

Title: Consonant-Vowel Interactions in Serbian:
Features, Representations and Constraint Interactions

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Consonant-Vowel Interactions in Serbian: Features, Representations and Constraint Interactions

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1. Introduction

Standard Serbian¹ displays several complex relationships among its phonetic, phonological and morphological components that pose serious challenges to most current theories of phonological features. Specifically, there are consonant-vowel interactions and alternations suggesting that consonants and vowels use the same sets of phonological features for both place and manner of articulation (in support of Clements, 1991a and Morén, 2003a), and that the mapping between phonological feature specification and phonetic realization is not as universal and straightforward as is usually assumed.

There are three main goals of this paper. The first is to establish some of the empirical facts regarding Serbian phonetics, phonology and morpho-phonology and to suggest that they provide direct support for a new perspective on the phonetic and phonological relationships among consonants and vowels. The second is to provide a unified representational analysis of several puzzles in Serbian phonology using a limited set of phonetically grounded features and simple structures. The third is to provide a constraint-based explanation for the proposed representational analysis, integrating segment-internal structures into markedness constraints, providing a detailed mechanism for deriving the segment inventory via constraint interaction, and

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¹ Roughly, this refers to the ekavian dialects spoken in and around Belgrade.

integrating that mechanism into an account of the consonant-vowel interactions and alternation under study.

The paper is organized as follows. First, I present a detailed description of the Serbian segment inventory and point out several phonetic and phonological issues, such as phonetic enhancement strategies and curious inventory gaps. Second, I describe four morpho-phonological consonant-vowel interactions (i.e. velar palatalization, velar dentalization, iotization and mid-back vowel fronting), and demonstrate that these cannot be explained using traditional feature theory. Third, I discuss a puzzling alternation between lateral approximants and mid back vowels (i.e. ‘l’ --> ‘o’) that is not phonologically “natural” under most models. Fourth, I propose a unified account of the inventory facts, consonant-vowel interactions and consonant-vowel alternation using a minimal set of articulator-based phonological features and simple phonological representations. Fifth, I provide a constraint-based approach to explain the empirical facts. Finally, I present some general conclusions.

This paper not only provides detailed data from an under-reported language, but it also demonstrates the importance that a single language can have in challenging or supporting theories of universal grammar. Specifically, Serbian shows that there is not a one-to-one correspondence between phonological features and phonetic realization, that there is a need to dismantle the traditional distinction between consonant and vowel features, and it highlights the importance of viewing the grammatical system of a language as a whole (including phonetics and morphology) when dealing with any given phonological phenomenon. It also shows that issues of features and segment-internal representations, which have been largely ignored since the advent of Optimality Theory (Prince and Smolensky, 1993), are vital to a full understanding of phonological

phenomena and are somewhat independent of theories of constraint interactions. Yet, features and representations can play an important role in constraint-based analyses.

2. Description of Serbian

This section provides a basic description of the Serbian segment inventory, the four morpho-phonological consonant-vowel interactions under investigation, and a consonant-vowel alternation.

2.1. Vowel inventory

The surface inventory of vowels in Standard Serbian is given in (1) (Magner 1991, Browne 1993, Mønnesland 2002). It is a typical five-vowel system, with the mid vowels having an open/lax articulation. These vowels may appear in any word position (initial, medial, final), they can be long or short, and they can be accented or unaccented.²

(1) Description of surface vowels

	Front	Central	Back/round
High	[i] 'i'		[u] 'u'
Mid lax	[ɛ] 'e'		[ɔ] 'o'
Low		[a] 'a'	

We will see in section 4 that some of the phonetic characteristics of these vowels, such as centrality and laxness are not phonologically relevant, and their morpho-phonological behavior suggests that their phonological features are not what might be initially expected based solely on the phonetics. Because the phonological

² I will not address the issues of vowel length or tone/accent in this paper.

representations and the phonetic representations do not always match, I will use different bracketing to avoid confusion. Square brackets (e.g. [a]) will be used for phonetic transcriptions, single slash brackets (e.g. /a/) will be used for output phonological representations, and double slash brackets (e.g. //a//) will be used for input phonological representations.

2.2. Consonant inventory

The surface inventory of consonants in Serbian is given in (2) (Magner 1991, Browne 1993, Mønnesland 2002, Miller-Ockhuizen and Zec 2003).

(2) Description of surface consonants

Passive place		Upper lip		Dental		Alveolar		Post-alveolar				Velar	
Active place		Lower lip				Laminal				Apical		Dorsal	
Laryngeal		Plain	Voiced	Plain	Voiced	Plain	Voiced	Plain	Voiced	Plain	Voiced	Plain	Voiced
Manner	Stop	[p] 'p'	[b] 'b'			[t] 't'	[d] 'd'					[k] 'k'	[g] 'g'
	Affricate					[tʃ] 'č'		[dʒ] 'D'		[tʃ ^w] 'č'	[dʒ ^w] 'dž'		
	Fricative			[f] ³ 'f'		[s] 's'	[z] 'z'			[ʃ] 'š'	[ʒ] 'ž'	[x] 'h'	
	Nasal		[m] 'm'				[n] 'n'		[ɲ] 'nj'				
	Lateral						[l] 'l'		[ʎ] 'lj'				
	Rhotic						[r] 'r'						
	Glide				[v] 'v'								

This surface consonant inventory is fairly self-explanatory. However, several claims and observations must be mentioned. First, the apical post-alveolar affricates have rounded lips. As Miller-Ockhuizen and Zec (2003:165) have shown, differences in lip protrusion/compression “categorically distinguishes the two affricates” because

³ The plain labial fricative is found only rarely in the native vocabulary.

lip protrusion causes a significant lowering of the spectral peaks associated with the frication noise of the affricates. As we will see in section 4, this lip rounding is best analyzed as a phonetic enhancement strategy, not as an indication of a phonological feature. This not only allows more economical feature sets to be built (see section 4.1), but it fits neatly into the analysis of the morpho-phonological alternations to be discussed (see section 4.2) and provides further support for the claim that phonetics and phonology are not isomorphic.

Second, [v] is usually described as a phonetic fricative in Serbian. However, its distribution and phonological behavior are consistent with that of a sonorant, not an obstruent - e.g. it does not participate in voicing alternations with [f]. Therefore, I assume, with Browne (1993), Barić *et al.* (1997) and Miller-Ockhuizen and Zec (2003) that it is a phonological sonorant (i.e. /v/) despite its surface fricative property.

Finally, there are two observations to make about the composition of this consonant inventory. First, there are no post-alveolar stops, despite the fact that there are two pairs of post-alveolar affricates and one pair of post-alveolar fricatives. This is a curious inventory gap that deserves explanation. Second, there are three obstruents that do not have a voiced counterpart (i.e. [f, $\text{t}_{\text{ɰ}}^{\text{h}}$, x]) and thus do not participate in voicing assimilation within words.⁴

2.3. *Four morpho-phonological consonant-vowel interactions*

There are a number of consonant-vowel interactions in Serbian that provide cues to how best to characterize and combine the phonological features necessary to produce the segment inventory. These interactions are mid vowel fronting, velar fronting, velar

⁴ I do not discuss lexical or post-lexical voicing assimilation in this paper.

palatalization and iotization. This section provides a description of these phenomena and suggests possible descriptive analyses.

2.3.1. Mid vowel fronting

Mid vowel fronting is a morpho-phonological process by which the mid back vowel of some suffixes becomes front following post-alveolar consonants. A typical descriptive rule is given in (3) and examples are given in (4).

(3) [ɔ] --> [ɛ] / [t̪̚, d̪̚, t̪̚^w, d̪̚^w, ʃ, ʒ, ɲ, ʎ, j] + ____

[i] 'i'		[u] 'u'
[ɛ] 'e'	←	[ɔ] 'o'
	[a] 'a'	

(4) a. Neuter noun nominative accusative singular [-ɔ]~[-ɛ]

sel-o [ʃɛlɔ] 'village' ~ *polj-e* [pɔɮɛ] 'field'

b. Masculine instrumental singular [-ɔm]~[-ɛm]

grâd-om [gra:ɔm] 'city' ~ *mûž-em* [mu:ʒɛm] 'husband'

c. Dative/locative singular [-ɔ:m]~[-ɛ:m]

dobr-ōm [ɔbrɔ:m] 'good' ~ *los-ēm* [lɔʃɛ:m] 'bad'

d. Genitive singular [-ɔg]~[-ɛg]

dobr-og [ɔbrɔg] 'good' ~ *los-eg* [lɔʃɛg] 'bad'

e. Masculine plural [-ɔv-i]~[-ɛv-i]

grad-ov-i [gradɔvi] 'city' ~ *mûž-ev-i* [mu:ʒɛvi] 'husband'

These data suggest that post-alveolar consonants and (at least some) front vowels share a phonological feature that assimilates in this morphological environment. It is important to note that the high vowels do not participate in fronting, and that this cannot be analyzed as a strictly phonetic phenomenon (e.g. articulatory overlap) since it only applies in particular morphological contexts. Mid vowel fronting does not occur within morphemes, e.g. *šólja* [ʃɔ:ʎa] ‘cup’, *šofirati* [ʃɔfi:raʦi] ‘to drive’.

2.3.2. Velar palatalization

Velar palatalization is a morpho-phonological process by which velar obstruents become apical post-alveolar when followed by some suffixes beginning with ‘i’ or ‘e’. A descriptive rule is given in (5) and representative data given in (6).

(5) $[k, x, g^5] \rightarrow [tʃ^w, ʃ, ʒ] / __ + [i, \varepsilon]$

[t̚] ‘t’			[k] ‘k’
[t̚s̚] ‘c’	[t̚ʃ̚] ‘c’	[t̚ʃ̚ ^w] ‘č’	
[s̚] ‘s’		[ʃ̚] ‘š’	[x] ‘h’

⁵ I will not analyze the manner alternations between the voiced velar stop and coronal fricatives. Similar changes occur in other Slavic languages (e.g. Polish) and are beyond the scope of the present paper.

(6) a. Masculine vocative singular [-ε]

vojnīk [vɔjni:k] ‘soldier’ ~ *vojnīč-e* [vɔjni:ʧ̥ˀwε]

bôg [bɔ:g] ‘god’ ~ *bož-e* [bɔʒ.ε]

siromāh [ʃirɔma:x] ‘poor’ ~ *siromāṣ-e* [ʃirɔma:ʃ̣.ε]

b. Diminutive [-it̪̥(-a)]

krûg [kru:g] ‘circle’ ~ *kruž-íc* [kruʒ.ít̪̥]

rúka [ru:ka] ‘hand’ ~ *ruč-ic-a* [ruʧ̥.ít̪̥a]

d. Denominals [-it̪̥-i]

muka [muka] ‘pain’ ~ *muč-it-i* [mut̪̥.ít̪̥i]

súh [ʃu:x] ‘dry’ ~ *súṣ-it-i* [ʃu:ʃ̣.ít̪̥i]

These data suggest that apical post-alveolar obstruents and the palatalizing front vowels share a phonological feature that assimilates in this morphological environment. It is important to note that the velar stop alternates with a phonetic affricate, not another stop. While it is tempting to assume that this manner mismatch is simply due to the lack of a post-alveolar stop in this language (i.e. structure preservation), such an assumption fails to account for similar stop-affricate alternations to be discussed below. Thus, we must explain why a change in phonological place triggers a change in manner for stops but no other segments. Finally, this consonant-vowel interaction cannot be analyzed as a strictly phonetic phenomenon (e.g. articulatory overlap) since it only occurs in particular morphological environments. Velar obstruents are found before front vowels within morphemes, e.g. *kéks* [kɛ:kʃ̣] ‘cookie’, *kít* [kit] ‘whale’, *hiljada* [xiʎaɖa] ‘thousand’.

2.3.3. Velar fronting (a.k.a. dentalization/sibilantization)

Velar fronting is a morpho-phonological process by which velar obstruents become laminal alveolar when followed by some suffixes beginning with ‘i’. A descriptive fronting rule is given in (7) and representative data given in (8).

(7) $[k, x, g^6] \rightarrow [t_{\text{̣}}^{\text{̣}}, s_{\text{̣}}^{\text{̣}}, z_{\text{̣}}^{\text{̣}}] / ___ + [i]$

[ṭ] ‘t’			[k] ‘k’
[ṭ̣] ‘c’	[ṭ̣̣] ‘c’	[ṭ̣̣̣] ‘č’	
[ṣ] ‘s’		[ṣ̣] ‘š’	[x] ‘h’

(8) a. Masculine plural nominative [-i]

junāk [juna:k] ‘hero’ ~ *junác-i* [juna:ṭ̣̣̣i]

bubreg [bubrɛg] ‘kidney’ ~ *bubrez-i* [bubrɛẓ̣̣̣i]

orah [ɔrax] ‘walnut’ ~ *oras-i* [ɔraʃ̣̣̣̣i]

b. Masculine plural dative/ instrumental/locative [-ima]

junāk [juna:k] ‘hero’ ~ *junác-ima* [juna:ṭ̣̣̣ima]

bubreg [bubrɛg] ‘kidney’ ~ *bubrez-ima* [bubrɛẓ̣̣̣ima]

orah [ɔrax] ‘walnut’ ~ *oras-ima* [ɔraʃ̣̣̣̣ima]

c. Imperfective [-ijax]

pek [pɛk] ‘roast’ ~ *pec-ijah* [pɛṭ̣̣̣ijax]

These data suggest that laminal alveolar obstruents and the fronting high front vowel share a phonological feature that assimilates in this morphological environment. It is important to note that velar stop alternates with a phonetic affricate, not another stop.

⁶ See previous footnote.

Although this is similar to what occurs in velar palatalization, it is somewhat surprising here since there is an available laminal alveolar stop. One has to wonder why the velar stop seems to change manner in this context. In addition, velar fronting cannot be analyzed as a strictly phonetic phenomenon (e.g. articulatory overlap) since it only applies in particular morphological environments. Velar obstruents may occur before high front vowels within morphemes, e.g. *kikiriki* [kikiriki] ‘peanut’, *gibanica* [gi:banit̚sa] ‘cheese cake’, *hiljada* [xiʎaɖa] ‘thousand’.

2.3.4. Iotization

The most complex of the consonant-vowel interactions in Serbian is iotization. This morpho-phonological process has two surface reflexes depending on the place and/or manner of the base-final consonant. Underlyingly non-labial consonants become post-alveolar. However, the correspondence between the original place/manner and the iotized place/manner is somewhat puzzling: stops become affricates, alveolar laminal affricates and velar stops both become post-alveolar apical affricates, while alveolar laminal stops become post-alveolar laminal affricates, and no separate iotizing element is found on the surface. A descriptive rule for this state of affairs is given in (9) and representative data are given in (10). Note that the trigger of iotization is transcribed as a superscript ‘i’.

(9) [k, x, g, t̪s̪, ʃ, z, t̪, d̪, n, l] + /i/ --> [t̪ʃ̪^w, ʃ̪, ʒ̪, t̪ʃ̪^w, ʃ̪, ʒ̪, t̪ʃ̪, d̪ʒ̪, n, k]

	Alveolar	Post-alveolar		Velar
	Laminal	Apical		Dorsal
Stop	[t̪] 't'			[k] 'k'
Affricate	[t̪s̪] 'c'	[t̪ʃ̪] 'č'	[t̪ʃ̪ ^w] 'č'	
Fricative	[ʃ̪] 's'		[ʃ̪̥] 'š'	[x] 'h'
Nasal	[n] 'n'	[ɲ] 'nj'		
Lateral	[l] 'l'	[ɭ] 'lj'		

(10) a. Comparative // -i: //

ljât [ɭu:t̪] 'angry' ~ *ljuć-ī* [ɭut̪ʃ̪ i:]

jâk [ja:k] 'strong' ~ *jac-ī* [jat̪ʃ̪^w i:]

tih [tix] 'quiet' ~ *tis-ī* [tiʃ̪ i:]

gûst [gu:st̪] 'thick' ~ *gušć-ī* [guʃ̪t̪ʃ̪ i:]

b. Collective words // -i:ε //

cvet [t̪s̪ vɛt̪] 'flower' ~ *cveć-e* [t̪s̪ vɛt̪ʃ̪ ε]

grôzd [grɔ:zd̪] 'grape' ~ *grôžD-e* [grɔ:ʒ̪ d̪ʒ̪ ε]

c. Present // -i:ε //

pîs-ati [pi:ʃ̪ati] 'to write' ~ *pîš-ē* [pi:ʃ̪ ε:]

skâk-ati [ʃ̪ka:kati] 'to jump' ~ *skâc-ē* [ʃ̪ka:t̪ʃ̪^w ε:]

d. Passive participle // -en //

rod-iti [rɔd̪iti] 'to give birth' ~ *roD-en* [kɔd̪ʒ̪ en]

nos-iti [nɔʃ̪iti] 'to carry' ~ *noš-en* [nɔʃ̪ en]

e. Imperfect //ⁱa:x//

grád-iti [gra:ḍiṭi] ‘to build’ ~ *grâD-āh* [gra:ḍ̥a:x]

nos-iti [noṣiṭi] ‘to carry’ ~ *noš-āh* [noṣ̥a:x]

Like velar palatalization and fronting, this consonant-vowel interaction suggests that the post-alveolar consonants and the iotizing element share a phonological feature.

However, unlike velar palatalization and fronting, iotization seems to involve coalescence, not assimilation. This is particularly visible in the imperfect forms (10e) where the iotized consonant is followed by a non-front vowel. In addition, one has to wonder why the laminal alveolar stop becomes a laminal post-alveolar while the laminal alveolar affricate becomes an apical post-alveolar, not the available laminal affricate.

In contrast, underlyingly labial consonants do not change under iotization.

Rather, they must be followed by a post-alveolar lateral consonant, as shown in (11) and (12).

(11) //ⁱ// --> [ʎ] / [p, b, m, f, v] + ____

(12) a. Comparative //ⁱ://

glûp [glu:p] ‘stupid’ ~ *glup-ljī* [glupʎi:]

grûb [gru:b] ‘rude’ ~ *grub-ljī* [grubʎi:]

krava [krava] ‘cow’ ~ *krav-ljī* [kravʎi:]

b. Present //ⁱε://

kap-ati [kapaṭi] ‘to drip’ ~ *kap-ljē* [kapʎε:]

The presence of a lateral following only labials in the iotizing context suggests that iotizing merger cannot take place here due to an incompatibility between the labial feature and the iotizing feature. The question is why the iotizing segment surfaces as a post-alveolar lateral and not as a post-alveolar glide or a less-marked alveolar lateral?

At this point, it might be instructive to highlight two ways in which palatalization and iotization differ. First, the set of consonants that palatalize is limited to velar obstruents, while the set of consonants that undergo iotization includes velar and alveolar obstruents and sonorants. Second, palatalization requires that the triggering segment surfaces as a separate segment, while the trigger of iotization does not surface as a separate segment following non-labials. This suggests that palatalization involves assimilation and iotization (usually) involves coalescence.

2.4. Consonant-vowel ('l' ~ 'o') alternation

A final phenomenon that provides cues to how best to characterize and combine the phonological features necessary to produce the segment inventory, is, in fact, quite difficult to account for using SPE-style (Chomsky and Halle, 1968) feature theory. This is the phonological alternation found between laminal alveolar laterals and mid back vowels in (most) syllable-final positions. The descriptive rule is given in (13) and representative data are given in (14).

(13) [l] --> [ɔ] / V_{-stress} ____]□

(14) a. Perfective Participle Masc. Sing.

*[pɛ.val] --> [ˈpɛ.vaɔ] *pev-ao* ‘sang’

This consonant-vowel alternation would seem to suggest that the lateral approximant and mid back vowel are similar with respect to feature composition and that this is a case of neutralization. The problem is that an alternation between the lateral approximant and mid back vowel is regarded as quite unnatural in most feature theories since mid back vowels and lateral approximants are thought to have very different phonological features.

2.5. Summary of the data

Serbian has a fairly typical 5-vowel system on the surface, but a quite complex consonant inventory - including a large set of coronal consonants. In addition, Serbian has four morpho-phonological interactions that are difficult to account for using traditional feature theory. Not only do these suggest that coronal consonants and front vowels have the same place features, but they also suggest that manner features may not be read directly from the phonetics. Finally, the alveolar lateral approximant neutralizes to a mid back vowel in some contexts. This suggests that the lateral and the mid back vowel have similar feature compositions. The remainder of this paper will integrate the descriptive facts into a unified representational and constraint-based analysis.

3. Theoretical background (the Parallel Structures Model)

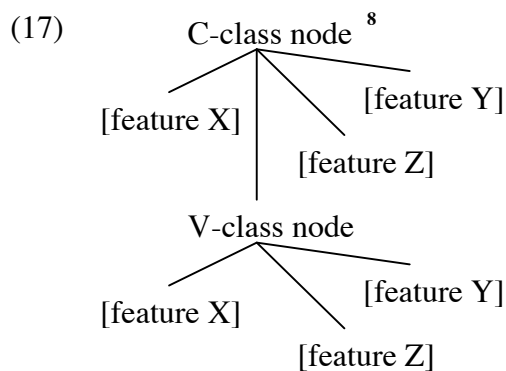
The phonological analysis of the segment inventory, consonant-vowel interactions and consonant-vowel alternations in Serbian will make use of the Parallel Structures Model of feature geometry (Morén 2003a, b, 2004a, b) and Optimality Theory (Prince and Smolensky 1993). Since the Parallel Structures Model is fairly new and may be unfamiliar to many readers, a review of its basic premises and how it works is given here.

There are currently many competing feature theories and models of segment-internal representations. Despite differences in detail, however, the general proposals are fairly uniform, each making minor modifications to the feature set of SPE (Chomsky and Halle 1968) and the geometry of Clements (1985) – with four notable exceptions. First, Clements (1991a) proposed an innovative unification of consonant and vowel place features, which greatly economizes the set of those features and helps to explain place harmony asymmetries. Second, Clements (1991b) proposed a set of vowel height features that makes a more direct connection between those features and degrees of constriction of the vocal tract. Third, Steriade (1993a, b, c, 1994) proposed that consonant manners are differentiated via different types of root nodes corresponding to different degrees of constriction of the vocal tract. Fourth, Particle Phonology (Schane 1984), Dependency Phonology (Anderson and Ewen 1987, van der Hulst 1989, 1999, etc.) and Element Theory (Harris and Lindsey 1995) differ radically from the SPE feature tradition in a number of ways - most notably, they assume that vowels and consonants make use of the same set of features/elements.

The Parallel Structures Model of feature geometry combines insights and pieces of each of these lines of research. It extends the mechanism of Clements' place model to other areas of the phonology, unifies Clements' constriction model and Steriade's aperture model, and incorporates some of the segment-internal organization proposed in Particle Phonology, Dependency Phonology and Element Theory. In addition, it makes use of structural and featural economy to the greatest extent possible. The result is a feature theory that eliminates a large number of features from the grammar (including the major class features); provides a unified analysis for consonants, vowels, place and

manner; and captures consonant-vowel interactions, alternations and harmony asymmetries in a natural and straightforward way.

According to the Parallel Structures Model, phonological segments are composed of a limited set of identical structures and a limited set of privative, articulator-based features. The form of the basic structure is essentially that proposed by Clements (1991a) and is shown in (17).



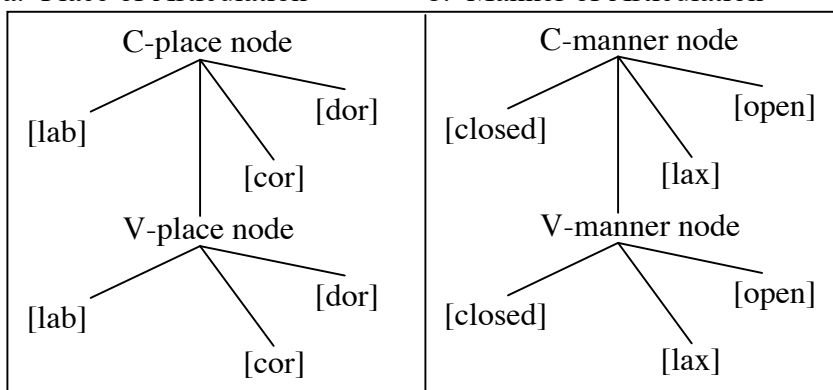
Minimally, there is a set of place and manner features that associate with identically configured place and manner class nodes, as shown in (18).

⁸ The use of “C” and “V” to indicate node type is a mnemonic device more than a statement about the phonological nature of the nodes. That is, vowels can have “C-node” features and consonants can have “V-node” features. In the lack of a contrast, all segments will have “C-node” features. However, if there is overt evidence in the language that consonants and vowels behave differently with respect to a particular feature, then the consonant has the “C-node” feature and the vowel has the “V-node” feature.

(18)

a. Place of Articulation

b. Manner of Articulation



The place features are currently in widespread use and will not be discussed.

See Clements 1991a for a full discussion. The manner features are based on degrees of vocal tract constriction and relative articulator rigidity. Since the lax feature is irrelevant to Serbian, it is not discussed here. See Morén (2003a) for a general discussion of this feature. The manner features [open] and [closed] are demonstrated below.

The Parallel Structures Model also assumes that the grammar is economical/parsimonious and that more complex structures are built from less complex structures. This is in keeping with some of the principles of Particle Phonology, Dependency Phonology and Element Theory, the Modified Contrastive Specification Model (Dresher and Rice 1993, Dresher *et al.* 1994), as well as other work of Avery and Rice (1989), Rice and Avery (1990) and Rice (1992), etc. One consequence of this is the prediction that languages can have simple segments that are featurally minimal - having only a manner feature or only a place feature.

To demonstrate how the Parallel Structures Model establishes minimal feature specification for a given contrastive inventory, let us assume the following very limited

set of segments: [t, ɬ, s, l, ɹ, i, e, a]. Note that this set does not have any place contrasts, but differentiates among stops, lateral fricatives, fricatives, lateral approximants, rhotic approximants, high vowels, mid vowels and low vowels. In other words, it contrasts among three major classes (obstruents, sonorant consonants and vowels), and within each of these major classes, there are manner and height distinctions. In addition, the mapping from a given feature specification to a phonetic realization of is determined on a language-by-language basis based on a combination of contrasts and behavior. Therefore, a given phonetic transcription (i.e. IPA symbol) can correspond to different feature specifications in different languages. Using the features in (18b), and building complex feature combinations from simpler feature combinations, we can describe this inventory as in (19).

(19) PSM feature specification for the target segment inventory

		C-manner [closed]	C-manner [open]	V-manner [closed]	V-manner [open]		
Stop	[t]	✓				Consonant	Obstruent
Lateral fric.	[ɬ]	✓	✓				
Fricative	[s]		✓				
Lateral approx.	[l]	✓		✓		Sonorant	
Rhotic approx.	[ɹ]		✓	✓			
High vowel	[i]			✓		Vowel	
Mid vowel	[e]			✓	✓		
Low vowel	[a]				✓		

Note: shaded cells indicate simple manner feature specification.

There are a number of observations that are important here. As discussed in Morén (2003a), the major classes are not defined in the Parallel Structures Model via separate major class features (e.g. [+/-sonorant]), but rather they are defined structurally via combinations of C-manner and/or V-manner features, as shown in (19). Consonants have a C-manner feature, while vowels do not, and sonorants have a V-manner feature,

while obstruents do not. Sonorant consonants have both a C-manner and a V-manner feature. Second, “lateral” consonants are not defined via a distinct lateral feature, but rather as a combination of a C-manner[closed] and a more open gesture. Third, manner of articulation and vowel height are captured using the same set of articulator-based features distributed across two related class nodes. Fourth, relative markedness relationships among manners and heights are captured via relative structural complexity. That is, plain stops and plain fricatives are less marked than lateral fricatives because they each have only a single manner feature, whereas the lateral fricative has two. Similarly, high and low vowels are less marked than mid vowels because they each have only a single manner feature, whereas the mid vowels have two. Sonorant consonants are also more marked than either simple obstruents or simple vowels for the same reason.

To summarize, there has been much insightful work done on segmental features and geometry over the past few decades, and we continue to refine the feature sets and representations that we assume to be universal. However, there are still unresolved issues and many important questions to answer. Specifically, what is the full minimal set of universal features, and what are the ways in which they can combine to form all the segments found cross-linguistically? The Parallel Structures Model takes the insights and formalisms of several current feature theories and combines them into a new model in which parallel structures and feature sets are used wherever possible.

As we will see below, the assumption that more complex structures are built from less complex structures, and the assumption that consonants and vowels make use of the same features, will provide for a simple and straightforward analysis of the

Serbian segment inventories, consonant-vowel interactions and the consonant-vowel alternation.

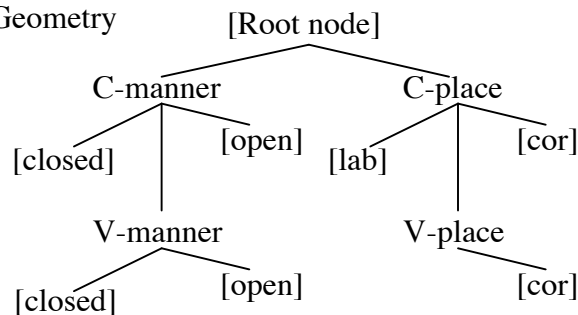
4. Applying the Parallel Structures Model to Serbian

With the basics of the Parallel Structures Model established, we can turn to the task of applying it to Serbian.

4.1. The surface segment inventory

To account for both the contrastive inventory and the behavior of these contrastive segments discussed in section 2, I will use the Parallel Structures Model. If we ignore the nasals and laryngeal features, the feature geometric structure relevant to Serbian is given in (20) and the proposed feature sets for individual segments is given in (21).⁹

(20) Serbian PSM Geometry



⁹ A discussion of the nasals and laryngeal/tone features is beyond the scope of this paper.

(21) PSM feature specifications for individual Serbian segments

Manner Description	Orth.	Phonologic	Phonetic	Features						
				C-place		V-place	C-manner		V-manner	
				[lab]	[cor]	[cor]	[closed]	[open]	[closed]	[open]
Mannerless ¹⁰	‘f’	/f/	[f]	✓						
	‘t’	/t̥/	[t̥]		✓					
		/i/ iot				✓				
	‘c’	/c̥/	[t̥ʃ̥]		✓	✓				
Stop	‘k’	/k/	[k]				✓			
	‘p’	/p/	[p]	✓			✓			
	‘c’	/t̥ʃ̥/	[t̥ʃ̥]		✓		✓			
	‘č’	/c/	[t̥ʃ̥ ^m]			✓	✓			
Fricative	‘h’	/x/	[x]					✓		
	‘s’	/s̥/	[s̥]		✓			✓		
	‘š’	/ʃ/	[ʃ]			✓		✓		
Closed Approx.	‘l’	/l/	[ɫ]				✓		✓	
	‘v’	/v/	[v]	✓			✓		✓	
	‘lj’	/ɫ/	[ɫ]			✓	✓		✓	
Open Approx.	‘r’	/r/	[r]					✓	✓	
High	‘o’	/ɔ/	[ɔ]						✓	
	‘u’	/u/	[u]	✓					✓	
	‘i’	/i/ front	[i]		✓				✓	
	‘e’	/ɛ/	[ɛ]			✓			✓	
	‘i’	/i/ pal	[i]		✓	✓			✓	
Low	‘a’	/a/	[a]							✓

Before justifying these feature specifications, there are several important things to note about this chart. First, the segments are arranged in increasing sonority based on

¹⁰ See section 3 for a brief discussion of mannerless segments. Note that these segments are all marginal in some way in this language, as one might expect from mannerless segments since it is the manner features that define relative sonority and thus play a major role in sonority-based restrictions such as syllabification. The /f/ is found only in loan words and does not participate in a voicing contrast. The /t̥/ does not participate in iotization as one might expect if it were a phonological stop. The /c̥/ is highly dispreferred and is absent in related dialects/languages. The /i/ does not surface faithfully at all in this language.

manner feature specification - this includes four phonologically mannerless segments. Second, there is a set of phonologically placeless segments. Third, there is not a transparent relationship between the phonological representation and the phonetic implementation. For example, the phonetic affricates are represented here as phonological stops, the orthographic ‘t’ is transcribed as /t̚/ because it is a phonologically mannerless segment in this language for which the IPA has no symbol and the symbol /t̚/ is used here for the phonological stop corresponding to the orthographic ‘c’. To account for the fact that some suffix-initial ‘i’s trigger velar palatalization, while others trigger velar fronting, I propose that they are two different vowels.¹¹ Fourth, the shaded cells indicate simple segments composed of single features. Finally, the three phonetic vowel heights are captured here via a combination of two phonological heights and the presence or absence of place features.

This feature system has several advantages. First, every complex structure implies a less complex structure - this means that the system is non-redundant and maximally economical/parsimonious. Second, it allows us to define the target of morphological place assimilation (fronting and palatalization) as the natural class of phonologically placeless segments with simple manner (i.e. /k, x, ɔ/). Third, it allows us to define the trigger of velar fronting as the natural class of vowels with C-place[cor], the trigger of palatalization as the natural class of vowels with V-place[cor], and the trigger of iotization is a simple segment with just the V-place[cor] feature. Finally, the triggers of fronting and palatalization are not susceptible to coalescence because they

¹¹ There is ample diachronic and comparative work showing the presence of two phonetically similar high front vowels within the Slavonic language family that might suggest independent support for this claim.

already have manner, while the trigger of iotization is susceptible to coalescence because it is phonologically mannerless.

4.2. The consonant-vowel interactions

Having proposed a set of phonological features for each segment in the inventory, we can use these feature specifications to account for the consonant-vowel interactions and alternation found in this language. To make sense of the place assimilations (mid vowel fronting, velar palatalization and velar fronting), we can begin by viewing them from the autosegmental perspective in (22) through (24). Note that the targeted segments are all placeless and the assimilating feature is always [cor]. This characterization allows us to unify what have been traditionally considered quite different phenomena.

4.2.1. Mid vowel fronting and velar palatalization

Mid vowel fronting is analyzed here as the sharing of V-place[cor] between a post-alveolar consonant and a placeless non-low vowel. As we can see in (22a), the entire place structure is shared if the triggering segment has simple place, and (22b) shows that only the V-place[cor] feature is shared if the triggering segment has complex place. The latter entails the epenthesis of a C-place node to carry the dependent V-place node. Recall that //A// indicates a lexical representation, /A/ indicates an output phonological representation and [A] indicates a phonetic transcription.

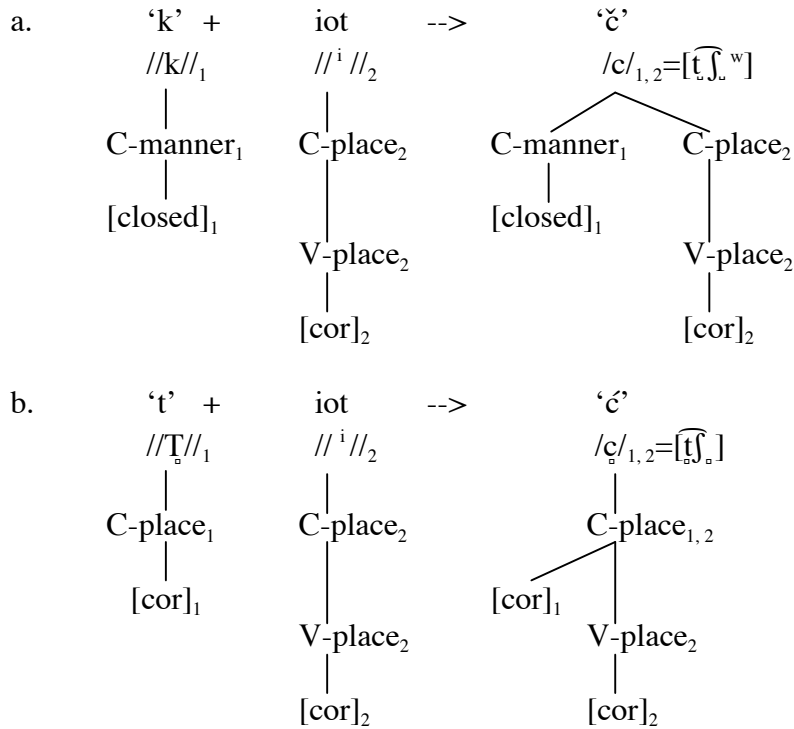
affricate is actually a phonological stop¹² and the phonetic stop is phonologically mannerless (see (21)). Therefore, the phonologically placeless (phonetically velar) stop becomes a coronal stop due to feature sharing, and it does not lose its original manner. Note that //k// --> /ṽṽ/[ṽṽ] would involve the loss of the C-manner[closed] feature in this analysis.

4.2.3. Iotization

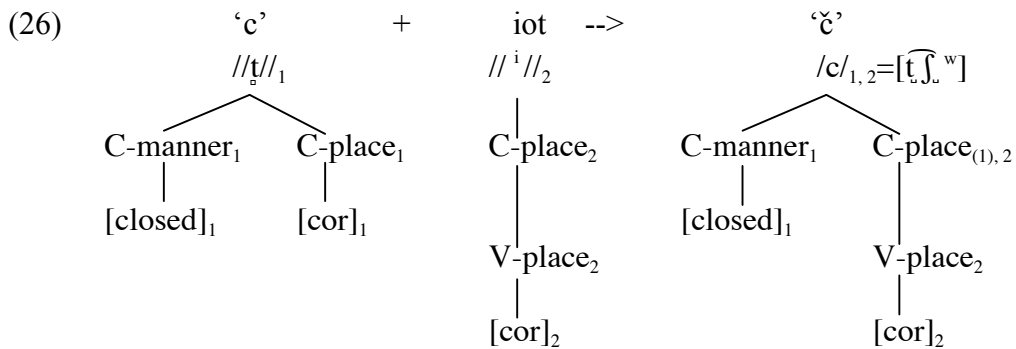
To make sense of iotization, we may view it as the merging of a V-place[cor] segment with the preceding segment if possible, as shown in (25) through (27). Note that this analysis unifies iotization with the other consonant-vowel interactions in that it also involves the [cor] feature. In (25a) and (25b), we see the merger of two segments - creating a licit segment in this language that has faithful exponence to both original segments. The indices in the following representations show the relationship between input and output structures.

¹² Clements (1999) makes similar claims that phonetic affricates are phonological stops. In addition, there are articulatory reasons for why palatal stops would tend to have significant release frication. As Ladefoged (2001, p. 144) states, “Because of the shape of the roof of the mouth, the contact between the front of the tongue and the hard palate often extends over a fairly large area. As a result, the formation and release of a palatal stop is often not as rapid as in the case of other stops, and they tend to become affricates.”

(25) Non-labial Iotization



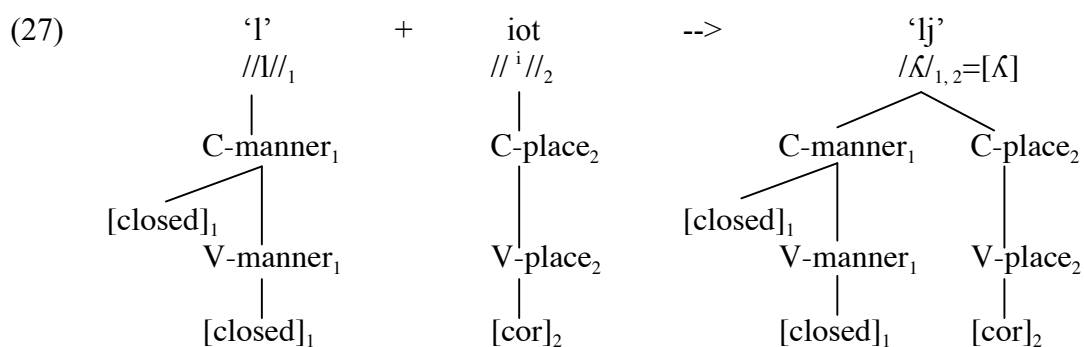
However, (26) shows the merger of two segments with concurrent deletion of the C-place[cor] feature. Deletion occurs because a stop with two place features is illicit in this language.



We now have an explanation for why the velar stop and the laminal alveolar affricate both become apical, while the laminal alveolar stop remains laminal. The C-place[cor] maps to a laminal gesture in this language. Velar iotization (25a) does not involve this feature and laminal alveolar affricate iotization (26) involves the loss of this feature. In

contrast, the laminal alveolar stop (25b) does not lose C-place[cor] under iotization. As was the case with affrication in velar palatalization and fronting, affrication is analyzed here as phonetic frication of the stop release, not as an indication of a phonological contour segment.

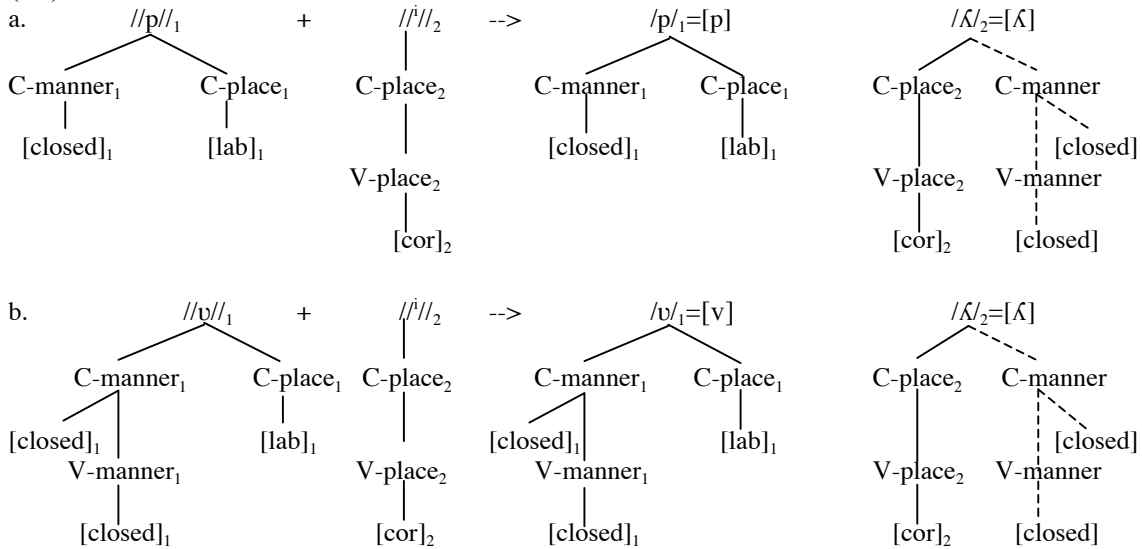
Finally, (27) shows the faithful merger of a lateral consonant with the iotizing segment.



The presence of a lateral post-alveolar following labials is readily explained if 1) palatalized labials are prohibited in this language, 2) neither C-place[lab] nor V-place[cor] can be deleted, and 3) the least marked consonant allowed as the second member of onset clusters is a lateral¹³. The prohibition against palatalized labials and the deletion of the labial place feature ensures that the labial segment surfaces faithfully. The prohibition against deleting V-place[cor] and the condition that the second member of a consonant cluster is a sonorant (thus satisfying the Sonority Sequencing Principle) ensures that the iotizing segment surfaces with its original place of articulation and sufficient manner features to make it sonorant. This is shown in (28) and will be captured via the interaction of violable constraints in section 5.2.2.

¹³ See Morén (2003a) for a discussion of the relative markedness of sonorant consonants under the Parallel Structures Model.

(28) Labial Iotization



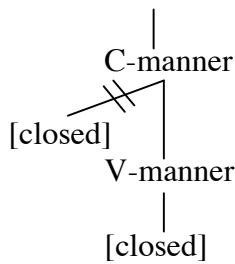
4.3. The consonant-vowel alternation

Recall that the alternation between the alveolar lateral and the mid back vowel is difficult to model using traditional feature theory. This is because there is very little similarity between vowels and consonants from the view of tradition feature theory. However, the Parallel Structures Model assumes that consonants and vowels are not fundamentally different from a feature perspective. Therefore, it accounts for sonorant consonant-vowel alternations quite easily. As (29) shows, the change from a lateral approximant to a mid back vowel in Serbian involves the simple delinking of the stop gesture associated with the lateral.¹⁴ Note that the conditioning environment for this neutralization will be discussed below.

¹⁴ Alternations between sonorant consonants and either vowels or obstruents are quite common cross-linguistically and have been something of a problem for feature theory. Besides the ‘l’ ~ ‘o’ alternation in Serbian, Icelandic has alternations between ‘l’ and ‘t’, Costa Rican Spanish and many Dutch and German dialects (Wiese 2001, Sebregts 2004) have alternations between rhotic approximants and fricatives, and Slovak has alternations between labial approximants and

(29) Lateral vocalization

//l// --> /ɔ/



5. Explaining the inventory and morpho-phonological patterns using OT

Having explored a representational description of the inventory and some of the morpho-phonological patterns found in Serbian, we must now provide a means to explain them. In generative linguistics, it is not enough to simply state the facts. Rather, we must also try to explain how and why only certain segments are licit in Serbian, as well as how and why the consonants and vowels interact the way they do. To do this, I propose an analysis using constraint interaction in the spirit of Optimality Theory (Prince and Smolensky 1993). However, this analysis differs from the usual OT accounts in four important ways. First, it assumes particular segment-internal representations. This is in contrast with most constraint-based analyses, which either do not mention segment-internal structure or assume that it does not exist at all.¹⁵ Second,

either fricatives or vowels depending on the context (Rubach 1993). All of these phenomena are easily captured using the Parallel Structures Model since approximants are like obstruents in having a C-manner feature and are like vowels in having a V-manner feature.

¹⁵ Padgett's (2002) work on feature classes denies the feature geometric notion of class nodes. Thus, he makes the strong claim that feature geometric structures are unnecessary in an OT framework. However, note that OT is a system of constraint interaction that has no specific bearing on issues of segment-internal representation. The assumption (or not) of representations is independent of the assumption of a constraint-based grammar.

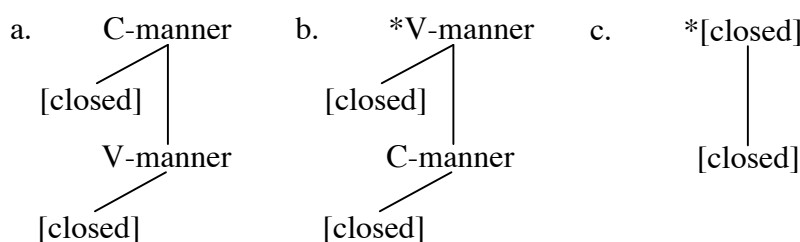
it is built on a detailed justification for using particular features to account for both the inventory facts and the phonological patterns of this language. Most constraint-based (and recent rule-based) phonological analyses simply assume convenient features for a given phenomenon without providing independent evidence for their importance in the language. Third, I provide an explicit constraint-based account for the inventory facts. Most constraint-based analyses fail to take the inventory into account and do not provide a means to derive it. Finally, I provide a detailed account for an array of morpho-phonological patterns, rather than an account of only one or two. This is important because it shows that several seemingly unrelated phenomena can all be accounted for using the same basic mechanism and the same constraint ranking.

5.1. An OT analysis of the Serbian segment inventory

Most OT analyses in the literature do not explicitly state the mechanism by which the segment inventories of languages are captured using constraints. Nor do they motivate the feature specifications that they assume for given segments. Rather, they simply assume a particular (usually fully-specified) feature set for given segments and use constraint interaction to account for specific phenomena without questioning the validity of those features and constraints for the rest of the language. While such analyses are certainly interesting and address particular theoretical and empirical questions, it is also important to put analyses within the larger context of the grammar of that language. For this reason, I will provide an OT characterization of both the segment inventory and the consonant-vowel interactions/alternation that are the focus of this paper. As we will see, the constraints used to define the segment inventory also play an important role in accounting for other phonological phenomena.

Before providing an OT analysis of Serbian, it is important to state some assumptions regarding features, segment-internal representations and featural markedness and faithfulness constraints. First, I assume the Parallel Structures Model features discussed above. Second, I assume that only the representations of the Parallel Structures Model are possible segment-internal structures. Therefore, universally illicit structures are impossible outputs of the Gen(erator) function and are thus absent from the candidate set. This is an explicit statement about the nature of Gen and the grammar, in which Gen, not the constraint ranking, ensures that only particular representations are universally available. It reduces the set of re-rankable constraints and limits the typological predictions made by re-rankable constraints. It also reduces the workload of the Eval(uator) function and makes for a more learnable grammar by eliminating the need for learners to reject universally unavailable structures or consider universally untenable constraint rankings during the acquisition process. Finally, this makes an explicit statement about the division of labor between segment-internal representations and constraints. The representations regulate the possible relationships among segment-internal elements while the constraint ranking determines which representations occur in a given context in a specific language. Some examples of possible and impossible structures are given in (30).

(30) Examples of possible and impossible structures



Third, I assume a Correspondence Theory (McCarthy and Prince 1995) version of faithfulness constraints, but one in which features are treated as autosegments, not attributes. Thus, I use MAX(imality) and DEP(endency) constraints rather than IDENT(ity) constraints. Fourth, the feature markedness and faithfulness constraints make reference to both class node and feature specification. Examples are given in (31) and (32) for some simple features.

(31) a. ***C-manner[closed]** - the C-manner[closed] configuration is prohibited.

b. ***V-manner[closed]** - the V-manner[closed] configuration is prohibited.

(32) a. **MAXC-manner[closed]** - Every C-manner[closed] in the input has a correspondent in the output (do not delete).

b. **MAXV-manner[closed]** - Every V-manner[closed] in the input has a correspondent in the output (do not delete).

c. **DEPC-manner[closed]** - Every C-manner[closed] in the output has a correspondent in the input (do not epenthesize).

d. **DEPV-manner[closed]** - Every V-manner[closed] in the output has a correspondent in the input (do not epenthesize).

Finally, there are a number of possible ways to formalize constraints against feature co-occurrence. For example, one could have constraints against every possible feature combination, as in (33), or one could have the conjunction of individual feature constraints of the type given in (31), as shown in (35).

- (33) ***C-manner[closed]V-manner[closed]** - a structure with both C-manner[closed] and V-manner[closed] is prohibited.
- (34) Local Conjunction¹⁶ (Smolensky 1997) - The local conjunction of C1 and C2 in domain D, C1 & C2, is violated when there is some domain of type D in which both C1 and C2 are violated.
- (35) ***C-manner[closed]&*V-manner[closed]** - the local conjunction of *C-manner[closed] and *V-manner[closed] is violated when both *C-manner[closed] and *V-manner[closed] are violated by the same segment.

For the purposes of this paper, both the complex structure feature co-occurrence constraints, as in (33), and the local conjunction feature co-occurrence constraints, as in (35), are roughly equivalent. However, I will use the conjoined constraints for reasons that are beyond the scope of this paper.

With essential assumptions made, we can move on to the analysis of Serbian. Recall from the representational analysis of Serbian provided above that this language has seven segments composed of only a single feature - three segments are mannerless and four segments are placeless. Using the standard OT strategy of ranking markedness constraints below faithfulness constraints to yield a contrast, the following constraint rankings yield these first order contrastive segments.

¹⁶ Local conjunction is an operation by which constraints applying to a specific domain (the segment in this case) are combined such that the conjoined constraint is violated if and only if all its members are violated.

- (36) a. MAXC-place[lab] >> *C-place[lab] /f/ ‘f’
 b. MAXC-place[cor] >> *C-place[cor] /t̥/ ‘t’
 c. MAXV-place[cor] >> *V-place[cor] /i/
 d. MAXC-manner[closed] >> *C-manner[closed] /k/ ‘k’
 e. MAXC-manner[open] >> *C-manner[open] /x/ ‘h’
 f. MAXV-manner[closed] >> *V-manner[closed] /ɔ/ ‘o’
 g. MAXV-manner[open] >> *V-manner[open] /a/ ‘a’

The tableaux in (37) and (38) demonstrate how this provides the correct results for the velar fricative and the mid back vowel. In both tableaux, the feature deletion in candidate (b) is ruled out by the higher-ranked faithfulness constraint.

(37)

//C-manner[open]//	//x//	MAX C-manner[open]	*C-manner[open]
--> a. C-manner[open]	/x/ ‘h’		*
b. / /	---	*!	

(38)

//V-manner[closed]//	//ɔ//	MAX V-manner[closed]	*V-manner[closed]
--> a. V-manner[closed]	/ɔ/ ‘o’		*
b. / /	---	*!	

In contrast, segments composed of only the features not used in this language (e.g. C-place[dor]) are prohibited because the relevant markedness constraint outranks the related faithfulness constraint, as shown in (39). This means that the dorsal C-place never surfaces in this language.

(39)

//C-place[dor]//	*C-place[dor]	MAXC-place[dor]
a. C-place[dor]	*!	
--> b. / /		*

If we assume that more complex structures are necessarily built up of less complex structures, then the only combinations of features allowed in this language are those making use of the seven features in (36). Combining two of the relevant markedness constraints at a time, we get $7C2 = 7!/(2!(7-2)!) = 21$ second order constraints. This entails 21 logically possible segments composed of two features. Of these, only 11 are actually used in this language. Four of the unused feature combinations are due to restrictions on the co-occurrence of C-place[lab], and six are due to restrictions on the co-occurrence of V-manner[open] (it does not co-occur with any other features). The allowable combinations of two features are the result of the constraint rankings in (40). Tableau (41) demonstrates how the labial stop results from the ranking in (40b). In contrast, tableaux (42) and (43) show how a labial fricative is not allowed even though both the labial feature and the fricative feature are allowed independently (see (36)).

(40) a. MAXC-place[cor], MAXV-place[cor] >>

*C-place[cor]&*V-place[cor] /ç/ 'ç'

b. MAXC-place[lab], MAXC-manner[closed] >>

*C-place[lab]&*C-manner[closed] /p/ 'p'

c. MAXC-place[cor], MAXC-manner[closed] >>

*C-place[cor]&*C-manner[closed] /t/ 'ç'

- d. MAXV-place[cor], MAXC-manner[closed] >>
 *V-place[cor]&*C-manner[closed] /c/ ‘č’
- e. MAXC-place[cor], MAXC-manner[open] >>
 *C-place[cor]&*C-manner[open] /s̥/ ‘s’
- f. MAXV-place[cor], MAXC-manner[open] >>
 *V-place[cor]&*C-manner[open] /ʃ/ ‘š’
- g. MAXC-manner[closed], MAXV-manner[closed] >>
 *C-manner[closed]&*V-manner[closed]¹⁷ /l/ ‘l’
- h. MAXC-manner[open], MAXV-manner[closed] >>
 *C-manner[open]&*V-manner[closed] /r/ ‘r’
- i. MAXC-place[cor], MAXV-manner[closed] >>
 *C-place[cor]&*V-manner[closed] /i/front ‘i’
- j. MAXC-place[lab], MAXV-manner[closed] >>
 *C-place[lab]&*V-manner[closed] /u/ ‘u’
- k. MAXV-place[cor], MAXV-manner[closed] >>
 *V-place[cor]&*V-manner[closed] /ɛ/ ‘e’

(41)

//C-place[lab] C-manner[closed]//	//p//	MAX C-place [lab]	MAX C-manner [closed]	*C-place [lab]& *C-manner [closed]	*C-place [lab]	*C-manner [closed]
--> a. C-place[lab] C-manner[closed]	/p/ ‘p’			*	*	*
b. C-place[lab]	/f/ ‘f’		*!		*	
c. C-manner[closed]	/k/ ‘k’	*!				*
d. / /	---	*!	*!			

¹⁷ This constraint ranking will be revised slightly in section 5.3.

(42)

//C-place[lab] C-manner[open]//	*C-place[lab]& *C-manner[open]	MAX C-place[lab]	*C-place[lab]
a. C-place[lab] C-manner[open]	*!		*
--> b. C-place[lab] /f/ 'f'			*
c. C-manner[open] /x/ 'h'		*!	
d. / / ---		*!	

(43)

//C-place[lab] C-manner[open]//	*C-place[lab]& *C-manner[open]	MAX C-manner[open]	*C-manner[open]
a. C-place[lab] C-manner[open]	*!		*
b. C-place[lab] /f/ 'f'		*!	
--> c. C-manner[open] /x/ 'h'			*
d. / / ---		*!	

Note that there is no evidence with which to decide the relative ranking of either the two faithfulness constraints, MAXC-place[lab] and MAXC-manner[open], or the two markedness constraints, *C-place[lab] and *C-manner[open]. Therefore, a single input containing both features, C-place[lab]C-manner[open], could result in either /f/ or /x/.

Combining three markedness constraints at a time using local conjunction, we get $7C3 = 7!/3!(7-3)! = 5040/6(24) = 5040/144 = 35$ third order constraints.¹⁸ Of these, only 3 are used in this language.

¹⁸ Alternatively, third order constraints could be built of combinations of first and second order constraints. This means there is a potential for $21(5) = 105$ third order constraints. However, we get only $11(5) = 55$ possible third order constraints in Serbian using the restricted set of second order constraints. Among these, only 3 are actually used in this language. For our present purposes, the way in which third order constraints are composed (either of combinations of 3 separate first order constraints or of second order and first order constraints) is unimportant. More work is needed in this area.

- (44) a. MAXC-manner[closed], MAXV-manner[closed], MAXC-place[lab] >>
 *C-manner[closed]&*V-manner[closed]&*C-place[lab] /v/ ‘v’
- b. MAXC-manner[closed], MAXV-manner[closed], MAXV-place[cor] >>
 *C-manner[closed]&*V-manner[closed]&*Vplace[cor] /ʌ/ ‘lj’
- c. MAXC-place[cor], MAXV-manner[closed], MAXV-place[cor] >>
 *C-place[cor]&*V-manner[closed]&*Vplace[cor] /i/pal ‘i’

Tableau (45) shows how /v/ surfaces, while (46) shows how the illicit feature combination of C-manner[closed]V-manner[closed]C-place[cor] does not. Since we do not have evidence at this point for the relative ranking of the faithfulness constraints, we do not know which of the unfaithful forms would actually surface in (46).

(45)

//C-manner[closed] V-manner[closed] C-place[lab]//	//v//	MAX V-manner [closed]	MAX C-manner [closed]	MAX C-place [lab]	*C-manner[closed]& *V-manner[closed]& *C-place[lab]
--> a. C-manner[closed] V-manner[closed] C-place[lab]	/v/ ‘v’				*
b. C-manner[closed] V-manner[closed]	/l/ ‘l’			*!	
c. C-manner[closed] C-place[lab]	/p/ ‘p’	*!			
d. V-manner[closed] C-place[lab]	/u/ ‘u’		*!		

(46)

//C-manner[closed] V-manner[closed] C-place[cor]//		*C-manner[closed]& *V-manner[closed]& *C-place[cor]	MAX V-manner [closed]	MAX C-manner [closed]	MAX C-place [cor]
a. C-manner[closed] V-manner[closed] C-place[cor]		*!			
--> b. C-manner[closed] V-manner[closed]	/l/ ‘l’				*
--> c. C-manner[closed] C-place[cor]	/c/ ‘ç’		*		
--> d. V-manner[closed] C-place[cor]	/i/ ‘i’			*	

There are no violations of the fourth order constraints composed of the seven constraints under investigation in this study. Therefore, corresponding representations do not surface.

To summarize, the constraint ranking necessary to account for the segment inventory of Serbian (ignoring laryngeal and nasal contrasts) is given in (47).

(47) Serbian segment inventory ranking

Unviolated feature markedness constraints	}	all $n^{\text{th}} > 3$ order markedness constraints,
		all unviolated third order markedness constraints,
		all unviolated second order markedness constraints,
		all unviolated first order markedness constraints
		>>
Faithfulness constraints against feature deletion	}	MAXC-place[lab], MAXC-place[cor], MAXV-place[cor],
		MAXC-manner[closed], MAXC-manner[open], MAXV-manner[closed], MAXV-manner[open]
	>>	
Violated 3rd order feature markedness constraints	}	*C-manner[closed]&*V-manner[closed]&*C-place[lab],
		*C-manner[closed]&*V-manner[closed]&*V-place[cor],
		*V-place[cor]&*V-manner[closed]&*C-place[cor],
		*C-place[cor]&*V-place[cor],
Violated 2nd order feature markedness constraints	}	*C-place[lab]&*C-manner[closed],
		*C-place[cor]&*C-manner[closed],
		*V-place[cor]&*C-manner[closed],
		*C-place[cor]&*C-manner[open],
		*V-place[cor]&*C-manner[open],
		*C-manner[closed]&*V-manner[closed],
		*C-manner[open]&*V-manner[closed],
		*C-place[cor]&*V-manner[closed],
Violated 1st order feature markedness constraints	}	*C-place[lab]&*V-manner[closed],
		*V-place[cor]&*V-manner[closed],
		*C-place[lab], *C-place[cor],
		*V-place[cor], *C-manner[closed], *C-manner[open], *V-manner[closed], *V-manner[open]

5.2. An OT analysis of the Serbian consonant-vowel interactions

5.2.1. Palatalization and Fronting

With the constraints and rankings used to derive the segment inventory in place, let us move on to the consonant-vowel interactions. Recall that there are three morpho-

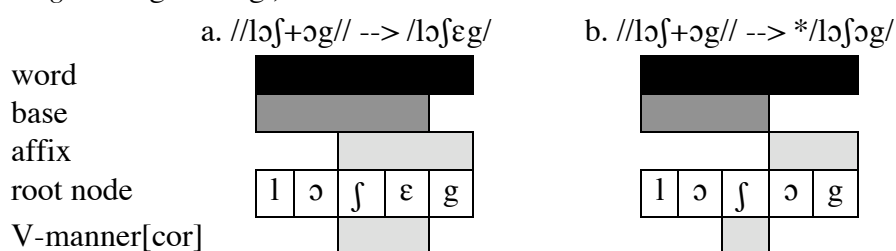
phonological consonant-vowel assimilations that only occur across the boundary between a base and certain suffixes. First, the mid back vowel in particular affixes becomes front when following post-alveolar consonants. Second, velar obstruents become post-alveolar when followed by particular affixes beginning with either ‘i’ or ‘e’. Third, velar obstruents become alveolar when followed by particular affixes beginning with ‘i’. Despite the fact that these all look, on the surface, to be quite different phenomena, I proposed above that they are different manifestations of the same general phonological phenomenon - the assimilation of an underlyingly placeless segment (velars and mid back vowels) to the coronal place of an adjacent segment.

There are three things to explain here. First, how and why do these assimilations occur only across morpheme boundaries, not morpheme-internally? Second, why do they occur only with specific morphemes? Third, why does assimilation take place, but not merger (foreshadowing the discussion of iotization below)? I propose that these three assimilatory processes result from the relative ranking of alignment constraints on different classes of morphemes with respect to each other, featural faithfulness constraints and featural markedness constraints.

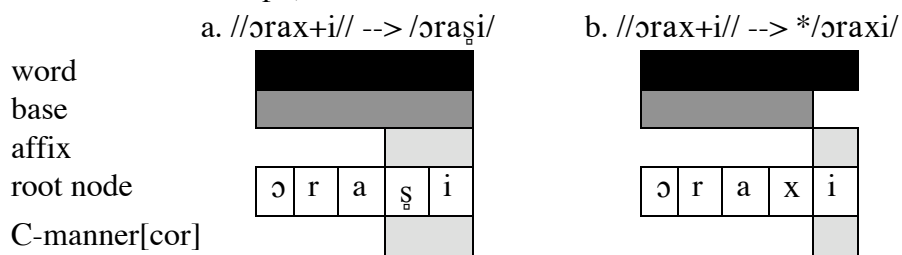
To make sense of these assimilations, recall the autosegmental perspective discussed in section 4.2 (see (22) through (24)). I propose that the motivation for these assimilations is the need to have both the base of affixation and the affix aligned as far left in the word as possible, but with the base material taking precedence. This results in the base surfacing to the left of the affix, and the best the affix can do to minimally violate alignment is to share a feature with the final segment of the base. Thus, double linking allows the edge of the affix to be closer to the left edge of the word by one segment than it would be as a simple, unassimilated, suffix. This is illustrated in (48)

and (49) for mid vowel fronting and velar fronting. In each of these depictions, the shaded area shows the extent to which the morphological or featural domain defining each tier overlaps the segmental material as measured by the sequence of root nodes. For example, in (48a), the word includes all segments, the base of affixation includes only the first four segments, and the affix includes only the last three segments. In comparing (48a) with (48b), we see that the assimilation of the V-manner[cor] feature in (48a) has the effect of extending the domain of both the base of affixation and the affix to include all segments sharing the assimilated feature.

- (48) Constituent alignment with and without mid vowel fronting
(lošeg ‘bad’ gen. sing.)

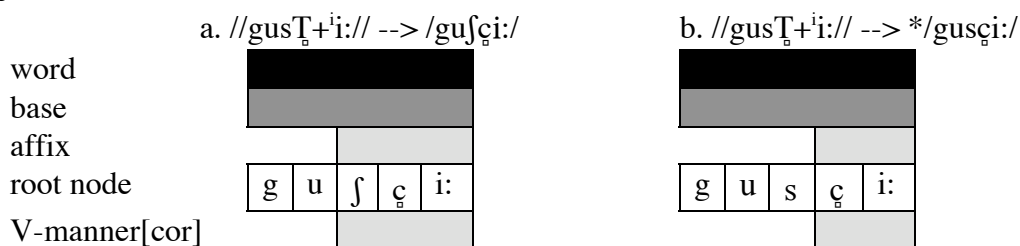


- (49) Constituent alignment in the presence and absence of velar fronting
(orasi ‘walnut’ nom. pl.)



As (50) shows, this feature sharing extends as far to the left as possible, thus triggering place assimilation within clusters when possible.

(50) Constituent alignment with and without mid vowel fronting
 (*guščī* ‘denser’)



In both (48) and (49), the base is aligned at the left edge of the word. In (48a), there are two segments intervening between the left word edge and the left affix edge, while in (48b), there are three intervening segments. In (49a), there are three segments intervening between the left word edge and the left affix edge, while in (49b), there are four intervening segments. In both cases, the affix is more closely aligned with the left edge of the word in (a) - the assimilated scenario.

This has several interesting consequences. First, there is a common motivation behind what have been analyzed in the past as unrelated regressive (i.e. velar fronting and palatalization) and progressive assimilations (i.e. mid vowel fronting). Thus, the direction of assimilation is epiphenomenal and need not be encoded in the constraints proposed to account for these facts. Second, these suffixes are in a sense trying to be prefixes, but fail to even properly infix. Third, constituent edges can be measured at a sub-segmental level. That is, feature sharing has the effect of extending constituent edges. In these cases, the shared coronal feature extends the left edge of the affix to the left edge of the base-final segment, while simultaneously extending the right edge of the base to the right edge of the affix-initial segment. Fourth, these assimilations do not take place within morphemes because they are driven by morpheme alignment (to be demonstrated below). Finally, these phenomena may be unified with other cases of

morphological alignment argued for in the Southern Slavic literature. For example, Legendre (1998, 1999a, b, 2000 a, b, c) analyzes Southern Slavic clitic placement as an interaction among a set of constraints including those requiring that each morpheme (clitic) be aligned with the left edge of its syntactic constituent. In her analysis, the order of clitics within a cluster is the result of relative ranking among alignment constraints.

To capture the morphologically driven place assimilations in OT, we need several constraint interactions. First, there is a set of conflicting alignment constraints. Assuming that the driving force behind assimilation here is leftward alignment, there must be a constraint aligning the base to the left of the word and a constraint aligning the affix to the left of the word. These are given in (51) and (52).

(51) **ALIGN-Left[base]** - Align morphemes within the class of bases with the left edge of the word (simplified definition - based on McCarthy and Prince 1995)

(52) **ALIGN-Left[affix]** - Align morphemes within the class of affixes with the left edge of the word (simplified definition - based on McCarthy and Prince 1995)

Since the affixes in question always surface as suffixes, the base alignment constraint must rank higher than the affix alignment constraint, as shown in (53).

(53)

	/base + affix/	ALIGN-Left[base]	ALIGN -Left[affix]
--> a.	[base-affix]		*
b.	[affix-base]	*!	

To complicate matters even further, we saw that there are actually two classes of affixes under investigation here, each of which has a different behavior. There are

affixes affecting velar obstruents and affixes affecting non-labials. To account for these different behaviors, I propose that each affix has its own alignment constraint and that these group together in two distinct places in the hierarchy. To simplify the following discussion, I use the cover-constraints in (54) and (55). Bear in mind that the diacritics ‘ClassI’ and ‘ClassII’ have no linguistic content here and are used only as an expositional device.

(54) **ALIGN-Left[affix]_{ClassI}** - Align morphemes within the velar-assimilating class of affixes (class I) with the left edge of the word (simplified definition)

(55) **ALIGN-Left[affix]_{ClassII}** - Align morphemes within the non-labial-assimilating class of affixes (class II) with the left edge of the word (simplified definition)

To ensure that there is assimilation across the morpheme boundary, the affix alignment constraint must outrank a set of markedness constraint against the co-occurrence of C-place[cor] or V-place[cor] with various other features. In the case of mid vowel fronting, the affix alignment constraint must be ranked above the constraint against the co-occurrence of V-place[cor] and V-manner[closed].

(56) *lošeg* ‘bad’ gen. sing.

<i>//loʃ+ɔg_{ClassI}//</i>	ALIGN-Left [affix]_{ClassI}	*V-place[cor]& *V-manner[closed]
a. <i>loʃɔg</i>	***!	
--> b. <i>loʃɛg</i>	**	*

However, to ensure that the alignment constraint does not force the affix into the base as an infix, a constraint maintaining segmental contiguity must outrank alignment.

(57) **CONTIGUITY** - The portion of S1 standing in correspondence forms a contiguous string, as does the correspondent portion of S1 (McCarthy and Prince 1995).

(58)

//...ʃ + ə _{ClassI} //	CONTIGUITY	ALIGN -Left [affix] _{ClassI}
a. ...əʃ	*!	...*
--> b. ...ʃɛ		...**

As (59) and (60) show, these constraints force assimilation across the morpheme boundary but not within a morpheme.

(59) *lošēm* ‘bad’ dat./loc. sing.

//lɔʃ+ə:m _{ClassI} //	CONTIGUITY	ALIGN-Left [base]	ALIGN-Left [affix] _{ClassI}	*V-place [cor]& *V-manner [closed]
a. lɔʃə:m			***!	
--> b. lɔʃɛ:m			**	*
c. ə:mlɔʃ		*!*		
d. lɔɔ:ʃm	*!		**	

(60) *šólja* ‘cup’

//ʃɔ:ʎa//	CONTIGUITY	ALIGN-Left [base]	ALIGN-Left [affix] _{ClassI}	*V-place[cor]& *V-manner[closed]
--> a. ʃɔ:ʎa				
b. ʃɛ:ʎa				*!

To account for both velar fronting and velar palatalization, the alignment constraint must outrank four other co-occurrence constraints. These rankings are given in (61).

- (61) a. ALIGN-Left[affix]_{ClassI} >> *C-place[cor]&*C-manner[closed] //k// --> /t̪/ ‘c’
 b. ALIGN-Left[affix]_{ClassI} >> *C-place[cor]&*C-manner[open] //x// --> /s̪/ ‘s’

c. ALIGN-Left[affix]_{ClassI} >> *V-place[cor]&*C-manner[closed] //k// --> /c/ ‘č’

d. ALIGN-Left[affix]_{ClassI} >> *V-place[cor]&*C-manner[open] //x// --> /ʃ/ ‘š’

Since the assimilating segments (underlyingly placeless) do not assimilate to any other place of articulation and assimilation does not apply to segments already underlyingly specified with place, the alignment constraint must be dominated by all other feature co-occurrence constraints containing a place feature. In addition, the placeless consonants and vowel do not interact across the morpheme boundary to create sonorant consonants by assimilating manner features. Therefore the feature co-occurrence constraints against sonorant consonants must also dominate the alignment constraints. The resulting constraint ranking is given below in (72).

In (62) and (63), we see a lack of mid vowel assimilation to either C-place[lab] or C-place[cor]. In each tableau, the assimilated vowel violates the higher-ranked constraint against that feature co-occurrence (see 21) for feature specifications).

(62) *tòpom* ‘cannon’ inst. sing.

	//tòp+òm _{ClassI} //	*C-place[lab]& *V-manner[closed]	ALIGN-Left [affix] _{ClassI}
--> a.	tòpòm		***
b.	tòpum	*!	**

(63) *grâdom* ‘city’ inst. sing.

	//gra:dòm _{ClassI} //	*C-place[cor]& *V-manner[closed]	ALIGN-Left [affix] _{ClassI}
--> a.	gra:dòm		****
b.	gra:dìm	*!	***

In (64) and (65), we see a lack of secondary place on consonants as a result of assimilation.

(64) *tòpe* ‘cannon’ voc. sing.

	//tɔp+ɛ _{ClassI} //	*C-place[lab]& *V-place[cor]	ALIGN-Left [affix] _{ClassI}
--> a.	tɔpɛ		***
b.	tɔpʰ	*!	**

(65) *bràte* ‘brother’ voc. sing.

	//braT _o + _{ClassI} //	*C-place[cor]& *V-place[cor]	ALIGN-Left [affix] _{ClassI}
--> a.	braT _o		****
b.	braç	*!	***

In (66), we see a lack of manner assimilation under pressure from alignment.

(66) *vojnikom* ‘soldier’ inst. sing.

	//vɔjni:k+ɔm _{ClassI} //	*C-manner[closed]& *V-manner[closed]	ALIGN-Left [affix] _{ClassI}
--> a.	vɔjni:kɔm		*****
b.	vɔjni:lɔm	*!	*****
c.	vɔjni:klm	*!	*****

In addition, the alignment constraint must also be outranked by a set of faithfulness constraints ensuring that underlying features are not lost to satisfy alignment.¹⁹ Combining (47) and (61), we get the correct result via ranking transitivity. An example evaluation is given in (67).

¹⁹ IDENT constraints make the wrong predictions here since the “do not delete” component must be ranked above the markedness constraints to account for the surface inventory, but the “do not insert” component must be ranked below alignment to force assimilation. Since alignment is ranked below some of the markedness constraints defining the inventory, this results in a markedness paradox. Separating the MAX and DEP components allows for independent ranking and does not result in a paradox.

(67) *tòpe* ‘cannon’ voc. sing.

// tɔp + [Class] //	MAX C-place[lab]	*C-place[lab]& *C-manner[closed]	ALIGN -Left [affix] _{ClassI}
--> a. tɔp		*	***
b. tɔc	*!		**

Finally, the last piece of the assimilation analysis is to explain why velar palatalization involving /i/ and mid vowel fronting involving /c/ shares the V-place[cor] feature and not the C-place[cor] feature (see (22b) and (23b)). This can be explained if the rankings in (68) hold. Note that (68a) was already established in (61). (69) demonstrates the interaction between (68b) and the alignment constraint.

- (68) a. *C-place[cor]&*V-manner[closed] >> *V-place[cor]&*V-manner[closed]
 b. *C-place[cor]&*C-manner[closed] >> *V-place[cor]&*C-manner[closed],
 c. *C-place[cor]&*C-manner[open] >> *V-place[cor]&*C-manner[open]

(69) *ručica* ‘hand’ dim.

//ru:k+içã _{ClassI} //	ALIGN-Left [affix] _{ClassI}	*C-place[cor]& *C-manner[closed]	*V-place[cor]& *C-manner[closed]
a. rukičã	***!		
--> b. ruciçã	**		*
c. ruṭiçã	**	*!	

With an analysis of assimilation in place, we can now answer the question of why merger does not occur instead of assimilation. There are three reasons for this. First, merger involving no feature deletion could potentially create segments that are not allowed to surface in this language due to highly ranked feature co-occurrence constraints (see section 5.1). As (70) demonstrates, the constraint ensuring that the affix class I morphemes are as far left as possible can only enforce assimilation, not coalescence under this scenario.

(70) *ručica* ‘hand’ dim.

//ru:k+i _{ča} ClassI//	*C-manner[closed]& *C-place[cor]& *V-place[cor]	ALIGN-Left [affix _{ClassI}]	*C-manner [closed]& *V-place[cor]
a. ru _k i _{ča}		***!	
--> b. ru _c i _{ča}		**	*
c. ru {C-manner[closed] i _{ča} C-place[cor] V-place[cor]}	*!	**	*

Second, merger involving no feature deletion by either underlying segment could potentially create segments that are allowed to surface in this language but are ruled out by the same ranking that prohibits total assimilation (i.e. (61)). This is demonstrated in (71).

(71) *vojniče* ‘soldier’ voc. sing.

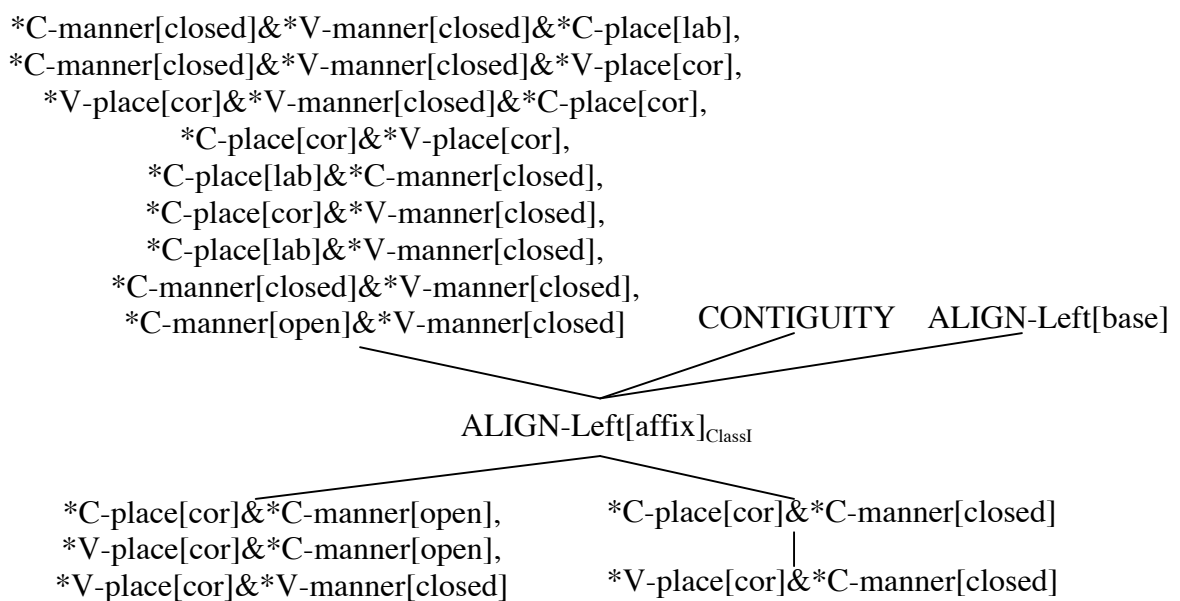
//vɔjni:k + □ _{ClassI} //	*C-manner[closed]& *V-manner[closed]& *V-place[cor]	ALIGN-Left [affix _{ClassI}]	*C-manner [closed]& *V-place[cor]
a. vɔjni:k□		*****!	
--> b. vɔjni:c□		*****	*
c. vɔjni:kʎ	*!	*****	*
d. vɔjni:ʎ	*!	*****	*

Third, the merger option by which one of the original vowel features is deleted is ruled out by highly ranked faithfulness constraints, as discussed in section 5.1.

To summarize, velar fronting, velar palatalization and mid vowel fronting may all be analyzed as the result of best satisfying the need to align particular affixes as far left in a word as possible while 1) allowing the base to be even further to the left, 2) not disrupting the contiguity of segments, 3) not creating illicit segments, 4) not creating particular licit segments, 5) preferring to share V-place[cor] over C-place[cor], and 6) not losing underlying contrastive features. The fact that only velar consonants and the

“mid” back vowel participate in these assimilations is a direct result of the claim that these are all placeless segments in this language and thus are most susceptible to place additions. This state of affairs is accounted for using the combined constraint rankings in (47) and (72). Note that the affix alignment constraint is being ranked among the constraints used to define the segment inventory. This unifies the inventory analysis and the phonological process analysis under one ranking.

(72)



5.2.2. Iotization

With the descriptive and OT analyses of the consonant-vowel assimilations as a backdrop, we can now move to iotization. Recall that there are two dimensions to iotization. First, non-labial consonants become post-alveolar when followed by certain suffixes. Second, labials in the iotizing context do not change features. Rather, they surface followed by a post-alveolar lateral. I propose that these facts lead to the conclusion that this is a process involving segment coalescence in the non-labial context and feature epenthesis in the labial context.

Recall that in bases ending in placeless obstruents, the mannerless suffix-initial segment merges with the placeless base-final obstruent. This was discussed in section 4.2.3 (see (25) through (26)). In the case of bases ending in consonants with C-place[cor], there are two responses depending on the presence or absence of manner features. A mannerless C-place[cor] segment (e.g. 't') simply merges with the iotizing segment to become a consonant with two coronal place features. In contrast, a segment with both C-place[cor] and a manner feature cannot simply merge and maintain all the underlying features because that would result in an impossible segment in this language. Therefore, there is a loss of the C-place[cor] feature. Recall that it is this presence or absence of the C-place[cor] feature that explains why the phonetic laminal stop remains laminal under iotization, while the phonetic laminal affricate becomes apical.

As was shown in (28), the presence of a labial causes the iotizing segment to surface as a post-alveolar lateral. I propose that the driving force behind iotization is the same as that for place assimilation in velar fronting, velar palatalization and mid vowel fronting. That is, there is a constraint aligning the affix as far left in the word as possible, without forcing prefixation or infixation. The difference lies in the nature of the triggering segment, the class of segments susceptible to the process, and the ranking of the alignment constraint relevant to the iotizing morphemes. In the case of the assimilations, the triggering segment (either base-final or affix-initial) had a manner of articulation and the target of the assimilation was a placeless segments. In the case of iotization, the trigger is a mannerless segment and the targets are all non-labial segments. In addition, the constraint aligning the assimilating morphemes is ranked as in (72). This limits both the triggering set and the target set. In contrast, we will see

that the alignment constraint on the iotizing morphemes is ranked higher. This will have the effect of extending the set of segments that are targeted by iotization.

Recall from section 5.2.1 that the assimilating affixes and the iotizing affixes behave differently, thus I assume that they belong to different morpheme classes. This translates into an alignment constraint on class I affixes (assimilating) and an alignment constraint on class II affixes (iotizing). These were given in (54) and (55). Like velar palatalization, iotization causes velar obstruents to surface as post-alveolar affricates. This is captured by the rankings in (73).

- (73) a. $\text{ALIGN-Left}[\text{affix}]_{\text{ClassII}} \gg *V\text{-place}[\text{cor}] \& *C\text{-manner}[\text{closed}] //k// \rightarrow /c/ \text{ 'č'}$
 b. $\text{ALIGN-Left}[\text{affix}]_{\text{ClassII}} \gg *V\text{-place}[\text{cor}] \& *C\text{-manner}[\text{open}] //x// \rightarrow /ʃ/ \text{ 'š'}$

As (74) shows, there is nothing in our ranking thus far to decide if iotization will result in assimilation (74b) or coalescence (74c). In velar palatalization, coalescence was ruled out independently by the ranking of most markedness constraints above the alignment constraint (see (72)). That strategy is not available for iotization because the alignment constraint outranks the markedness constraints against the merged segment structure.

(74) *jačt̄* ‘stronger’

$//jak_1 + \overset{i}{2}i:_{\text{ClassII}}//$	$\text{ALIGN-Left}[\text{affix}]_{\text{ClassII}}$	$*V\text{-place}[\text{cor}] \& *V\text{-manner}[\text{closed}]$
a. $jak_1 \overset{i}{2}i:$	***!	
--> b. $jac_1 \overset{i}{2}i:$	**	*
--> c. $jac_{12}i:$	**	*

The question that remains is why the iotizing segment does not surface as a separate segment. The reason for this is structural economy. The intuition is that having many segments (or root nodes) is less economical than having fewer segments. In

essence, features should combine into as few segments as possible. Thus, I make use of the constraint ensuring general structural economy given in (75).

(75) *SEG - segments are prohibited.

As (76) shows, this constraint can be relevant in deciding between candidates even if it is low-ranked.

(76) *jačt̄* ‘stronger’

<i>//jak₁+ⁱ₂i:ClassII//</i>	ALIGN-Left [affix] _{ClassII}	*V-place[cor]& *C-manner[closed]	...	*SEG
a. <i>jak₁ⁱ₂i:</i>	***!			*****
b. <i>jac₁ⁱ₂i:</i>	**	*		*****!
--> c. <i>jac₁₂i:</i>	**	*		*****

Unlike palatalization, iotization also causes the lateral and laminal alveolar to surface as post-alveolar. This is captured by the rankings in (77), and demonstrated in (78) and (79).

(77) a. ALIGN-Left[affix]_{ClassII} >>

*V-place[cor]&*C-manner[closed]&*V-manner[closed] //V// --> /ʎ/ ‘lj’

b. ALIGN-Left[affix]_{ClassII} >> *V-place[cor]&*C-place[cor] //Ṭ// --> /ç/ ‘č’

(78) *hvaljē* ‘praise’ pres.

<i>//xval+ⁱε:ClassII//</i>	ALIGN-Left [affix] _{ClassII}	*V-place[cor]& *C-manner[closed]& *V-manner[closed]
a. <i>xvalⁱε:</i>	*****!	
--> b. <i>xvaʎε:</i>	***	*

(79) *ljuĉi* ‘angrier’

	// $\lambda u T_{\text{v}}^+ i$: _{ClassII} //	ALIGN-Left [affix] _{ClassII}	*V-place[cor]& *C-place[cor]
a.	$\lambda u T_{\text{v}}^+ i$:	***!	
-->	b. $\lambda u \text{ĉ} i$:	**	*

Finally, iotization causes the laminal alveolar stop and fricative to surface as post-alveolar. However, since these segments have an underlying C-place[cor] feature that deletes under iotization, the alignment constraint must also be ranked above the faithfulness constraint to this feature.

(80) a. ALIGN-Left[affix]_{ClassII} >> MAXC-place[cor] >>

*V-place[cor]&*C-manner[closed] //t/ --> /c/ ‘ĉ’

b. ALIGN-Left[affix]_{ClassII} >> MAXC-place[cor] >>

*V-place[cor]&*C-manner[open] //s/ --> /ʃ/ ‘š’

(81) *nošāh* ‘carry’ past. part.

	// $n o \text{š}^+ a : x$ _{ClassII} //	ALIGN-Left [affix] _{ClassII}	MAX C-place[cor]	*V-place[cor]& *C-manner[open]
a.	$n o \text{š}^+ a : x$	***!		
-->	b. $n o \text{ʃ} a : x$	**	*	*

Having established the analysis of iotization in the non-labial context, we can move on to the labial context. Recall that the labial feature can never combine with another place feature in this language. From an inventory perspective, this was the result of a set of markedness constraints ranked above the relevant faithfulness constraints. Since iotization usually entails the merging of a V-place[cor] feature with the preceding segment, the lack of such merger on labials is captured by ranking the

The lack of a simple lateral is easily accounted for if we assume that the iotizing feature (V-place[cor]) cannot delete because of high-ranking faithfulness (established above).

(85) *tuplji* ‘duller’

	//tup+ ⁱ i _{ClassII} //	MAX V-place[cor]	*C-manner[closed]& *V-manner[closed]& *V-place[cor]
-->	a. tup λ i		*
	b. tupli	*!	

The answer for why the iotizing segment does not surface as a glide is a little more interesting. First, unlike the initial vocalic segment of the assimilating affixes, which is never followed by another vowel, the initial segment of the iotizing affixes is always followed by a vowel.²⁰ Thus it always surfaces in onset (pre-vocalic) position regardless of whether it merges with the preceding consonant or not. Further, that onset segment has an underlying V-place[cor] feature, which it cannot delete because of high ranking faithfulness. I will show that it is syllable structure that drives the epenthesis of C-manner[closed] and V-manner[closed] features. However, a full account of Serbian syllable structure is beyond the scope of this paper. So, the details relevant to syllable structure beyond the context under study here are necessarily omitted.²¹

²⁰ This is a result of the history of the language, not due to a systematic synchronic restriction (Morpheme Structure Constraint).

²¹ Clearly, there is an interaction between the account of syllabification within morphemes and syllabification in this morphological context that deserves careful consideration. This is left to future research.

Given the need to turn an iotizing segment into a post-alveolar lateral after labials, and the inability to merge or delete features, then there are a number of logical possibilities for segmental content. Several of these are given in (86) for the present tense form of the verb *kaplje* ‘drip’.

- (86) a. /ka.pⁱ/ ---
 b. /ka.pi/ [ka.pj] C-place[cor]&V-manner[closed]
 c. /ka.p/ V-manner[closed]
 d. /ka.pʌ/ C-manner[closed]&V-manner[closed]
 e. /ka.pʃ/ C-manner[open]
 f. /ka.pc/ C-manner[closed]
 g. /ka.pç/ C-place[cor]

How do we ensure that the segment does not surface faithfully (perhaps as a glide) and that both the C-manner[closed] and V-manner[closed] features are epenthesized rather than just one or the other? (87) shows that the segment that actually surfaces is one of the more complex segments having V-place[cor].

(87)

		Features						
		C-place		V-place	C-manner		V-manner	
		[lab]	[cor]	[cor]	[closed]	[open]	[closed]	[open]
‘ć’	/ç/		✓	✓				
‘č’	/c/			✓	✓			
‘š’	/ʃ/			✓		✓		
‘lj’	/ʎ/			✓	✓		✓	
‘e’	/ɛ/			✓			✓	
‘i’	/i/ pal		✓	✓			✓	

As (89) shows, an appropriate ranking of a constraint corresponding to the Sonority Sequencing Principle provides the correct result.²²

(88) **SON-SEQ** (Sonority Sequencing Principle) - complex onsets rise in sonority and complex codas fall in sonority (from Morelli 1999 and Kager 1999, based on Clements 1990).

(89) *kapje* ‘drip’ pres.

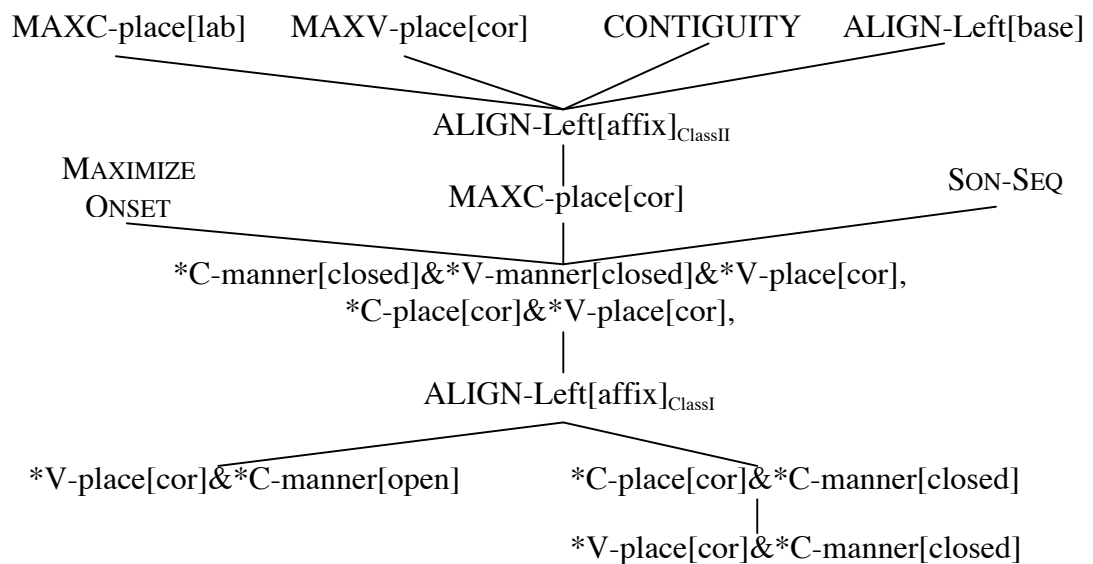
<i>//kap+ⁱε_{ClassII}//</i>	SON-SEQ	*C-manner[closed]& *V-manner[closed]& *V-place[cor]
a. ka.p ⁱ ε	*!	
b. ka.piε	*!	
c. ka.pεε	*!	
--> d. ka.pʌε		*
e. ka.pʃε	*!	
f. ka.pçε	*!	
g. ka.pç̣ε	*!	

In tableau (89), the only candidate in which feature epenthesis creates the preferred sonority profile of obstruent-sonorant-vowel is (d). Candidates (e) through (g) have obstruent-obstruent clusters that do not rise in sonority. Although (e) may look like a rise in sonority, Morelli (1999, p. 24) specifically claims, based on an typological investigation of obstruent clusters, that “fricatives and stops form a single class” with respect to the Sonority Sequencing Principle. Candidates (b) and (c) have a vowel-vowel sequence that does not rise in sonority. Candidate (a) has an obstruent-mannerless segment-vowel sequence that does not rise in sonority.

²² This constraint is most likely shorthand for a more adequate constraint or constraint interaction.

To summarize, iotization is like velar fronting, palatalization and mid vowel fronting in being the result of the need to align particular affixes as far left in a word as possible while 1) allowing the base to be even further to the left, 2) not disrupting the contiguity of segments, 3) not creating illicit segments, 4) preferring to share V-place[cor] over C-place[cor], and 5) not losing underlying contrastive features. It differs in applying to all non-labials and in manifesting as coalescence rather than assimilation. In the labial environment, coalescence cannot occur due to feature co-occurrence restrictions and the need to maintain the underlying labial and C-place[cor] features. In addition, manner features are epenthesized to ensure that the best sonority profile is created to satisfy the Sonority Sequencing Principle. This state of affairs is accounted for using the combined constraint rankings in (47), (72) and (90).

(90)



5.3. An OT analysis of the Serbian consonant-vowel alternation

Recall that the alveolar lateral approximant becomes a mid back vowel when it would otherwise be syllabified as the coda of an unstressed syllable.

Representationally, this entails the delinking of the C-manner[closed] feature, as was shown in (29). One way to capture this positional neutralization is to make use of general markedness constraints and positional faithfulness constraints (Beckman 1995). To ensure that the lateral neutralizes in the least prominent position (unstressed coda), the constraint against the co-occurrence of the features defining the lateral must be ranked above a general faithfulness constraint against deleting the C-manner[closed] feature. This is shown in (91).

(91) *orao* ‘eagle’

	//ɔral//	*C-manner[closed]& *V-manner[closed]	MAX C-manner[closed]
a.	'ɔ.ral	*!	
--> b.	'ɔ.raɔ		*

Since the lateral does not become a velar stop, faithfulness to the V-manner[closed] must be ranked above faithfulness to C-manner[closed].

(92) *orao* ‘eagle’

	//ɔral//	MAX V-manner[closed]	MAX C-manner[closed]
a.	'ɔ.rak	*!	
--> b.	'ɔ.raɔ		*

To ensure that the lateral does not change in onset position regardless of stress, I propose using the positional faithfulness constraint in (93).

- (93) **MAX_{onset}C-manner[closed]** - Every C-manner[closed] in the input has a correspondent in the output if it is found in onset position.

(94) *kálan* ‘dirty’

	//ka:lan//	MAX _{onset} C-manner[closed]	*C-manner[closed]& *V-manner[closed]	MAX C-manner[closed]
-->	a. 'ka:.lan		*	
	b. 'ka:ɔan	*!		*

Similarly, there must be a high ranking faithfulness constraint relative to stressed syllables, and another relative to the lexical class of non-native morphemes. These are given in (95) and (96) and demonstrated in (97) and (98).

- (95) **MAX_{HeadSyll}C-manner[closed]** - Every C-manner[closed] in the input has a correspondent in the output if it is found in the head syllable of a foot.

- (96) **MAX_{Non-native}C-manner[closed]** - Every C-manner[closed] in the input has a correspondent in the output if it is found in a non-native lexical item.

(97) *žalba* ‘complain’

	//žalba//	MAX _{HeadSyll} C-manner[closed]	*C-manner[closed]& *V-manner[closed]	MAX C-manner[closed]
-->	a. 'žal.ba		*	
	b. 'žao.ba	*!		*

(98) *bokāl* ‘goblet’

	//bɔka:l//	MAX _{Non-native} C-manner[closed]	*C-manner[closed]& *V-manner[closed]	MAX C-manner[closed]
-->	a. 'bɔka:l		*	
	b. 'bɔka:ɔ	*!		*

Since the prohibition against the co-occurrence of C-manner[closed] and V-manner[closed] does not apply to segments with place (i.e. /v/ or /ʌ/), it must also be more important to be faithful to C-manner[closed] associated with place features.

(99) **MAXLinkC-place[lab]C-manner[closed]** - Every C-manner[closed] associated with C-place[lab] in the input has a correspondent in the output if C-place[lab] is in the output. (Shorthand formulation - see Morén (1999) for a full discussion of MAXLink constraints as they apply to moraicity, and Blaho (2004) for a discussion of similar constraints on features.)

(100) **MAXLinkV-place[cor]C-manner[closed]** - Every C-manner[closed] associated with V-place[cor] in the input has a correspondent in the output if V-place[cor] is in the output. (Shorthand formulation - see Morén (1999) for a full discussion of MAXLink constraints as they apply to moraicity, and Blaho (2004) for a discussion of similar constraints on features.)

(101) *náziv* ‘name’

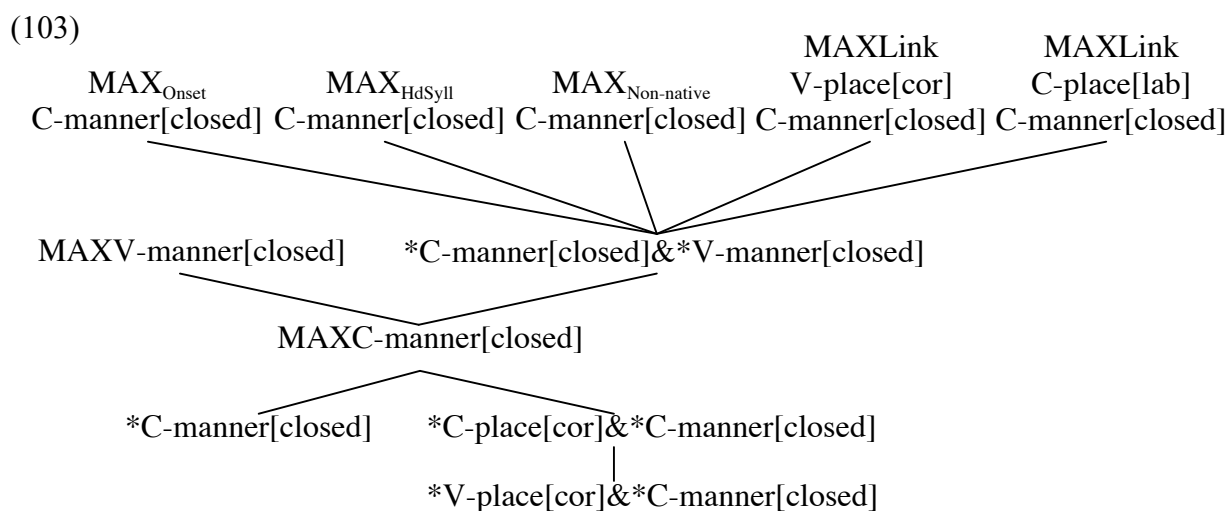
//na:ziʊ//	MAXLinkC-place[lab] C-manner[closed]	*C-manner[closed]& *V-manner[closed]	MAX C-manner[closed]
--> a. 'na:.ziʊ		*	
b. 'na:.ziu	*!		*

(102) *obítelj* ‘family’

//ɔbi:tɛʌ//	MAXLinkV-place[cor] C-manner[closed]	*C-manner[closed]& *V-manner[closed]	MAX C-manner[closed]
--> a. ɔ'bi:.tɛʌ		*	
b. ɔ'bi:.tɛɛ	*!		*

To summarize, lateral vocalization is a neutralization process. This means that the combination of C-manner[closed] and V-manner[closed] is generally not allowed. Since faithfulness to V-manner[closed] is higher ranked than faithfulness to C-manner[closed], the consonantal feature is lost, leaving only the vocalic feature. However, this feature combination is allowed in particular environments. To ensure that the lateral arises in onsets, stressed syllables and non-native vocabulary items, positional faithfulness constraints to these prominent positions and lexical class must be ranked above the markedness constraint.

From an acquisition perspective, the child must learn that there is a difference in the occurrence of the lateral and the mid back vowel, including alternations, such that the lateral is not allowed in coda position. This entails the default ranking of markedness over general faithfulness. However, the child must also learn that the lateral is allowed in prominent positions and particular lexical classes, thus entailing the re-ranking of markedness below positional and lexical faithfulness. In addition, the child must learn that the C-manner[closed] feature is not deleted when it is underlyingly associated with a place feature. Therefore, the markedness constraint must also be re-ranked below faithfulness constraints on some featural associations. The constraint ranking that accounts for the lateral vocalization pattern is given in (103).



6. Conclusion

Serbian has some curious inventory and alternation facts that are either easy or difficult to account for individually using traditional feature theory. However, taken in concert, a coherent analysis of all the data is elusive. To provide a unified explanation, I proposed using the Parallel Structures Model of feature geometry. This model assumes that consonants and vowels use the same features and a very limited set of segment-internal structures that make interactions and alternations among consonants and vowels more natural. In addition, this model makes very explicit claims about the relationship between segment inventories, the feature sets used to define them, and structural markedness relationships that help to explain the unexpected patterns found in Serbian. Importantly, every segment composed of a combination of features entails the presence of a set of segments composed of single features. This has the result of not only ensuring that segment inventories are economical, but it also claims that the relationship between phonological feature specification and phonetic implementation of those features is not as transparent as is usually assumed. For example, Serbian has three sets of phonetic affricates that are analyzed here as phonological stops, and a set

of velar obstruents that are analyzed as phonologically placeless. Viewing the Serbian facts from a Parallel Structures Model perspective has the further advantage of accounting for the consonant-vowel interactions and alternation found in this language and simplifying and unifying those interactions. For example, velar palatalization, velar fronting and mid vowel fronting all involve the sharing of a coronal feature between a segment with manner and a placeless segment across a morpheme boundary. Whether the target of assimilation is a consonant or a vowel, and whether the assimilation is progressive or regressive, is epiphenomenal.

In addition to contributing to the phonological literature by presenting empirical facts and a representational analysis, this paper also makes a contribution by integrating those facts and analysis into a constraint-based explanation. I demonstrated that the same constraint ranking used to define the segment inventory can be used to explain phonological processes. The inventory is captured by ranking a set of constraints against each feature, and sets of local conjunctions of those constraints, relative to feature faithfulness constraints. The consonant-vowel interactions in Serbian are essentially the result of a set of alignment constraints to different classes of morphemes ranked with respect to one another, as well as the markedness and faithfulness constraints used to define the segment inventory. Finally, the neutralization of the alveolar lateral to a mid back vowel results from the relative ranking of the markedness constraint against the co-occurrence of features that make up the lateral with both general and positional faithfulness constraints.

Overall, this paper demonstrates that Serbian does not show a one-to-one correspondence between phonological features and phonetic realization and that there is the need to dismantle the traditional dichotomy between consonant and vowel features.

The Parallel Structures Model does just that and accounts for the empirical facts of Serbian both simply and elegantly. Further, this paper also shows the importance of viewing the grammatical system as a whole when dealing with phonological phenomena - i.e. one must carefully consider a range of phonetic, phonological and morphological facts. Finally, this paper shows that it is possible to integrate a model of segment-internal representations into a constraint-based evaluation system.

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Abstract

This paper provides a representational and constraint-based analysis of the segment inventory and consonant-vowel interactions of Standard Serbian. It shows that the phonological and morpho-phonological patterns of this language pose several challenges to the more traditional feature theories, which assume that consonants and vowels use (for the most part) different features. To capture all the Serbian facts (including velar fronting, velar palatalization, iotization and lateral vocalization), I make use of the Parallel Structures Model of feature geometry and Optimality Theory. The advantage of using the Parallel Structures Model is that it representationally captures quite complex consonant-vowel and place-manner alternations using a limited set of privative features applicable to both consonants and vowels. OT is employed to explain the inventory, the morphological specificity of the consonant-vowel interactions, and the context specificity of lateral vocalization, as well as other “soft constraint” effects. However, this analysis differs from most constraint-based approaches in assuming segment-internal representations, providing an explicit mechanism to explain the inventory (including justifying particular feature specifications), and providing a unified account of both the inventory and phonological process facts.

Keywords: Slavic; Serbian; Feature theory; Constraint theory; Palatalization; Vocalization