Working Papers of the Cornell Phonetics Laboratory
2002, vol. 14, pp. 250-277

The role of prosody in morphologically governed phonotactic regularities

Draga Zec

My central concern in this paper is whether restrictions on segment sequencing necessarily mirror prosodically motivated segment distribution. The role of prosody in capturing the distributional regularities may well be less than straightforward in cases of abundant interactions with morphology. One such case, found in Serbian (Neo-ćtokavian dialect), is the focus of the present study. After addressing issues of syllabicity, I turn to syllable weight, focusing on presonorant lengthening: vowel lengthening in syllables closed with a sonorant, encountered only at certain morphological junctures. I present two analyses of presonorant lengthening. One provides prosodic motivation for this process but depends on a baroque set of opaque constraint interactions. The other interprets presonorant lengthening as a static phonotactic regularity, and includes only transparent constraint interactions. The former analysis has a considerable advantage over its alternative because of its straightforward nature. Its disadvantage, however, is that presonorant lengthening is left with no prosodic motivation, yet it does bear a clear mark of a prosodically motivated phonological process.

One of the most convincing arguments for positing prosodic constituents such as the syllable or the mora comes from capturing the regularities of segment distribution. Under this view, originally introduced by Kahn (1978), prosodic organization is directly responsible for most aspects of segment sequencing and segment alternations. However, determining the role of prosody in cases of abundant interactions with morphology may be less than a straightforward task. One such case, found in Serbian (Neo-ćtokavian dialect), is the focus of the present study. In this paper we first establish the properties of syllabic and moraic structures in Serbian, and then turn to the issue of how these properties account for one specific distributional regularity. My central concern is whether static restrictions on segment sequencing necessarily mirror prosodically motivated groupings of segments. The analysis is cast in Optimality Theory (McCarthy and Prince 1993, Prince and Smolensky 1993). We first focus on the syllable nucleus, and the segments that may occupy this position, and then turn to the problem of what segments may contribute to syllable weight. Of central relevance, in determining the set of weight bearing segments, are the interactions with a morphologically based distributional requirement.

* I am grateful to Eungyeong Kang and Abby Cohn for invaluable comments on several earlier versions of this paper.

1. Syllabicity

In this section we will determine what segments may occupy the nuclear position in the Serbian syllable. We begin with the phonotactic constraints on syllable margins, which are of a fairly familiar sort (cf. Selkirk 1984, Clements 1990). While both onset and coda clusters are permitted, there are strict sonority restrictions on possible sequences: the onset cluster may not exhibit any descending sonority, as stated in (1a), while the coda cluster may not be of ascending sonority, as stated in (1b) (Ivić 1967, Surdučki 1964). The sonority hierarchy assumed here is standard, with vowels being more sonorous than consonants, sonoront consonants more sonorous than obstruents, and then, within the class of sonorants, *r* more sonorous than *l*, which in turn is more sonorous than the nasals (e.g., Clements 1990). The glides *v* and *j* share the sonority of vowels. Onset clusters may contain members of equal sonority, such as *pt* or *mn*. Certain clusters that satisfy the constraint in (1) are ruled out because of illicit place combinations (e.g., two coronals as in *nl*, *nr*, or two labials as in *pm*, *bm*).

(1) SYLMARGIN

a. *Onset clusters* may not be of descending sonority.
b. *Coda clusters* may not be of ascending sonority.

The two constraints regulating sonority sequencing of onsets and codas in (1) will henceforth be referred to as a single syllable margin constraint, SYLMARGIN.

Constraints on segment sequencing at syllable margins interact directly with the syllabicity of segments. While all vowels are of course syllabic, sonorant consonants may assume this role under well-defined conditions: only when any of the constraints in (1) is violated. However, circumstances under which a sonorant consonant may be syllabic differ in the native and loan vocabulary. First, only *r* is syllabic in native forms, while any sonorant consonant may be syllabic in loan words; and second, different environments are apportioned to syllabic consonants in native and loan words.

In the native lexicon, *r* is the only consonant with a clear syllabic status. This is illustrated in (2), with the syllabic consonant capitalized, and dots standing for syllable boundaries:

(2) vRt 'garden', tRg 'square', sR.ce 'heart', Ée.tvR.tak 'Thursday', R.dja 'rust'

The examples in (2) bring to relief the fact that *r* is syllabic only when its non-syllabic status would lead to the violation of SYLMARGIN, e.g., **srce*, **Éetvr.tak* or **rdja* in place of *sR.ce*, *Ée.tvR.tak*, or *R.dja*, respectively. Moreover, whether syllabic or non-syllabic, *r* exhibits unified phonological behavior. Syllabic *r* is subject to the same phonotactic constraints as its non-syllabic counterpart. Listed in (3) are impossible onset sequences, which contain combinations of coronals followed by *r*, with only palatal coronals excluded in the case of obstruents:[1]

(3) Prohibited consonant+*r* onset sequences:
*jr, *lr, *nr, *ljr, *njr, * Êr, *djr, *Ér, *dār

Syllabic *r* is prohibited in these same environments (IviÊ 1967, 1968a, 1968b). Thus, a single clustering constraint captures the phonotactics of *r*, regardless of whether it is realized as syllabic or non-syllabic. In sum, *r* patterns with consonants, but can occupy the peak position in the syllable under the pressures of sonority. The syllabicity of *r* is thus contextually conditioned. The segment *r* is syllabic when it forms a local sonority peak, and is non-syllabic otherwise. This is captured by the following constraints, from the peak family, which designate as marked any segment that acts as a syllable peak, in the spirit of Prince and Smolensky (1993):

[1] Some *ār* onset sequences do occur, as in *āreb* 'dice'. Most such sequences have been eliminated through obstruent epenthesis, e.g., *āerebe* 'colt' (IviÊ 1968a). Sequences of *ā* followed by syllabic *r,* as in *āRvanj* 'mill stone', are also found.

(4) *P-OBSTR >> *P-NASAL >> *P-L >> *P-R >> *P-V

According to (4), least marked in the nuclear position are vowels, and most marked are obstruents, with *r*, *l*, and the nasals falling in between. The ranking of the peak family of constraints recapitulates the sonority hierarchy. SYLMARGIN will rank immediately above the *P-R constraint, as in (5), thus allowing for the syllabic status of vowels and *r*, but not of any less sonorous segments.

(5) *P-OBSTR >> *P-NASAL >> *P-L >> SYLMARGIN >> *P-R >> *P-V

It further follows from this ranking that *r* will not be syllabic if adjacent to a vowel, as in (6):

(6) a. trag 'trace' (*tR.ag)
b. park 'park' (*pa.Rk)

In sum, *r* is rendered syllabic under the pressure of avoiding the violation of SYLMARGIN, as shown in tableau (7):

(7) SYLMARGIN >> *P-R >> *P-V

rdja	SYLMARGIN	*P-R	*P-V
☞ R.dja		*	*
rdja.	* !		*
trag			
☞ trag			*
tR.ag		* !	*

There is one case in which *r* is syllabic even though it does not form a local sonority peak. In (8b), syllabic *r* in the verbal form *R.dja.ti* 'to rust' is preceded by a vowel that belongs to the prefix *za-*; (8a) provides the morphological constituency, which shows that *r* occurs in stem initial position. The form in (8b) is to be construed as having a hiatus, which is a possible configuration in Serbian (Lehiste and IviÊ!1967)/

(8) a. [za [rdjati $]_{St}]_{St}$
b. za.R.dja.ti ‘become rusty’ vs. *zar.dja.ti

This effect will be attributed to the alignment constraint in (9), which requires that the stem’s left edge coincide with the left edge of a syllable:

(9) ALIGN-LEFT (STEM-L, SYL-L)

Due to this constraint’s ranking above *P-R, both the vowel and *r* assume the role of syllable peaks, as shown by the tableau in (10):

(10) ALIGN-L (STEM-L, SYL-L) >> *P-R >> *P-V

[za [rdjati$]_{St}]_{St}$	ALIGN-L	*P-R	*P-V
☞ za.R.dja.ti		*	* * *
zar.dja.ti	* !		* * *

However, syllabic *r* is not permitted in word final position. When *r* appears stem finally, as in *vetr* or *bistr*, forming a consonant sequence of rising sonority, such a sequence is resolved by epenthesis, as in (11a) and (12a). Epenthesis does not take place in (11b) and (12b) due to the inflectional ending in word final position, which places the rising sonority sequence in the onset.

(11) a. vetar ‘wind-NomSg’ stem: *vetr*
b. vetra ‘wind-GenSg’

(12) a. bistar ‘clear-Masc’ stem: *bistr*
b. bistra ‘clear-Fem’

This will be captured by a constraint that prohibits a syllabic *r* in word final position:

(13) *P-R-WDFIN

No syllabic *r* in word final position.

This constraint obviously ranks higher than DEP, since epenthesis is invoked in order to avoid word final syllabic *r*, as in tableau (14):

(14) *P-SON -WDFIN >> DEP

vetr	SYLMARGIN	*P- R-WDFIN	DEP	*P-R	*P-V
☞ve.tar			*		* *
ve.tR		* !		*	
vetr	* !				

To conclude, in the native lexicon, *r* is the only consonant that may appear in sequences that violate SYLMARGIN. When it appears in such a sequence, it either assumes the role of a syllabic consonant or, if word final, triggers epenthesis.

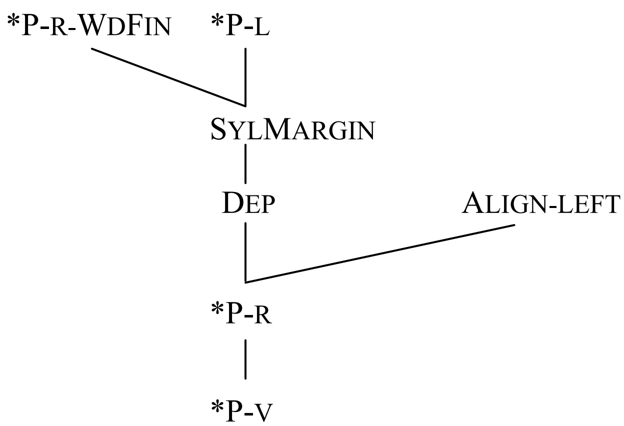
The syllabic status of *l* and nasals is harder to evaluate. This is because the native forms possess no sequences in which either *l* or the nasals could be rendered syllabic. Nasal consonants are never found in sequences that violate SYLMARGIN. And, while *l* may occur in illicit margin sequences, it occurs in such sequences only in stem final position, the very position in which *r* triggers epenthesis. In this case, *l* also triggers epenthesis, as in (15).[2]

(15) a. svetao ‘radiant-Masc’ stem: svetl
b. svetla ‘radiant-Fem’

[2] The added complication in (15a) is that *l* becomes *o* in syllable final position. This process is obviously opaque, since *l* first needs to be placed in syllable final position, by virtue of epenthesis, and then converted to *o*. This further complication is not relevant for the point we are focusing on here.

These gaps in the distribution of *l* and nasals can be interpreted as either systematic or accidental. Interpreting these distributional gaps as systematic is consistent with the ranking in (5), with SYLMARGIN ranked above *P-R but below *P-L. A more complete ranking along these lines is given in (16).

(16) Native lexicon 1: *r* is the only syllabic consonant



Due to this ranking, a SYLMARGIN violation cannot be avoided by making *l* syllabic. The only “repair” that this ranking allows for is vowel insertion, as shown by the evaluation of the form (15a), in the tableau in (17).

(17) SYLMARGIN >> DEP

svetl	*P-L	SYLMARGIN	DEP	*P-R	*P-V
☞ svetal			*		* *
sve.tL	* !				*
svetl		* !			*

The tableau in (17) presents the first step of an opaque interaction, the only step relevant for our discussion; in the next step, *l* in *svetal* is converted to *o*, yielding *svetao* (as detailed in note 2).

Thus, in the analysis summarized by the ranking in (16), *r* is in effect the only syllabic consonant in the native lexicon, since illicit margin sequences can be resolved by making it syllabic. The ranking in (16) excludes both *l* and the nasals from this role, which is treated as a systematic gap.

But the failure of *l* and the nasals to be syllabic in the native lexicon can also be construed as an accidental gap. Such an analysis would capitalizes on the fact that, in the native lexicon, only *r* appears in contexts in which it is eligible for the syllabic status. That *l* and nasals do not occur in such contexts is treated as an accidental gap. This then further allows for a vacuous syllabic status of *l* and the nasals. In sum, under the alternative analysis, the set of segments that can become syllabic in order to resolve illicit margin clusters increases considerably, with all sonorant consonants potentially assuming this role, as captured by the ranking in (18). Epenthesis triggered by *r* in (14), and by *l* in (17), will be attributed to a constraint that prohibits syllabic sonorant consonants word finally, *P-SON –WDFIN. In (18), this constraint directly dominates DEP. The three peak constraints, *P-NASAL ,*P-L and *P-R are encapsulated into a single constraint, *P-SON.

(18) Native lexicon 2: all sonorant consonants are potentially syllabic

*P-SON -WDFIN

DEP SYLMARGIN ALIGN-LEFT

*P-SON

*P-V

In the loan lexicon, on the other hand, all sonorant consonants may be syllabic, as illustrated in (19) and (20) for *l* and nasals, respectively (DjordjiÊ 1931). Thus the set of consonants that are realized as syllabic in the loan lexicon is considerably increased. Also increased is the range of positions occupied by syllabic consonants: both syllabic *l* and syllabic nasals readily appear in word final position.

(19) Syllabic L:

a. dāen.tL.men 'gentleman'
b. pL.zen 'Plzen'
c. bi.ci.kL 'bicycle'
d. di.ri.āa.bL 'dirigible'

(20) Syllabic nasals:

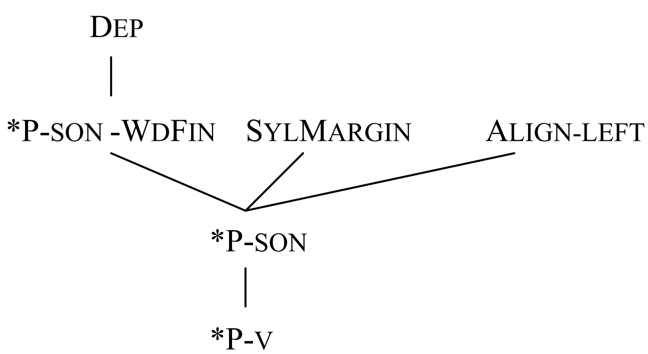
a. klo.vN 'clown'
b. ak(t)N taćna 'briefcase'

Thus, in the loan lexicon, SYLMARGIN ranks above *P-SON (which encapsulates *P-NASAL >> *P-L >> *P-R), as in (21), which captures the fact that any sonorant consonant can be syllabic:

(21) *P-OBSTR >> SYLMARGIN >> *P-SON

And, in order to accommodate syllabic consonants in word final position, DEP has to rank higher than *P-SON -WDFIN, that is, higher than in the native lexicon. The rankings relevant for the loan lexicon are given in (22):

(22) Loan lexicon: all sonorant consonants are syllabic



Note that the ranking in (22) differs minimally from the ranking in (18), the only difference being that the dominance relation between DEP and *P-SON –WDFIN in (18) is reversed in (22). If (18) is taken to be the correct analysis of syllabicity in the native lexicon, then the difference between the native and loan lexical strata can be reduced to the reranking of a single faithfulness constraint (cf. Itô and Mester 1995).

It is interesting to note that there are two types of loans ending in *r*. Those listed in (23) comply with the rankings posited for the native lexicon, both (16) and (18); and those in (24), comply with the loan lexicon ranking in (22).[3] This suggests that loan words in (23) are fully integrated into the native lexicon, while those in (24) belong to the loan lexical stratum.

(23)	teatar (vs. teatra)	'theater'
	spektar (vs. spektra)	'specter'
(24)	ǟanR	'genre'
	kandelabR	'street lamp'

To conclude, we have shown that the sets of syllabic segments differ in the native and loan lexicons in terms of the actual instantiations: only vowels and *r* are instantiated as syllabic in the native lexicon, while vowels and all sonorants are instantiated in loan words. This is directly captured in the analysis presented in (16), in which the set of syllabic segments in the native lexicon is smaller than that in the loan lexicon. But, under the analysis in (18), which allows for accidental gaps, the set of syllabic segments in the native lexicon is identical with that in the loan lexicon.

Both the analysis in (16), and that in (18), is consistent with the set of facts relevant for determining the syllabicity of segments in the native lexicon. The difference is that, under the analysis in (16), the syllabicity threshold is lower in the loan lexicon, while the thresholds in the native and loan lexicons are identical under the analysis in (18). In the next section we turn to the weight bearing status of segments, and evaluate the analyses in (16) and (18) against this additional set of facts.

[3] Note that the onset sequence *nr* which, as noted earlier, is prohibited in the native lexicon (see (3) above), is possible in *ǟanra*, the genitive singular form of *ǟanR* in (24). The latter form includes the sequence of *n* followed by syllabic *r*, also prohibited in the native lexicon.

2. Syllable weight

Heavy syllables in Serbian are those that contain either a long vowel or a long syllabic *r*. Closed syllables are not heavy; that this is indeed the case is shown by their systematic patterning with light syllables. Here we present two such cases.

The first piece of evidence comes from accent shift in the genitive plural forms, a morphologically driven accentual alternation (cf. Zec 1993). The genitive plural form may differ accentually from other case forms, represented in our examples by the nominative singular, and when it does, this is interpreted as leftward accent shift. Specifically, accent shifts from the last syllable of the stem onto the immediately preceding syllable when that syllable is light, as in (25), but not when it is heavy, as in (26).

(25)	a.	Nom Sg:	j[illegible]lén	'deer'
	b.	GenPl:	jéleena	

(26)	a.	Nom Sg:	naaród	'people'
	b.	GenPl:	naaróoda	

The closed syllables in (27) and (28) pattern with the light syllable in (25): accent shifts both on the syllable closed by an obstruent in (27b), and the syllable closed by a sonorant in (28b).

(27)	a.	Nom Sg:	kaktús	'cactus'
	b.	GenPl:	káktuusa	

(28)	a.	Nom Sg:	zumbúl	'hyacinth'
	b.	GenPl:	zúmbuula	

Accent fails to shift onto a closed syllable only when that syllable contains a long vowel, as in (29):

(29)	a.	Nom Sg:	koornjá[illegible]a	'turtle'
	b.	GenPl:	koornjáb[illegible]a	

The accentual facts presented in (25)-(29) thus strongly suggest that closed syllables are light. This is corroborated by vowel lengthening in monosyllabic forms triggered by the minimal word effect (Zec 1999).[4] As shown in (30)-(31), the stem vowel is lengthened in the nominative singular, when the entire form corresponds to a single closed syllable, but not in other case forms (represented here by the genitive form), which are disyllabic. In (30a)-(31a), a monomoraic syllable acquires an additional mora by virtue of vowel lengthening. The closing consonant, regardless of whether it is an obstruent as in (30a), or a sonorant, as in (31a), does not affect the number of moras in this monosyllabic form.

(30)	a.	Nom Sg:	brood	'boat'
	b.	GenSg:	broda	

(31)	a.	Nom Sg:	tvoor	'skunk'
	b.	GenSg:	tvora	

Syllable weight is thus determined by the structure of the nuclear segment: a light syllable contains a short nuclear segment, while a heavy one contains a long nuclear segment. The nuclear segment corresponds either to a vowel or to a syllabic *r*, as shown by (32), where the nuclear *r* is lengthened in response to the minimal word requirement:

(32)	a.	Nom Sg:	kRRv	'blood'
	b.	GenSg:	kRvi	

In sum, the two moras of a heavy syllable have to be linked to the same segment, either a vowel or *r*, as expressed by the constraint in (33):

(33) HEAVYSYL: The second mora of a heavy syllable can be linked to segment s_i only if s_i is also linked to the syllable's first mora.

---

[4] This minimal word effect is encountered only with those monosyllabic forms that belong to the circumflex accentual class, which are treated in Zec (1999) as lexically toneless.

If the facts that serve as basis for (33) were the only ones relevant for positing the set of weight bearing segments, we would then be led to conclude that only vowels and *r* are moraic, which in turn is consistent with the analysis in (16), according to which this same set of segments is also syllabic. When addressing the issue of weight bearing segments, we minimally assume that segments compatible with the most prominent position in the syllable, its nucleus, should also be compatible with the lesser peak, the one corresponding to the second mora of the syllable (as in Zec 1988). That is, we assume that all syllabic segments will be weight bearing.

However, the fairly robust phenomenon of presonorant lengthening provides an indirect piece of evidence that all sonorant consonants may well be weight bearing. In this phonological process, a vowel is lengthened in syllables closed with a sonorant consonant (Leskien 1911, 1914). This is illustrated by forms like those in (34)-(36), whose stems end in a consonant cluster consisting of a sonorant followed by an obstruent. While in (34a)-(36a) this consonant cluster is broken by *a*, this is not the case in (34b)-(36b), in which the genitive ending leads to the creation of a closed syllable (which is italicized), and the accompanying presonorant lengthening.[5]

(34)	a.	Nom Sg:	magarac	'donkey'	stem: *magarc*
	b.	GenSg:	ma*gaar*ca		
(35)	a.	Nom Sg:	konac	'thread'	stem: *konc*
	b.	GenSg:	*koon*ca		
(36)	a.	Nom Sg:	novac	'money'	stem: *novc*
	b.	GenSg:	*noov*ca		

Forms as in (37) do not exhibit lengthening because the closed syllable in (37b) ends in an obstruent.

[5] The forms in (34)-(36) are traditionally analyzed as possessing an underlying jer vowel, which is realized as *a* in the nominative, but not in the genitive forms (cf. Bethin 1998). Here, this case is interpreted synchronically as a case of epenthesis, driven by the formation of illicit consonant clusters. But the point we are making here, that presonorant lengthening is evidenced in forms in which *a* does not occur, is independent of what analysis of these facts one opts for. This case differs from the case of epenthesis in section 1; the epenthetic vowel in (11), (12), and (15) is not historically traced to the jer vowel.

(37) a. Nom Sg: vosak ‘wax’ stem: *vosk*
b. GenSg: *vos*ka

But presonorant lengthening is heavily morphologized. This is a derived environment process (in the sense of Mascaro 1976, Kiparsky 1982, 1993), restricted to morpheme junctures. Moreover, presonorant lengthening takes effect at only some morpheme junctures. There are three distinct morphological constituencies that need to be recognized: one that demarcates inflectional constituency, *MI*, and two that demarcate derivational constituency, to be referred to as *MD1* and *MD2*. Presonorant lengthening takes effect at the inflectional juncture, *MI*, and only one of the derivational junctures, *MD1*. It does not take effect at the *MD2* juncture.[6]

That presonorant lengthening takes effect at the *MI* juncture has already been illustrated in (34)-(36) above. Crucial in these cases is the presence of the genitive singular ending -*a* in (34a)-(36a), which creates the morphological constituencies [mag*aar*c]$_{MI}$ a, [*koon*c]$_{MI}$ a, and [*noov*c]$_{MI}$ a, respectively. Because all inflectional endings are vowel-initial, only stems ending in a consonant cluster, in particular, a sonorant/obstruent sequence, are subject to presonorant lengthening at the *MI* juncture.

As already noted, only one of the two derivationally defined junctures, *MD1*, exhibits presonorant lengthening. This is illustrated in (38)-(39), in which stems ending in a sonorant consonant are followed by a consonant-initial suffix. In (38) are given examples derived by the suffix -*stv*: vowel lengthening takes effect in the syllable immediately preceding the suffix when it is closed with a sonorant, as in (38a), but not when it is closed with an obstruent, as in (38b).

(38) The suffix -*stv*

a. lukav 'cunning' lu*kaav*stvo 'cunning(n.)'
pijan 'drunk' pi*jaan*stvo 'drunkenness'
b. brat 'brother' bratstvo 'brotherhood'
vodj 'leader' voÊstvo 'leadership'

Next, a number of forms created by the suffix *-k* provide evidence for the productivity of presonorant lengthening, which takes effect in newly created colloquialisms, such as those listed in (39):[7]

(39) The suffix *-k*

a.	simultan	'simultaneous'	simul*taan*ka	'multiple chess game'
	agresivan	'aggressive'	agre*siiv*ko	'an aggressive person'
	pospan	'sleepy'	pos*paan*ko	'a sleepy person'
b.	praćina	'dust'	praćko	'duster'
	tRÉati	'run'	tRÉko	'treadmill'

However, the other derivationally defined morphological juncture, *MD2*, does not exhibit presonorant lengthening. Thus, the adjective forming suffix *-sk*, illustrated in (40), does not trigger this process, although its phonological environment closely resembles that of the suffix *-stv* in (38).

(40) The suffix *-sk*

podrum	'basement'	podrumski
visina	'height'	visinski
slava	'glory'	slavski
kola	'cart'	kolski
ǣena	'woman'	ǣenski
Dunav	'Danube'	dunavski

The properties of different morphological junctures with respect to presonorant lengthening are summarized in (41): [8]

[6] See Zec (1988) for an analysis of presonorant lengthening within the framework of lexical phonology and morphology, in which this process is analyzed as a cyclic phonological rule associated with only some morphological levels.

[7] The suffixes *-stv* and *-k* are both historically reconstructed as being jer initial. Given that they do not exhibit any synchronic alternations, it is justified to analyze them as consonant initial.

[8] Syllables closed by sonorant consonants in word final position should also be subject to presonorant lengthening, given the morphological conditioning of this process outlined in (42), since any morphological word is inflected, and any inflected form corresponds to a *MI* constituent. However, presonorant lengthening is practically absent from the word final syllable. This can be explained as a general tendency towards elimination of vowel length in final syllables (IviÊ 1958). Leskien (1914) lists a number of forms with presonorant lengthening taking effect in the word final syllable, which reflects an older situation in the

(41) Morphological conditioning for presonorant lengthening (PL)

MD1: PL before consonant initial suffixes (e.g., *-stv*, and *-k*)
MD2: No PL before consonant initial suffixes (e.g., *-sk*)
MI: PL before inflectional endings in stems that end in consonant clusters

In sum, presonorant lengthening needs to be characterized in both phonological and morphological terms. While its phonological environment is a syllable closed with a sonorant consonant, presonorant lengthening takes effect only if this environment coincides with a designated morphological juncture. It is thus a clear derived environment process which never takes effect morpheme internally. Monomorphemic forms in both native and loan lexicons possess non-final syllables closed with a sonorant consonant. Such syllables, however, may contain either a short or a long vowel, as shown in (42a) and (42b), respectively:

(42) a. *san*duk 'coffer', *Var*varin (place name), *mar*ka 'stamp'
b. *suun*ce 'sun', *maar*va 'cattle' *kaar*ta 'ticket'

The central issue to be addressed at this point is whether presonorant lengthening warrants the analysis that sonorant consonants are potentially moraic. If presonorant lengthening is triggered by the moraic status of sonorant consonants in (34)-(36) and (38)-(39), then sonorant consonants can be moraic at morpheme junctions, but not morpheme internally. As already noted, syllables closed with a sonorant consonant in (42a) are to be construed as light. Alternatively, presonorant lengthening could well be analyzed as a phonotactic regularity, unrelated to syllable weight, that takes effect at morpheme boundaries. In what follows, I will outline two approaches to the facts of presonorant lengthening. One will be a prosodically based analysis, with the crucial assumption that sonorant consonants are potentially moraic. The other account, which does not depend on this assumption, will be a phonotactically based analysis. The set of facts pertaining to presonorant lengthening is obviously fairly complex, and this complexity is bound to be reflected in any formal account. But an important difference

language. But some monosyllabic forms do exhibit presonorant lengthening. This however happens only in syllables closed with glides, that is, *v* and *j*, e.g., *raaj, raja* 'paradise', *roov*, *rova* 'trench'. These forms do between these two analyses is that the former will include opaque constraint interactions, while the latter will not.

2.1 A prosodic account of presonorant lengthening

We begin with the prosodically based analysis of presonorant lengthening. On the phonological end, presonorant lengthening is analyzed as a prosodically driven process, triggered by the moraic status of sonorant consonants. On the morphological end, we need to explain why the moraicity of a sonorant consonant emerges at certain morpheme junctures, and is dormant elsewhere. This will be accomplished by allowing the emergence of weight under closely defined circumstances (cf. Hayes 1994, Rosenthal and van der Hulst 1999). As will be shown, presonorant lengthening emerges under morphologically driven pressure.

Under this analysis, weight emergence is a response to the requirement for phonological demarcation of morphological junctures (following Kang 2003). In the general case, both syllables closed by sonorants, and those closed by obstruents, are light. The relevant constraints are stated in (43), in the spirit of Rosenthal and van der Hulst (1999): (43a) and (43b) prohibit the weight bearing status of obstruents and sonorants respectively, while (43c) prohibits weightless consonants, that is, those coda consonants that link directly to the syllable node.

(43) a. *μOBS No moraic obstruents in coda
b. *μSON No moraic sonorants
c. *APPEND No weightless consonants syllable finally (i.e., in the appendix)

The two constraints that prohibit the weight bearing status of consonants both rank higher than *APPEND, as in (44), granting preference to light closed syllable over heavy ones.

---

not belong to the circumflex accentual class which exhibits the minimal word effect (see note 4).

(44) *μOBS, *μSON >> *APPEND

a. CVS	*μOBS	*μSON	*APPEND
☞ CVS			*
$CVS_μ$		* !	
b. CVO			
☞ !CVO			*
$CVO_μ$	* !		

But CVS syllables may emerge as heavy due to the agency of edge demarcation. The constraint which states the demarcation requirement for *MI* is given in (45).[9]

(45) EDGE DEM-*MI*

The rightmost syllable $σ_i$ in the morphological constituent *MI*, if closed, has to be bimoraic. (That is, $σ_i$ may not be followed by $σ_j$, such that $σ_j$ exhaustively included in *MI*.)

By ranking this edge demarcation constraint higher than *μSON, which prohibits weight bearing sonorants, but lower than *μOBS, which prohibits weight bearing obstruents, we get the desired result: that sonorant consonants, but not obstruents, are weight bearing at the right edge of *MI*. This is presented in tableau (46), which captures the facts in (34)-(37). Note however that the winning $CVS_μ$ syllable in (46a) is not the actual output, which of course should be CVVS. We return to this in a moment.

[9] The following condition specifies when syllable $σ_i$ counts as constituent final: All segments dominated by $σ_i$ are exhaustively included in *MI*, and there is no $σ_j$ which follows $σ_i$, such that its segments are exhaustively included in *MI*. The same condition is also relevant for edge demarcation of *MD1* and *MD2* constituents.

(46) *µOBS >> EDGE DEM-*MI* >> *µSON

a. CVSC$]_{MI}$ V$]_{MI}$	*µOBS	EDGE DEM-*MI*	*µSON	*APPEND
☞CVS$_{\mu}$ C$]_{MI}$ V$]_{MI}$			*	
CVS C$]_{MI}$ V$]_{MI}$		* !		*
b. CVO C$]_{MI}$ V$]_{MI}$				
☞CVO C$]_{MI}$ V$]_{MI}$		*		*
! ! !CVO$_{\mu}$ C$]_{MI}$ V$]_{MI}$	* !			

Two further edge demarcation constraints are also at work here. The one that demarcates the right edge of *MD1*, and captures the situation in (38)-(39), is stated in (47). Note that its effect is identical with that of EDGE DEM-*MI* in (45).

(47) EDGE DEM-*MD1*

The rightmost syllable σ_i in the morphological constituent *MD1*, if closed, has to be bimoraic.

The other constraint, responsible for edge demarcation at *MD2*, requires that its rightmost syllable faithfully reflect the moraic content of its input correspondents, as in (48), and thus in effect precludes presonorant lengthening.

(48) EDGE DEM-*MD2*

The rightmost syllable σ_i in the morphological constituent *MD2* has to be faithful to the weight of its input correspondent segments.

The ranking in (49) insures that each higher morphological constituent overrides the edge demarcation effect of the lower one. This is relevant for those cases in which a single edge marks off more than one constituent, as in *magaarc*$]_{MD1}]_{MD2}]_{MI}$ *a*], listed in (34b), in which the highest ranked EDGE DEM-*MI* insures that presonorant lengthening does take effect.

(49) EDGE DEM-*MI* >> EDGE DEM-*MD2* >> EDGE DEM-*MD1*

The three constraints responsible for edge demarcation thus ensure the correct distribution of syllable weight: syllables closed with a sonorant consonant emerge as heavy at the right edge of *MD1* and *MI*, but not at the right edge of *MD2*.

We now return to tableau (46a), whose winning candidate, CVS_μ, does not correspond to the actual output form, which should be CVVS. What remains to be accounted for is the weight transfer from a CVS_μ to $CVV_\mu S$ syllable. This can only be accounted for as an opaque constraint interaction, and calls for an account that would involve either multiple levels (Kiparsky 1982, 2002), or sympathy to a failed candidate (McCarthy 1999). I will outline here a level based analysis of opaque constraint interactions at the *MI* juncture. Tableau (46a) above presents interactions at the first level, at which HEAVYSYL ranks below both *µSON and EDGE DEM-*MI*. This allows for the formation of heavy syllables with a moraic coda consonant, which meet the edge demarcation requirement posed by EDGE DEM-*MI*. At the next level, however, HEAVYSYL ranks above the edge demarcation constraint, and thus enforces that it be satisfied only by a heavy syllable with both moras linked to a single segment, as in tableau (50), which presents the relevant interactions: the winning candidate has a $CVV_\mu S$ syllable at the right margin of *MI*, which satisfies both HEAVYSYL and the edge demarcation constraint, as well as IDENTWT, the constraint which requires identical mora count in the input and output candidates (cf. McCarthy 2000, Rosenthal and van der Hulst 1999). This complex set of interactions insures that the moraicity of the sonorant consonant be manifested indirectly, that is, by virtue of compensatory lengthening.

(50) IDENTWT, HEAVYSYL >> EDGE DEM-*MI*

CVS_μ C]$_{MI}$ V]$_{MI}$	IDENTWT	HEAVYSYL	EDGE DEM-*MI*
☞CVV_μSC]$_{MI}$ V]$_{MI}$			
CVS C]$_{MI}$ V]$_{MI}$	*!		*
CVS_μ C]$_{MI}$ V]$_{MI}$		*!	

In sum, while this analysis crucially depends on invoking the weight bearing potential of sonorant consonants at relevant morphological edges, the indication of their weight is indirect, and this can only be captured by opaque constraint interactions.

Moreover, there are further complexities exhibited by presonorant lengthening. This process overapplies at the *MD1* juncture, as illustraetd in (51). In this case, the suffix -*(a)n* , which varies in shape, creates both forms with a closed and with an open syllable within a single paradigm. In (51a), the sonorant consonant closes the *MD1* final syllable in the feminine, but not in the masculine forms, yet both sets exhibit presonorant lengthening. Forms in (51b) are closed with an obstruent, and thus exhibit no lengthening.[10]

(51) The suffix -*(a)n*

			Fem	*Masc*	
a.	sila	‘power’	siilna	siilan	‘powerful’
	slava	‘fame’	slaavna	slaavan	‘famous’
	otrov	‘poison’	otroovna	otroovan	‘poisonous’
	olovo	‘lead'	oloovna	oloovan	‘leaden’
	odmor	‘rest’	odmoorna	odmooran	‘rested’
	vera	‘faith’	veerna	veeran	‘faithful’
	bura	‘storm’	buurna	buuran	‘stormy’
b.	Éudo	‘wonder’	Éudna	Éudan	‘strange’
	jad	‘misery’	jadna	jadan	‘miserable’

The agentive suffix -*(a)c* also exhibits overapplication of presonorant lengthening. As shown in (52a), overapplication is evidenced in the nominative forms, in which the sonorant consonant is not tautosyllabic with the lengthened vowel. Forms in (52b), which contain an obstruent, exhibit no lengthening.

---

[10] The suffixes -*(a)n* in (51) and -*(a)c* in (52) are traditionally analyzed as possessing a jer vowel which is realized as *a* in, say, *siilan*, but is unrealized in *siilna*. An epenthesis analysis would be consistent with both the facts in (51) and (52). However the point made here does not depend on what analysis of these facts one opts for.

(52) The suffix *-(a)c*

			Nom	*Gen*	
a.	loviti	'hunt'	loovac	loovca	'hunter'
	pevati	'sing'	peevac	peevca	'rooster'
	tvoriti	'create'	tvoorac	tvoorca	'creator'
b.	kositi	'mow'	kosac	kosca	'mower'
	prositi	'beg'	prosac	prosca	'suitor'

These facts obviously call for further formal mechanisms. This case was analyzed in Zec (1988) by invoking cyclic rule application. One possibility within OT would be a modified version of the output to output faithfulness constraints (Benua 1995). However, a potential difficulty arises from the fact that the output form that serves as a model for output to output faithfulness (e.g., *siilna* in (51a)) is derived, rather than simplex, as required by the theory.

In sum, in the prosodical analysis presented in this section, the weight of sonorant consonants emerges at certain morphological junctures. This can only be captured by opaque constraint interactions, and thus calls for at least two formal mechanisms that encode such interactions. In contrast, the phonotactic account to be presented in the next section does not depend on the moraicity of sonorant segments, and due to this, avoids a number of complex interactions that the prosodic account crucially depends on.

2.2 A phonotactic account of presonorant lengthening

The alternative, phonotactically based, analysis of presonorant lengthening is more straightforward, and is transparent. But it is also less intuitively appealing than the prosodically based one. In this analysis, presonorant lengthening is reduced to a phonotactic regularity. Significantly, however, in this analysis, all the facts, including those of overapplication, will be captured without resorting to opaque constraint interactions.

In this alternative analysis, presonorant lengthening is again driven by edge demarcation, that is, by the same morphologically driven constraints as in the prosodically based analysis. The crucial issue again is how to induce *MD1* and *MI* final lengthening, and also, how to insure that it takes effect only in the environment of a sonorant consonant. This time, no reference will be made to the weight bearing properties of segments. Instead, we posit two contextually confined faithfulness constraints, one requiring that vowel length in the output be faithful to that in the input in the context of an obstruent, as in (53), and the other making the same faithfulness requirement in the context of a sonorant consonant, as in (54) (based on the faithfulness constraint on vowel length in McCarthy 2000 and Rosenthal and van der Hulst 1999).

(53) IDENT-WEIGHT /_OBS

Vowel length in the output is identical to vowel length in the input, immediately before an obstruent consonant.

(54) IDENT-WEIGHT /_SON

Vowel length in the output is identical to vowel length in the input, immediately before a sonorant consonant.

By ranking (53) above (54), we capture a higher value of length preservation in vowels immediately preceding an obstruent, than in those immediately preceding a sonorant. And by ranking EDGE DEMARCATION constraints above IDENT-WEIGHT /_SON, and below IDENT-WEIGHT /_OBS, we induce presonorant lengthening in the rightmost syllable of *MD1* as well as *MI*. The latter case is shown in tableau (55):

(55) IDENT-WEIGHT /_OBS >> EDGE DEM-*MI* >> IDENT-WEIGHT /_SON

a. CVSC]$_{MI}$ V]$_{MI}$	IDENT-WT/_OBS	EDGEDEM-*MI*	IDENT-WT/_SON
☞CVVSC]$_{MI}$ V]$_{MI}$			*
CVSC]$_{MI}$ V]$_{MI}$		* !	
b. CVOC]$_{MI}$ V]$_{MI}$			
☞CVOC]$_{MI}$ V]$_{MI}$		*	
CVVOC]$_{MI}$ V]$_{MI}$	* !		

Presonorant lengthening thus takes effect in syllables closed by a sonorant, as in (55a), but not in those closed by an obstruent, as shown in (55b).

Presonorant lengthening at the right edge of *MD1* would proceed in the same fashion as in (55). However, by slightly restating the relevant edge demarcation constraint, it is further possible to capture overapplication at the *MD1* juncture. The statement of EDGE DEM-*MD1* in (56) is more general than under the prosodically based analysis. In the restated version, this constraint makes reference to all *MD1* final syllables, rather than just the closed ones, as is the case in (47):

(56) EDGE DEM-*MD1* [revised]

The rightmost syllable σ_i in the morphological constituent *MD1* has to be bimoraic.

The relevant interactions are presented in (57). What the restated version of EDGE DEM-*MD1* captures is that the vowel preceding the sonorant consonant is lengthened regardless of whether it is tautosyllabic with this consonant, as in (57a), or heterosyllabic, as in (57b).

(57) IDENT-WEIGHT /_OBS >> EDGE DEM *MD1* >> IDENT-WEIGHT /_SON

a. CVS]$_{MD1}$ CV]$_{MD1}$	IDENT-WT/_OBS	EDGE DEM-*MD1*	IDENT-WT/_SON
☞CVVS]$_{\boldsymbol{MD1}}$ CV]$_{\boldsymbol{MD1}}$			*
CVS]$_{\boldsymbol{MD1}}$ CV]$_{\boldsymbol{MD1}}$		* !	
b. CVS]$_{\boldsymbol{MD1}}$ VC]$_{\boldsymbol{MD1}}$			
☞CVVS]$_{\boldsymbol{MD1}}$ VC]$_{\boldsymbol{MD1}}$			*
CVS]$_{\boldsymbol{MD1}}$ VC]$_{\boldsymbol{MD1}}$		* !	

Thus, by minimally modifying the *MD1* edge demarcation constraint, the phonotactically based analysis accounts for the overapplication of presonorant lengthening at this morphological juncture.

In sum, under this analysis, the complex facts of presonorant lengthening are accounted for without positing any opaque constraint interactions. Because HEAVYSYL is an undominated constraint, the set of segments that may surface under the second mora of a heavy syllable is identical to the set of syllabic segments. These will be only vowels and *r*, as captured in (16) above.

3. Concluding remarks

While the overall goal of this paper is to capture the prosodic properties of Serbian syllables, this task has proved to be less than straightforward. First, the set of syllabic segments is subject to at least two interpretations: the one in (16), which posits as syllabic only vowels and *r*, that is, segments that are indeed realized as syllable nuclei; and the one in (18), which posits a more numerous syllabic set than is actually realized, including vowels as well as all sonorant consonants, thus allowing for accidental gaps. We also presented two accounts of syllable weight. One, presented in section 2.2, treats as potentially moraic only vowels and *r*, that is, segments that may actually be weight bearing in bimoraic syllables, and is consistent with the analysis of the syllabic set presented in (16), but not with that in (18). In the other account, presented in section 2.1, the phonological process of presonorant lengthening is interpreted as providing a window into the moraicity of sonorant consonants, granting them a moraic status, although they do not actually appear in the weight bearing position within the syllable. This account coheres with either the analysis of syllabicity in (16) or in (18). Most notably, the prosodically based analysis in 2.1, with all sonorant consonants interpreted as potentially moraic, requires an opaque interpretation of the facts, while its alternative does not. Thus on the basis of overall simplicity, the phonotactic account should be favored over the prosodic one.

The choice between these alternative analyses further influences the status in the grammar attributed to presonorant lengthening. The prosodically based analysis in 2.1, while providing prosodic motivation for presonorant lengthening, depends on a baroque set of opaque interactions. Under the phonotactically based analysis in 2.2, this process is interpreted as a phonotactic regularity. Because this account includes only transparent constraint interactions, it reinforces a "what you see is what you get" analysis of the syllable and its subparts. This analysis has a considerable advantage over its alternative because of its straightforward nature. But it also has its disadvantages. Under this analysis, presonorant lengthening is left with no prosodic motivation, yet it does bear a clear mark of a prosodically motivated phonological process (cf. Hayes 1989). Any relatedness of presonorant lengthening to the prosodic portion of the phonological system can only be provided through a historical connection: this phonotactic regularity obviously has a root in a prosodic process at an earlier stage of the language, motivated by the weight bearing properties of sonorant consonants, as related in Bethin 1998. But this connection cannot be incorporated into the phonotactically based analysis. Under this analysis, any such resemblance is a mystery, and becomes something of a conspiracy.

References

Bethin, C.Y. 1998. *Slavic Prosody. Language Change and Phonological Theory*. Cambridge University Press.

Benua, L. 1995. "Identity Effects in Morphological Truncation." In Beckman, J., L. Walsh Dickey and S. Urbanczyk (eds.), *Papers in Optimality Theory*. pp. 77-136. Amherst, MA.: GLSA.

Clements, George N. 1990. "The Role of the Sonority Cycle in Core Syllabification." Kingston, J. i M. Beckman (ed). *Papers in Laboratory Phonology I: Between the Grammar and Physics of Speech*. Cambridge: Cambridge University Press. 283-333.

Djordjić, P. 1931. "Samoglasničko *l*." *Južnoslovenski filolog 11:* 219 -222.

Hayes, B. 1989. "Compensatory Lengthening in Moraic Phonology." *Linguistic Inquiry 20*: 253-306.

Hayes, B. 1994. "Weight of CVC Can Be Determined by Context." In Cole, J. and C. Kisseberth (eds.) *Perspectives in Phonology*. Stanford: CSLI.

Itô, J. and A. Mester. 1995. "The Core-Periphery Structure of the Lexicon." In Beckman, J., L. Walsh Dickey and S. Urbanczyk (eds.), *Papers in Optimality Theory*. pp. 181-210. Amherst, MA.: GLSA.

IviÊ, P. 1958 *Die serbokroatischen Dialekte. Ihre Struktur und Entwicklung*. Erster Band. Allgemeines und die stokavischen Dialektgruppe. The Hague: Mouton.

IviÊ, P. 1967. "Milan SurduÉki, The Distribution of Serbo-Croatian Consonants." *Zbornik Matice srpske za filologiju i lingvistiku* 10: 227-236.

IviÊ, P. 1968a. "Razvoj principa distribucije fonema u srpskohrvatskom jeziku." *Knjiǣvnost i jezik* 15: 13-32.

IviÊ, P. 1968b. "Vokalske grupe u srpskohrvatskom knjiǣvnom jeziku." *Slavia Orientalis* 17: 315 – 319.

Kahn, D. 1978. *Syllable-Based Generalization in English Phonology*. MIT Ph.D. Dissertation.

Kang, E. 2003. *Edge Demarcation in Phonology*. Ph.D. Dissertation. Cornell University.

Kiparsky, P. 1982. "Lexical Phonology and Morphology." In Yang I.S. (ed.), *Linguistics in the Morning Calm*. Vol 2 (pp. 3-91). Seoul: Hanshin.

Kiparsky, P. 1993. "Blocking in Non-derived Environments." In Hargus, S. and E. Kaisse (eds.), *Phonetics and Phonology 4: Studies in lexical Phonology*. 277-313. San Diego: Academic Press.

Kiparsky, P. 2002. "Syllables and Moras in Arabic." In Fery, C. and R. van de Vijver (eds.), *The Optimal Syllable*. Cambridge: Cambridge University Press.

Lehiste, I. and P. IviÊ. 1967. "Some Problems Concerning the Syllable in Serbocroatian." *Glossa* 1:126 -136.

Leskien, A. 1911. *Untersuchungen über Quantität und Betonung in den slavischen Sprachen*. Slavische und Baltische Forschungen. Leipzig 1975.

Leskien, A. 1914. *Grammatik der serbo-kroatischen Sprache*. Heidelberg: Carl Winter's Universitätsbuchhandlung.

Mascaro, J. 1976. *Catalan Phonology and the Phonological Cycle*. MIT Doctoral Dissertation.

McCarthy, J. 1999. “Sympathy and Phonological Opacity.” *Phonology* 16: 331-99.

McCarthy, J. 2000. “The Prosody of Phase in Rotuman.” *Natural Language and Lingusitic Theory* 18: 147-197.

McCarthy, J. and Prince, A. 1993. *Prosodic Morphology 1. Constraint Interaction and Satisfaction*. Ms. University of Massachusetts, Amherst and Rutgers University.

Prince, A. and Smolensky, P. 1993. *Optimality Theory. Constraint Interaction in Generative Grammar*. Ms. Rutgers University and University of Colorado, Boulder.

Rosenthal, S. and H. van der Hulst. 1999. “Weight-by-Position by Position.” *Natural Langauge and Lingusitic Theory* 17: 499-540.

Selkirk, E. O. 1984. “On the Major Class Features and Syllable Theory.“ Aronoff, M. and R. Oehrle (ed). *Language Sound Structure*. Cambridge: MIT Press. 107-136.

SurduÉki, M. I. 1964. “Distribution of Serbo-Croatian Consonants.” *The Slavic and East European Journal* 8: 159 –181.

Zec, D. 1988. *Sonority Constraints on Prosodic Structure*. Ph.D. Dissertation. Stanford University.

Zec, D. 1993. “Rule Domains and Phonological Change.” 1993. In Hargus, S. and E. Kaisse (eds.), *Lexical Phonology*. Academic Press.

Zec, D. 1999. “Footed Tones and Tonal Feet.” *Phonology* 16: 225-264.