but only /t/ may precede a nonhomorganic stop.
16. The presence or absence of a place-neutral segment word-finally appears to be a language-specific property of Japanese-type languages. Japanese lacks a place-neutral obstruent but allows a place-neutral nasal-finally. And in loans, epenthetic final vowels occur, allowing the place contrast to be maintained. Minangkabau has the same pattern of major place distribution for obstruents as Japanese but allows glottal stop word-finally (the historical merger of **p*, **t*, and **k*.)
17. In the many Australian Aboriginal languages that have a six-way place contrast between /p, t, ṭ, t̪, ʈ, k/ intervocalically, the only common neutralization word-initially is between the apical series /t, ʈ/ (Dixon 1980, Steriade 1998). Generalizations like those in (8) emerge only when major place contrasts (coronal/labial/dorsal) are distinguished from place-internal contrasts (alveolar/postalveolar; laminodental/laminopalatal; velar/uvular) or secondary place features (palatalization, labialization, velarization).
18. In many dialects of Toba Batak /k/ in heterorganic clusters is realized as glottal stop, consistent with the view that place is minimally contrastive preconsonantally.
19. Or, in the dialects described by note 18, no place feature is present, and a glottal stop surfaces.
20. As described in the text, “none” for phonotactic constraints in environments 1–4 in (9) is not entirely accurate. There is some place neutralization preconsonantally, where only coronals contrast with homorganic nasals, but it is not total. Nasal place is still contrastive in this position.
21. Another logical possibility is that a “middling” segment between two categories occurs. In some Australian languages, a segment in between the extreme alveolar and postalveolar points of articulation is found in positions of neutralization (Butcher 1992). However, given the noncontinuity (in articulatory terms) of the major place contrasts, this option does not appear to be available.
22. Whether these strings are fully syllabified is unclear. However, the initial and final Cs of $C_1C_2C_3$ clusters appear to be syllabified, since, for example, in Umpila, C_1 will block tonic lengthening of a preceding vowel, while C_3 can serve as an onset for final -CV reduplication.
23. A referee comments that the phonotactic constraints illustrated in this study make exclusive reference to major class features in defining phonological contexts and that

this may, in a sense, double aspects of syllable theory. However, exclusive reference to major class features is not a general property of phonotactic constraints and occurs here only because the focus of this study is constraints that have previously been analyzed as syllable based. Many phonotactic constraints must mention place and/or manner features. For example, in Pero, a West Chadic language, there is a constraint against consonant clusters in which the first segment is nondorsal and the second is dorsal (*pk, *bg, *vɣ, *dg, etc.). Frajzyngier (1980: 40) highlights this in his discussion of vowel epenthesis: "The constraints that require vowel insertion are of two kinds: (a) syllable structure constraints and (b) consonant cluster constraints . . . the conditions of this constraint have nothing to do with syllable structure, but rather with the phonological features present in the consonants involved." In addition, though sonority is expressed in terms of major class features, there are no languages in which, for example, sonorants are excluded from onset position, and very few where all and only sonorants are allowed in coda position (Blevins 1999a). Hence, though syllables appear to be organizational units of sonority, what is of relevance are relative and not absolute values of sonority.

24. See also Flemming (1995) and Hamilton (1995) for treatment of other phonological patterns within the cue-based model of phonetic OT.
25. This scenario is hypothetical, but the absence of Cʔ clusters in Heiltsuk, another northern Wakashan language, is suggestive. Another possibility, suggested by the Class I glottalizing suffixes that derive glottalized sonorants from obstruent + ʔ sequences is that glottalized sonorants derive historically from ejectives and, hence, inherit their general phonotactics. Future historical work on northern Wakashan languages will, we hope, shed light on the evolution of the intriguing and highly marked pattern of Ahousaht. For a historical discussion of sonorant glottalization in southern Wakashan, see Gamble 1977.
26. While voiced/voiceless pairs neutralize in Catalan syllable-finally, what the surface phonetics are of neutralized stops in cluster environments is unclear and may be subject to dialect variation. For Catalan data, I am grateful to Ruth Català-Ferràndez, Maria Jesus Segura, and Esther Monzo. Catalan syllabification judgments were entirely consistent across speakers.
27. Underlying coda glides delete, while /l/ and /h/ are neutralized to obstruent [ɬ] in the coda.
28. As always, there is the possibility that these are instances of general markedness constraints, *h and *[+son, –nas], which are high ranking, but themselves dominated by an onset-specific positional faithfulness constraint.
29. Word-initial preconsonantal nasals are clearly moraic in Gilbertese words like *mka* 'compost' and *ŋ.ŋai* 'l sg pronoun'. Within a traditional syllable-based analysis, one is forced to analyze these as syllable codas of highly marked degenerate syllables. The analysis in (14), in contrast, allows word-initial nasals to be analyzed as syllabic (nuclear) elements.

    Note that Gilbertese is not a pure instantiation of sonority-based moras, since the phoneme /r/, an alveolar tap, is excluded from coda position (there are no phonemic glides in Gilbertese and no other liquids). Under the analysis suggested in the text, no explicit coda constraint is necessary, since /r/ is not defined as a mora in Gilbertese. For historical explanations of languages that allow nasal codas, but not more sonorous codas, see Blevins 1997, 1999a.

30. Wilson (1999: 7) makes a similar point about positional faithfulness constraints when he says, "under certain rankings, Onset-based positional faithfulness . . . can cause underlyingly-voiced (but not underlyingly voiceless) consonants to actively *avoid* being parsed in Onset position. This pattern is not attested. . . ."
31. Wilson (1999) does just this and shows the extent to which OT must still be modified with the introduction of "targeted constraints" to incorporate a theory of phonotactic markedness.

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