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46. Positional Effects in Consonant Clusters

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Sections

1 Introduction

It is commonly observed across languages that phonological processes may apply only in certain ("non-prominent") positions. In contrast, elements in other ("prominent") positions typically resist or trigger these processes. Such prominent *vs.* non-prominent positional distinctions are further applicable to more general patterns of licensing and neutralization of phonological contrasts; namely, featural/segmental contrasts are likely to be licensed in prominent positions, whereas these contrasts are likely to be neutralized in non-prominent positions. Pairs of prominent and non-prominent positions include word-initial *vs.* non-initial, stressed *vs.* unstressed, root *vs.* affix, and prevocalic *vs.* preconsonantal positions. Among the positional effects involving these pairs, this chapter is mainly concerned with those involving the two members of intervocalic consonant clusters. See Beckman (1998) and Barnes (2006) for recent extensive investigations of other positional effects; see also CHAPTER 104: ROOT—AFFIX ASYMMETRIES and CHAPTER 102: CATEGORY-SPECIFIC EFFECTS. In intervocalic C_1C_2 clusters, the preconsonantal C_1 is more likely to undergo phonological processes such as voicing and place assimilation, in contrast with the prevocalic C_2, which is rarely subject to such processes. I will refer to this asymmetric positional effect as the C_2 dominance effect.

This chapter discusses empirical data patterns which display positional effects. Its focus will be on how to explain the C_2 dominance effect. I will begin with a discussion of typical data patterns of the C_2 dominance effect and proceed to less common, somewhat exceptional, patterns which are nonetheless crucial in comparing the previous approaches. Specifically, I will concentrate on the comparison between prosody-based approaches (Itô 1986, 1989; Cho 1990; Goldsmith 1990; Rubach 1990; Lombardi 1995, 1999, 2001b; Beckman 1998; Kabak and Idsardi 2007) and cue-based approaches (Steriade 1993, 1995, 1999, 2001, 2009; Flemming 1995; Jun 1995, 2004; Padgett 1995; Boersma 1998; Hume 1999; Côté 2000; Wilson 2001; Blevins 2003; Seo 2003). It will be shown that current evidence is mixed. Much of the commonly observed data, to be discussed in the following two sections, can be equally well accommodated in the two approaches. However, there exist less common patterns which can be understood under only one of the two approaches. Evidence exclusively supporting the cue-based approach will be discussed in §4, and evidence for the prosody-based approach in §5.

2 C_2 dominance effect

Assimilation occurs in consonant clusters when one of two neighboring consonants takes on some property of the other. I will call the former (i.e. the undergoer of assimilation) the target, and the latter (i.e. the source of the assimilating property) the trigger. With respect to the assimilation in C_1C_2 clusters, it is cross-linguistically true that C_1 and C_2 are the target and the trigger, respectively, and thus the direction of assimilation is regressive. To illustrate this C_2 dominance effect, I will first consider patterns of voicing assimilation and then patterns of place assimilation. Finally, patterns of consonant deletion will be discussed.

As can be seen in (1), in Catalan, Polish and Russian, voiced and voiceless obstruents are separate phonemes, and they may occur unhindered in prevocalic position. But in clusters composed of obstruents, the first constituent of the cluster must agree in voicing with the following constituent. As shown in (1.i), underlyingly voiced obstruents in C_1 become voiceless before a voiceless obstruent in C_2 whereas underlyingly voiceless obstruents in C_1 become voiced before a voiced obstruent in C_2, as in (1.ii). Thus, voicing assimilation occurs in clusters, targeting C_1. This C_2 dominance effect in voicing assimilation can be seen in other languages, including Dutch, Yiddish, Sanskrit, Romanian, Serbo-Croatian, Ukrainian, Hungarian, Egyptian Arabic, and Lithuanian. **Steriade (1999)** and **Beckman (1998)** provide in-depth discussion of voicing assimilation, i.e. a type of laryngeal neutralization, in these languages, emphasizing that it is normally regressive, and thus its C_2 dominance effect is quite robust.

(1) *Regressive voicing assimilation*

a. *Catalan* (from Beckman 1998, citing Hualde 1992)

				__ voiceless	
i.	/b/	ˈʎoβə	'wolf (FEM)'	ˈʎoppəˈtit	'small wolf'
	/g/	əˈmɪɣə	'friend (FEM)'	əˈmɪkpəˈtɪt	'little friend'
				__ voiced	
ii.	/t/	ˈgatə	'cat (FEM)'	ˈgaddu'len	'bad cat'
	/k/	ˈpɔkə	'little (FEM)'	ˈpɔgˈdu	'a little hard'

b. *Polish* (from Rubach 1996, Beckman 1998)

				__ voiceless	
i.	/b/	ża[b]a	'frog'	ża[pk]a	'small frog'
	/d/	wo[d]a	'water'	wo[tk]a	'vodka'
				__ voiced	
ii.	/ʧ/	li[ʧ]yć	'count'	li[dzb]a	'numeral'
	/k/	szla[k]-u	'route (GEN SG)'	szla[gb]ojowy	'war route'

c. *Russian* (from Kenstowicz 1994, Kiparsky 1985, Padgett 2002)

				__ voiceless	
i.	/b/	korob-a	'bastbax (GEN SG)'	kirop-ka	'bastbax (DIM)'
	/d/	pod-nesti	'to bring (to)'	pot-pisatʲ	'to sign'
				__ voiced	
ii.	/s'/	pros'-it'	'to ask'	proz'-ba	'request'
	/t/	ot-jexatʲ	'to ride off'	od-brositʲ	'to throw aside'

Consonant place assimilation occurs in clusters when one of two adjacent consonants, i.e. the target, takes on the place of articulation of the other, i.e. the trigger. Consonants differ in the likelihood of being targeted in place assimilation depending on the manner and place of articulation. Nasals (as opposed to stops and continuants) and coronals (as opposed to labials and velars) are the most likely targets of place assimilation (**Mohanan 1993**; **Jun 1995, 2004**). For instance, as shown in (2.i), in Diola Fogny only nasals can be targeted in place assimilation, and in Yakut only coronals can be targeted. However, assimilation applies only when such potential target consonants occupy C_1, not C_2, position. Notice in (2a.ii) that nasals such as /m/ in C_2 only trigger, not undergo, assimilation. In (2b.ii), coronals in C_2 resist place assimilation.

(2) *Regressive place assimilation*

a. *Diola Fogny* (from Sapir 1965)

i.	/ni+gam+gam/	[niganŋgam]	'I judge'
ii.	/na+mi:n+mi:n/	[nami:mmi:n]	'he cut (with a knife)'

b. *Yakut* (from Krueger 1962)

i.	Coronals in C_1 are the target		
	/at+ka/	[akka]	'to a horse'
	/yn+kyr/	[yŋkyr]	'sloping, aslant'
ii.	Coronals in C_2 are not the target		
	/tobuk+ta/	[tobukta]	'knee (PART)'
	/silim+te/	[silimne]	'glue (PART)'

As shown above, place assimilation is typically regressive, just as voicing assimilation is; and thus it targets C_1, and its trigger is C_2. This C_2 dominance effect in place assimilation is very robust across languages, as shown in typological studies by **Webb (1982)**, **Mohanan (1993)**, and **Jun (1995, 2004)**, and there are only a small number of exceptions. (See **Jun 1995, 2004** and **McCarthy 2008** for discussion of such exceptional progressive assimilation patterns.) Optional patterns of place assimilation are not different from obligatory and categorical patterns in the preponderance of regressive assimilation over progressive assimilation. In Korean, the occurrence of place assimilation is subject to speech style and rate, and thus optional (**Kim-Renaud 1974**; **Jun 1996**; **Son *et al.* 2007**; **Kochetov and Pouplier 2008**; **Son 2008**). This optional assimilation is regressive. Specifically, only coronal and labial stops and nasals in C_1 are the target, and non-coronals in C_2 are the trigger, as can be seen in (3a.i). Notice in (3a.ii) that coronals in C_2 do not undergo the assimilation, and non-coronals in C_1 cannot trigger the assimilation (see CHAPTER **12**: CORONALS). English casual speech assimilation is very much like Korean assimilation in the direction of assimilation and segmental characteristics of the target. The only difference is that only coronals, not labials, can be the target in English assimilation. Notice that coronals undergo assimilation only when they are in C_1, not C_2, as can be seen in (3b).

(3) *Casual speech place assimilation*

a. *Korean*[1]

i.	/mit+ko/	[mitk'o] ~ [mikk'o]	'believe (CONN)'
	/ip+ko/	[ipk'o] ~ [ikk'o]	'wear (INF)'
	/cinan pam/	[cinanbam] ~ [cinambam]	'last night'
ii.	/ik+ta/	[ikt'a], *[itt'a], *[ikk'a]	'ripe (INF)'
	/ip+ta/	[ipt'a], *[itt'a], *[ipp'a]	'wear (INF)'
	/paŋ+pota/	[paŋbota], *[pambota], *[paŋgota]	'(more) than room'

b. *English* (based on Bailey 1970)

i.	right poor	righ[p] poor	
	good-bye	goo[b]bye	
ii.	keep track	*kee[t] track	*keep [p]rack
	back track	*ba[t] track	*back [k]rack

This C_2 dominance effect in casual speech assimilation can also be seen in other languages, such as German (**Kohler 1990, 1991a, 1991b, 1992**), Malay, Thai (**Lodge 1986, 1992**), Toba Batak (**Hayes 1986**), Spanish (**Harris 1969**), and Ponapean (**Rehg and Sohl 1981**); see also CHAPTER **79**: REDUCTION on assimilation as a casual speech phenomenon.

The C_2 dominance effect is not limited to assimilation in consonant clusters, but extends to consonant deletion in clusters. Consonant deletion occurs in clusters when one of two adjacent consonants, i.e. the target, deletes. It has been observed and emphasized in the literature (**Côté 2000**; **Wilson 2001**; **Jun 2002**; **McCarthy 2008**) that C_1, as opposed to C_2, is always the target in such deletions. For instance, as shown in (4), stops in C_1, not C_2, delete in Diola Fogny, West Greenlandic, and Basque.

(4) *Consonant deletion: C_1 is the target*

a. *Diola Fogny* (Sapir 1965)

/let+ku+jaw/	[le kujaw]	'they won't go'
/kutɛb sinaŋas/	[kutɛ sinaŋas]	'they carried the food'
/ɛkɛt bo/	[ɛkɛ bo]	'death there'

b. *West Greenlandic* (Rischel 1974; Fortescue 1980)

/qanik+lerpoq/	[qani lerpoq]	'begins to approach'
/ukijuq+tuqaq/	[ukiju tuqaq]	'old year'
/anguti+kulak/	[angu kulak]	'he goat'

c. *Basque* (Hualde 1987)

/bat+paratu/	[ba-paratu]	'put one'
/bat+kurri/	[ba-kurri]	'run one'
/guk+piztu/	[gu-piztu]	'we light'
/guk+kendu/	[gu-kendu]	'we take away'

In addition to those shown above, consonant deletion with a C_1 target can be found in Akan (**Lombardi 2001b**, citing **Schachter and Fromkin 1968**), Axininca person prefixes (**Lombardi 2001b**, citing **Payne 1981**), Carib (**Gildea 1995**), and Tunica (**Wilson 2001**, citing **Haas 1946**).

Consequently, as summarized below, the cross-linguistic generalization which is common to the three phonological processes (voicing assimilation, place assimilation, and consonant deletion) is that C_1 in intervocalic C_1C_2 clusters is the target, whereas C_2 is the trigger.

(5) *The C_2 dominance effect in voicing assimilation, place assimilation, and consonant deletion*

In intervocalic C_1C_2 clusters, C_1 is a typical target, and C_2 is a typical trigger.

Let us consider how to capture this C_2 dominance effect. It is not difficult to derive patterns with the C_2 dominance effect within the framework of previous theories such as classical generative theory, autosegmental phonology, and under-specification theory. For instance, regressive assimilation can easily be characterized by a rule of the type shown in (6a). However, progressive assimilation can also be formulated with equal complexity, as shown in (6b), and its absence, or at best rarity, in the typology would be a surprise. Representational theories such as autosegmental phonology, feature geometry, and underspecification theory would be no better in this respect than classical generative theory, as there is no plausible reason to differentiate in the complexity of the representation between the two members of a consonant cluster. (See **Jun 1995** for the relevant discussion.)

(6) *Rules for consonant place assimilation*

a. $C \rightarrow [\alpha\text{place}]$ / __ $[C, \alpha\text{place}]$ (regressive assimilation)
b. $C \rightarrow [\alpha\text{place}]$ / $[C, \alpha\text{place}]$ __ (progressive assimilation)

Compared to the rule-based theories with a focus on the correct formulation of the language-specific phonological processes, Optimality Theory (**McCarthy and Prince 1995**; **Prince and Smolensky 2004**) is more concerned with universal patterns, thus being in a better position to explain positional effects such as the C_2 dominance effect and understand the motivation behind processes showing the effect.

Along with the development of Optimality Theory, there have been two major lines of approach to the analysis of the positional effects, Licensing-by-cue and Licensing-by-prosody (in **Steriade's 1999** terminology). The prosody-based approach explains positional asymmetries by reference to prosodic structure. It attributes the C_2 dominance effect to the coda—onset asymmetry since C_1 and C_2 are usually syllabified as a coda and an onset, respectively. The C_1 in the coda is likely to be targeted in the processes since the coda is phonologically non-prominent and marked. In contrast, the C_2 in the onset resists these processes since the onset is phonologically prominent and unmarked. For an analysis of the data of the C_2 dominance effect, either greater faithfulness to the onset and/or dispreference for the coda or (marked) properties in the coda have been called on. Specifically, within the framework of Optimality Theory, positional faithfulness constraints for the onset or/and positional markedness constraints for the coda have been adopted in the literature. (See **Casali 1996, 1997** and **Beckman 1998** for positional faithfulness analyses, and **Zoll 1998** for the comparison between positional faithfulness and positional markedness.)

In contrast, the cue-based approach (**Flemming 1995**; **Steriade 1995, 1999, 2001, 2009**; **Boersma 1998**; **Côté 2000**; **Wilson 2001**; **Blevins 2003**; **Jun 2004**) explains the C_2 dominance effect by relying on the perceptual factors

involved. The C_1 has low perceptibility since it is preconsonantal and thus may lack important perception cues, such as release bursts and C-to-V formant transitions, to laryngeal/place features and segmenthood under overlap with C_2 (**Lamontagne 1993**; **Wright 1996**). In contrast, the C_2 is perceptually prominent since it is prevocalic, being able to maintain such perception cues. (See **Wright 2004** for a detailed discussion of perception cues.) From the assumption that change in perceptually prominent positions would cause drastic input—output difference, and thus be greatly dispreferred, whereas the comparable change in non-prominent positions would cause less difference, and thus be less dispreferred, it is derived that non-prominent C_1 is more likely to be modified, i.e. targeted in phonological processes, than prominent C_2. Thus, the cue-based approach attributes the C_2 dominance effect to higher perceptibility of C_2 over C_1.

The two approaches under consideration differ in whether the constraints (and rules) adopted to explain positional effects should be expressed as prosody-based or string-based (more precisely, cue-based) statements. However, the empirical data presented thus far will not distinguish the two approaches, since the pre-consonantal C_1 which is expected to be the target of the phonological processes in the cue-based approach is normally syllabified as a coda, which the prosody-based approach also expects to be the more likely target. In §4 and §5, I will present the data patterns for which the two approaches make distinct predictions.

3 Non-assimilatory neutralization

Assimilation can be considered as a case of contrast neutralization. As shown in the previous section, assimilation is primarily regressive (i.e. C_1 is the target), and thus potential contrasts of the assimilating feature are neutralized in C_1 position. For instance, in regressive voicing assimilation, consonants in C_1 with distinct voice feature values in their underlying form would have identical phonetic realization with respect to voicing, i.e. they are voiced before a voiced segment and voiceless before a voiceless one. Non-assimilatory neutralization of voicing, as well as other laryngeal features and place of articulation features, targets the C_1 and word-final position. In languages which have voicing assimilation in consonant clusters, the word-final position is the only available target of non-assimilatory neutralization, and in fact languages with voicing assimilation mentioned in the previous section show final devoicing, as in (7) (see also CHAPTER 69: FINAL DEVOICING AND FINAL LARYNGEAL NEUTRALIZATION).

(7) *Final devoicing in languages with voicing assimilation*

a. *Catalan* (Beckman 1998, citing Hualde 1992)

		__V		__#	
i.	/t/	[ˈgatə]	'cat (FEM)'	[ˈgat]	'bad (MASC)'
	/k/	[ˈpɔkə]	'little (FEM)'	[ˈpɔk]	'little (MASC)'
ii.	/b/	[ˈʎoβə]	'wolf (FEM)'	[ˈʎop]	'wolf (MASC)'
	/g/	[əˈmɪɣə]	'friend (FEM)'	[ˈəmɪk]	'friend (MASC)'

b. *Dutch* (Kager 1999)

		__V		__#	
i.	/t/	[pɛtən]	'caps'	[pɛt]	'cap'
		[bɛtən]	'(we) dab'	[bɛt]	'(I) dab'
ii.	/d/	[bɛdən]	'beds'	[bɛt]	'bed'
		[hudən]	'hats'	[hut]	'hat'

c. *Polish* (Rubach 1996)

	__V		__#	
/d/	sa[d]-y	'orchards'	sa[t]	'orchards (NOM SG)'
/z/	ko[z]-a	'goat'	kó[s]	'goat (GEN PL)'
/v/	pra[v]-o	'law'	pra[f]	'law (GEN PL)'

d. *Russian* (Hayes 1984; Kiparsky 1985; Padgett 2002)

	__V		__#	
/b/	klub-a	'club (GEN SG)'	klup	'club'
/d/	sa[d]-a	'garden (GEN SG)'	sa[t]	'garden (NOM SG)'
/g/	knig-a	'book (NOM SG)'	knik	'book (GEN PL)'

Notice that voiced obstruents may appear before a vowel, more precisely a sonorant, but only neutralized, normally voiceless, obstruents are allowed to occur word-finally in these languages.[2] In many other languages, such as Korean, Maidu, Greek, German, Thai, and Sanskrit, the non-assimilatory neutralization of the laryngeal features such as voicing, aspiration, and glottalization occurs not only at the end of the word, but also in preconsonantal C_1 position. As mentioned above, Korean has

a three-way laryngeal contrast between lenis, aspirated, and tense (i.e. glottalized) obstruents. As shown in (8a), the three-way contrast can be maintained before a vowel. However, Korean obstruents are neutralized to their homorganic lenis stop counterparts in word-final and preconsonantal C_1 position (see CHAPTER 111: LARYNGEAL CONTRAST IN KOREAN). As discussed in **Lombardi (1995)**, Maidu also has a three-way contrast between voiceless, implosive, and glottalized obstruents. Just as in Korean, the three-way contrast in Maidu is maintained only syllable-initially, i.e. prevocalically, whereas laryngeally marked consonants, i.e. implosive and glottalized, occur neither in C_1 nor at the end of the word. Some examples of alternations displaying neutralization of glottalized stops are shown in (8b). As discussed in **Steriade (1999)**, Ancient Greek has voiceless unaspirated, voiced, and voiceless aspirated stops. The laryngeal distinction among stops can be made before vowels (and sonorant consonants) whereas it is neutralized before obstruents. Some examples of relevant alternations are shown in (8c). Notice that stops in Greek are not allowed to occur word-finally, and thus there is no way to observe active word-final neutralization.

(8) *Laryngeal neutralization: target = word-final and preconsonantal C_1*

a. *Korean*

		underlying form		__V (-i (NOM))	__# isolation form	__C (-to 'too')
i.	lenis	/kuk/	'soup'	kugi	kuk	kukt'o
ii.	aspirated	/puək^h/	'kitchen'	puək^{h}i	puək	puəkt'o
iii.	glottalized	/pak'/	'outside'	pak'i	pak	pakt'o

b. *Maidu* (Lombardi 1995)

	__V	__#	__C
/pit'/	pit'i k'atanoky	pit	pitk'ololo
	'manure-rolling beetle'	'defecate, feces'	'intestines'
/jep'/	jep'im symi		jepsy
'male'	'buck deer'		'men'

c. *Greek* (Steriade 1999)

		__V		__C	
i.	voiceless	t^{h}orak-os	'thorax (GEN SG)'	t^{h}orak-si	'thorax (DAT PL)'
ii.	voiced	laryng-os	'larynx (GEN SG)'	larynk-si	'larynx (DAT PL)'
iii.	aspirated	trik^h-os	'hair (GEN SG)'	t^{h}rik-si	'hair (DAT PL)'

In summary, the preconsonantal C_1 position is the cross-linguistically common target position of both assimilatory and non-assimilatory laryngeal neutralizations, and the word-final position is additionally the common target position of the non-assimilatory neutralization.

Let us now consider non-assimilatory place neutralization. Just like laryngeal neutralization, place neutralization targets C_1 and the word-final position. In languages like Spanish, Ancient Greek, and Japanese, certain place distinctions are removed through regressive assimilation in clusters, and in a non-assimilatory way at the end of the word. As mentioned in **Steriade (2001)**, in Ancient Greek [n] and [m] in C_1 assimilate in place to the following consonant, and only [n] is allowed to occur at the end of the word. Similar neutralizations can be seen in Spanish and Japanese. In Spanish, there are three nasal phonemes, bilabial, alveolar, and palatal, which are contrastive only in prevocalic position: *ca*[m]*a*, *ca*[n]*a*, and *ca*[ɲ]*a* (**Harris 1984**). In intervocalic C_1C_2 clusters, place distinctions of nasals in C_1 are neutralized since they always agree in place with the following consonant in C_2, as shown in (9a.i). Moreover, only a single nasal may occur at the end of the word, although dialects differ in the exact place of articulation of the default nasal, i.e. alveolar in standard varieties and velar in non-standard varieties, as shown in (9a.ii, iii). In Japanese, in intervocalic C_1C_2 clusters, consonants in C_1 must agree in place with those in C_2, as shown in (9b.i, ii). Thus, within a word, only homorganic nasal and geminate clusters can occur. In addition, the word-final position can be occupied only by a single nasal, which is called the mora nasal and is usually transcribed as [N] or [ɲ]. This nasal is produced with no fixed oral constriction (**Vance 1987**: 35), and thus it is sometimes argued to be a placeless segment (for instance, **McCarthy 2008**: 278). (See CHAPTER 22: CONSONANTAL PLACE OF ARTICULATION.)

(9) *Place assimilation and final place neutralization*

a. *Spanish* (from Harris 1984)
   i. Homorganic NC clusters: ca[mp]o, ma[ns]o, ma[ŋk]o, á[ɱf]ora, ma[n̪t]o
   ii. Final [n] in standard varieties: e[n] Chile, ta[n] frío, u[n] elefante
   iii. Final [ŋ] in non-standard varieties: e[ŋ] Chile, ta[ŋ] frío, u[ŋ] elefante

b. *Japanese* (Vance 1987; Yip 1991; Itô *et al.* 1995; Kager 1999)
   i. *Geminates*

kap.pa	'a legendary being'
kit.te	'stamp'
gak.koo	'school'

   ii. *Homorganic nasal + obstruent*

tom.bo	'dragonfly'
non.do	'tranquil'
kaŋ.gae	'thought'
/jom + te/ → jonde	'reading'
/ʃin + te/ → ʃinde	'dying'

   iii. *Final mora nasal*

hoN	'book'
zeN	'goodness'

There are also languages in which place neutralization occurs only in a non-assimilatory fashion. As discussed in **Lombardi (2001b**, citing **Rice 1989**), non-sonorant consonants in Slave (Athabaskan) are realized as /h/ syllable-finally, as shown in (10a). Sonorants are like obstruents in having no place distinctions, although the exact final neutralization patterns are not the same. Syllable-final nasals delete, nasalizing the preceding vowel, and /j/ is the only possible coda among non-nasal sonorants. Another example of non-assimilatory place neutralization is from the Kelantan dialect of Malay (**Teoh 1988**). Final stops /k t p/ are realized as [ʔ], and final fricatives like /s/ as [h], as shown in (10b).

(10) *Final place neutralization* (from Lombardi 2001b)

a. *Slave*

i.	/ts'ad/	ts'ah	-ts'ade	'hat'
ii.	/xaz/	xah	-ɣaze	'scar'
iii.	/seeɣ/	seeh	-zeeɣe	'saliva'
	/tl'uɬ/	tl'uh	-tl'uɬe	'rope'

b. *Kelantan Malay*

i.	/ikat/	ikaʔ	'tie'
ii.	/səsak/	səsaʔ	'crowded'
iii.	/dakap/	dakaʔ	'embrace'
iv.	/tapis/	tapɪh	'to filter'

In these languages, contrasts of some features other than place can be maintained finally, for instance obstruents *vs.* sonorants in Slave and stops *vs.* fricatives in Kelantan Malay. But there are also many languages like Burmese in which all consonants are neutralized to [ʔ]. (See **Lombardi 2001b** and references therein for more details.)

In summary, as stated below, the preconsonantal C_1 is not only the typical target of assimilation, but also the typical target of the non-assimilatory neutralization. The word-final position is an additional typical target of the neutralization.

(11) *The* C_2 *dominance effect in (assimilatory and non-assimilatory) laryngeal and place neutralization*

Preconsonantal C_1 and word-final positions are common target positions.

It is usually the case that preconsonantal C_1 and word-final positions form a natural class, i.e. coda. Thus it is obvious that the prosody-based approach can provide a unified account of positional neutralizations of C_1 and word-final positions, attributing both cases to the coda—onset asymmetry. The cue-based approach also provides a somewhat unified account for the two common target positions based on the fact that the word-final position lacks C-to-V transition cues, just as preconsonantal C_1 does, and thus it has lower perceptibility compared to the prevocalic C_2 position. Consequently, the relatively common positional neutralization patterns presented thus far do not significantly distinguish the two approaches. In the remainder of this chapter, I will consider the patterns which crucially distinguish them.

4 Evidence for the cue-based approach

According to the prosody-based approach, neutralization contexts should be described in prosodic terms: for instance, "codas are the target of laryngeal neutralization." But, as discussed by **Steriade (1999)**, there are cases in which there is no consistent connection between neutralization sites and syllable structure.

First, there are languages in which neutralization targets only C_1, not word-final, positions. Languages in which laryngeal neutralization occurs only in C_1, not at the end of the word, include Yiddish, Romanian, Serbo-Croatian (**Lombardi 2001b**: 269), French, Hungarian, and Kolami (**Steriade 1999**). In addition, place neutralization of nasals occurs only in C_1, not at the end of the word, in Diola Fogny (**Sapir 1965**) and the Souletin dialect of Basque (**Hualde 1993**). Under the prosody-based approach, it is not clear why word-medial and final codas behave differently, and even less clear why medial codas are more likely to be targeted in the neutralization than word-final codas (see CHAPTER 36: FINAL CONSONANTS for more discussion). In contrast, in the cue-based approach, the asymmetry between preconsonantal C_1 and final positions may be derived from their relative perceptibility difference. C_1 may be considered less perceptible than word-final position, because stops in C_1, which overlap with consonants in C_2, are more likely to be unreleased, thus lacking the release burst and closure duration cues, than those in word-final position.[3]

Second, laryngeal neutralization targets C_1 only before obstruents, not before sonorants, regardless of its syllabic assignment in many languages, including Lithuanian, German, Russian, Greek, Sanskrit, Polish, Hungarian, and Kolami. Notice that it is possible that C_1 in intervocalic C_1C_2 clusters is syllabified as a coda when sonorant consonants occupy C_2, and its voicing contrast is then expected to be neutralized in the prosody-based approach. Also, it is usually the case that an obstruent is syllabified as an onset when it occurs as the first constituent of the word-initial clusters composed of obstruents, and then its voicing contrast is expected to be licensed in the prosody-based approach. These two expectations of the prosody-based approach are not satisfied in the languages mentioned above. For instance, in Lithuanian, where consonant clusters are heterosyllabic regardless of composition (e.g. /'auk.le/), voicing of obstruents may be contrastive in the coda when they occur before sonorants, as in (12c). The voicing of an obstruent is neutralized in the onset when it precedes another obstruent, as in (12b). Consequently, it is difficult to provide an adequate description of neutralization contexts in syllabic terms.

(12) *Lithuanian obstruents in clusters* (Steriade 1999)

		voiceless		*voiced*	
a.	licensed onsets	sam'gus	'cheerful'	žmo'gus	'man'
b.	neutralized onsets	spalva	'color'	'lizdas	'nest'
c.	licensed codas	aug.muo	'growth'	ak.muõ	'stone'
d.	neutralized codas	daũ[k]	'much'		

In contrast, to explain the difference in the likelihood of the neutralization between pre-obstruent and pre-sonorant positions, the cue-based approach may still rely on the perceptibility difference of the two positions. Specifically, the pre-obstruent position lacks the main contextual cues (VOT and other release-related cues), and thus is less perceptible than the pre-sonorant position, where the main cues can be maintained.

Finally, there are languages in which neutralization patterns are fixed despite the variable syllabification. As discussed by **Steriade (1999)**, for both Sanskrit and Ancient Greek syllable divisions in obstruent—sonorant clusters were variable, depending on "the dialect, the period, the literary style and the juncture separating the consonants." In contrast, there was no variation in the pattern of laryngeal neutralization: in styles or dialects where $VC_1.C_2V$ divisions were the norm for all clusters, laryngeal neutralization did not take place before heterosyllabic sonorants. This indicates that laryngeal features in these languages are neutralized irrespective of the syllabic affiliation of clusters, and thus the neutralization patterns cannot be adequately described in syllable terms.

The above patterns indicate that syllable positions like codas are neither a sufficient nor a necessary condition for the occurrence of neutralization. Codas are not a sufficient condition in the patterns in which only word-medial, as opposed to final, codas and pre-obstruent, as opposed to pre-sonorant, codas are neutralized. Codas are not a necessary condition in the patterns in which an obstruent onset in word-initial clusters is neutralized. Codas would be totally useless in describing the Sanskrit and Greek patterns with variable syllabification but fixed neutralization patterns. Consequently, all these patterns can be taken as evidence against the prosody-based approach and in favor of the cue-based approach.

4.2 Apical neutralization

As mentioned above, consonant place assimilation is predominantly regressive across languages. This strong cross-linguistic tendency toward regressive assimilation has been considered a subset case of the C_2 dominance effect in place

neutralization, as stated in (11) and repeated below as (13).

(13) *The C_2 dominance effect in (assimilatory and non-assimilatory) laryngeal and place neutralization*

Preconsonantal C_1 and word-final positions are common target positions.

The place neutralization typology displaying this C_2 dominance effect provides an important basis for the prosody-based approach's analysis of the coda—onset asymmetry. However, **Steriade (2001)** notes that this C_2 dominance effect in place neutralization is true only when contrasts between labials, alveolars, velars, and palato-alveolars (referred to by Steriade as *major C-Place contrasts*) are neutralized. In the case of the neutralization of contrasts between apico-alveolars and retroflexes (referred to by Steriade as *apical contrasts*), a completely opposite tendency is observed: postconsonantal C_2 and word-initial positions are typically targeted. Let us consider first assimilatory neutralization of apical contrasts and then non-assimilatory neutralization.

First, apical assimilation is typically progressive, as can be seen in (14). Notice that in both Sanskrit and Urali, postconsonantal C_2 alveolars in the underlying form are realized as retroflexes after post-vocalic C_1 retroflexes. Thus, apical assimilation targets C_2, not C_1, which is the opposite of major C-Place assimilation.

(14) *(Patterns of word-internal) apical assimilation* (Steriade 2001)

a. *Sanskrit*

/av-iḍ-dʰi/	[aviḍḍʰi]	'favor'
/ṣaṇ-na:m/	[ṣaṇṇa:m]	'of six'
/jyotiṣ-su/	[jyotiṣṣu]	'in planets'

b. *Urali*

/eṇ-nuuru/	[eṇṇuuru]	'hundred-8 = 800'
/keḍ-t-a-/	[keṭṭa-]	'spoil-INTRANS'

This C_1 dominance effect in apical assimilation seems as robust as the C_2 dominance effect in major C-Place assimilation, although the total number of cases of apical assimilation is relatively small. Based on a typological survey of apical assimilation, **Steriade (2001)** reached the conclusion that apical assimilation in clusters is predominantly progressive, and there is no exception to it when clusters belong to the same word and the two constituents of the clusters are identical in stricture (e.g. both stops).

Non-assimilatory neutralization of the apical contrast also targets the post-consonantal C_2, possibly along with word-initial positions. For instance, in Murinbata, alveolars and retroflexes contrast in both C_1 and word-final position. In contrast, the apical contrast is neutralized in postconsonantal C_2. Apicals in C_2 are always realized as alveolars after non-apicals, and as homorganic with an apical C_1. Thus, the non-assimilatory neutralization of the apical contrast targets C_2 in Muriṇbaṭa. Miriwung is just like Muriṇbaṭa, in that the apical contrast is maintained in C_1, but neutralized in C_2. Apical neutralization additionally occurs at the beginning of the word in which only alveolars, not retroflexes, are allowed to occur.

Consequently, the typical targets of apical neutralization may be summarized as below:

(15) *The C_1 dominance effect in (assimilatory and non-assimilatory) apical neutralization*

Postconsonantal C_2 and word-initial positions are common target positions.

This is therefore the complete opposite of the C_2 dominance effect in the neutralization patterns of laryngeality and major C-Places of articulation. Given that C_2 is usually an onset, the prosody-based approach cannot explain the C_1 dominance effect in apical neutralization in the same way as the C_2 dominance effect summarized in (13). In contrast, in the cue-based approach, the C_1 dominance effect may be derived naturally from the perception fact that cues to the apical distinction lie primarily in the V-to-C, not C-to-V, transitions, and thus C_1 is more prominent in the perception of the apical contrast than C_2. As discussed by **Steriade (2001)**, citing **Ladefoged and Maddieson (1986)**, **Dave (1976)**, **Stevens and Blumstein (1975)**, and **Bhat (1973)**, the formant transitions into retroflexes in C_1 show distinctively low F3 and F4 values, compared to those of denti-alveolars, whereas the transitions out of retroflexes in C_2 are not distinct from those of dentialveolars. This acoustic asymmetry originates from the characteristic articulation of retroflexes, in which the tongue tip moves forward during the closure and releases from the same constriction location as apico-alveolars.

Consequently, both the C_2 dominance effect in major C-Place assimilation and the C_1 dominance effect in apical assimilation

may be derived from the main argument of the cue-based approach, i.e. the neutralization targets positions which lack prominent perceptual cues to the contrasts in question. Thus, the apical neutralization typology may form very strong evidence for the cue-based approach by showing a case of contrast-specific neutralization. (See **Zhang's 2004** discussion of contour tone typology for an additional case of contrast-specific licensing/neutralization.)

5 Evidence for the prosody-based approach

5.1 Obstruent—sonorant clusters in Catalan

The cue-based approach provides a string-based, not prosody-based, account for positional neutralizations. If two sequences are segmentally identical, and thus not significantly different in the perceptibility involved, the cue-based approach expects the two to behave similarly with respect to neutralization even when they have different prosodic structures. Suppose that in obstruent—sonorant C_1C_2 clusters, the C_1 obstruent may be syllabified either as an onset or as a coda, depending on the environment. The cue-based approach expects that the C_1 obstruent will behave invariably with respect to positional neutralization, regardless of whether it is an onset or a coda. If, as predicted by the prosody-based approach, the C_1 is licensed when syllabified as an onset, but neutralized when syllabified as a coda, it will raise a serious problem for the cue-based approach. **Wheeler (2005)** shows that such a pattern exists in Catalan.

As shown in (16a, b), in Catalan, stops other than dentals are contrastive in voicing before liquids as well as glides, while sibilants are contrastive only before glides when the obstruent—sonorant sequences are within a word. However, sibilants are always voiced before liquids, as in (17a), and dentals are always voiced before laterals, as in (17b). There are no word-internal sibilant—liquid and dental—lateral sequences with distinct voicing values. In summary, in Catalan, although the voicing contrast of the C_1 obstruents in obstruent—sonorant sequences is in general licensed, sibilants and dentals are neutralized in voicing before liquids and laterals, respectively. In the cue-based approach, it is difficult to explain why some obstruent—sonorant sequences behave differently in voicing neutralization from other obstruent—sonorant sequences. In contrast, **Wheeler (2005)** argues that all obstruents with contrastive voicing in (16) occur in the onset whereas all with neutralized voicing in (17) occur in the coda.[4] Thus, the prosody-based approach can easily describe the voicing neutralization of obstruents in obstruent—sonorant sequences in Catalan.

(17) *Neutralized obstruent voicing in Catalan obstruent–sonorant clusters*

a. sibilant / __ liquid

voiced		*voiceless*
legislar [z.l]	'to legislate'	*none*
Israel [z.r] ~ [r]	'Israel'	

b. dental / __ lateral

voiced		*voiceless*
atleta [d.l]	'athlete'	*none*

Further, comparable active neutralization, which is even more difficult to explain within the cue-based approach, can be observed in the obstruent—sonorant sequences occurring across word boundaries. In Catalan, word-final obstruents assimilate in voicing to the following consonants including liquids. Word-final stops, which are voiceless before an initial vowel of the following word (18.ii), become voiced before an initial sonorant (18.i). Thus the C_1 obstruents here are neutralized with respect to voicing. This final obstruent neutralization would not be expected within the cue-based approach, since the same obstruent-sonorant sequences within a word are not subject to the voicing neutralization, as shown in (16a). So this is a case in which identical sequences behave differently with respect to neutralization, depending on where they occur. According to **Wheeler (2005)**, the only difference between the obstruent—sonorant sequences of (16a) and (18.i) is in syllabic affiliation: the C_1 obstruents in (16a) are onsets, whereas those in (18.i) are codas. Thus, only the prosody-based, not cue-based, approaches can explain the voicing patterns of obstruents in Catalan.

(18) *Neutralized obstruent voicing in Catalan obstruent sonorant clusters*

a. non-sibilant / __ #liquid

i.	*poc logic*	/ˈpɔk#əˈlɔʒik/	[ˈpɔg.ˈlɔʒik]	'not very logical'
ii.	*poc amable*		[ˈpɔ.kəˈmab.blə]	'not very friendly'

b. non-sibilant / __ #glide

i.	*poc whisky*	/ˈpɔk#ˈwiski/	[ˈpɔg.ˈwiski]	'not much whisky'
ii.	*poc usual*		[ˈpɔ.kuˈzwal]	'not very usual'

5.2 Obstruent—sonorant clusters in Eastern Andalusian Spanish

Eastern Andalusian Spanish shows an additional case in which sequences with similar perception cues behave differently in contrast distribution and neutralizing processes, thus posing a problem to the cue-based approach. The discussion of this section is mostly based on **Gerfen (2001)**.

As shown in (19), in Standard Peninsular Spanish, /s/ is allowed in pre-consonantal and word-final positions. In contrast, in Eastern Andalusian Spanish, /s/ is not allowed to occur in those positions. As shown in (20a), word-final /s/ deletes and aspirates the preceding vowel. Preconsonantal C_1 /s / also deletes but the deletion is accompanied by the gemination of the following C_2 consonant.

(19) */s/ in Standard Peninsular Spanish* (Gerfen 2001)

a.	word-final coda:	[ga.fas]	'eyeglasses'
b.	pre-C coda:	[gas.ko]	'helmet'

(20) */s/ in Eastern Andalusian Spanish* (Gerfen 2001)

a. *word-final coda*

/ganas/ [ga.na^h] 'desire'

b. *pre-C coda*

	SPS	*EAS*	
i.	[bos.ke]	[bo^{h}k.ke]	'forest'
ii.	[es.la.βo]	[e^{h}l.la.βo]	'Slavic'

The prosody-based approach can easily attribute the distributional restrictions of /s/ in Eastern Andalusian Spanish to a syllable coda restriction. In contrast, the Licensing-by-cue approach can adopt a string-based statement that /s/ is allowed to occur only before a vowel in Eastern Andalusian Spanish. But, as argued by **Gerfen (2001)**, this is hard to justify, since sibilants such as /s/ have very salient internal cues in the frication noise, and thus C-to-V transition cues would not be important in the perception of the presence or absence of /s/, unlike in the perception of laryngeal and place contrasts. Thus, there is no plausible phonetic motivation for such a string-based requirement, i.e. that a vowel must be present immediately after /s/, within the cue-based approach.

Gerfen discusses two more related patterns which are even more problematic for the cue-based approach. In Eastern Andalusian Spanish, the C_1 coda deletion (followed by the gemination of C_2) is not limited to /s/, but to all obstruents, as shown in (21) (see also CHAPTER 38: THE REPRESENTATION OF SC CLUSTERS).

(21) *Aspiration of all obstruent codas in Eastern Andalusian Spanish* (Gerfen 2001)

SPS	*EAS*	
[ap.to]	[a^{h}t.to]	'apt'
[piθ.ka]	[pi^{h}k.ka]	'pinch, small amount'
[ak.θjon]	[a^{h}θ.θjon] ([ahs.sjon])	'action'
[ob.tu.so]	[o^{h}t.tu.so]	'obtuse'

Notice that the C_1 obstruents in obstruent—liquid sequences, word-initially or medially, are not subject to this deletion, as shown in (22). In the prosody-based approach, this difference can be attributed to the coda—onset asymmetry: stop + liquid clusters are syllabified as onsets, thus resisting coda deletion, whereas obstruent clusters shown in (21) are syllabified as coda—onset sequences, and thus C_1 obstruents in the coda are subject to the deletion. In contrast, to explain the above difference between obstruent—obstruent and stop—liquid sequences, the cue-based approach would rely on the asymmetry

in perceptibility between pre-obstruent and pre-sonorant positions. Specifically, C_2 liquids may have richer perceptual cues to the preceding obstruents than C_2 obstruents.

(22) *Stop + liquid clusters in Eastern Andalusian Spanish* (Gerfen 2001)

a. *Initial stop + liquid clusters*
   i. [klaro] 'clear'
   ii. [grado] 'grade'
   iii. [plano] 'flat'
   iv. [trapo] 'rag'

b. *Word-internal obstruent + liquid clusters*
   i. [a.klara] 's/he/it clears up'
   ii. [a.grada] 's/he/it pleases'
   iii. [a.plana] 's/he/it applies'
   iv. [a.trapa] 's/he/it traps'

But it is still unclear why /sl/, an obstruent—liquid sequence, does not behave like stop—liquid sequences. As shown in (20b.ii), /s/ is subject to coda deletion before /l/. Also, as shown below, /tl/, a stop—liquid sequence, behaves like /sl/, not like /kl/ and /gl/. If rich perceptual cues to C_1 before a liquid can guarantee the surface realization of stop—liquid sequences like /kl/, /gr/, /pl/, and /tr/, it is difficult to understand why /tl/ and /sl/ cannot surface as such.

(23) /tl/ *clusters in Eastern Andalusian Spanish* (Gerfen 2001)

/atleta/ [a^{h}lleta] 'athlete'

To summarize, both Catalan and Eastern Andalusian Spanish show asymmetric patterns in which only a subset of obstruent—sonorant sequences is subject to the distributional restrictions and related alternations targeting an obstruent in C_1. For the analysis of these patterns, the prosody-based approach can still attribute the difference among the obstruent—sonorant sequences to the coda-onset asymmetry, but an equally plausible, string-based, solution seems to be unavailable in the cue-based approach. See **Kabak and Idsardi (2007)** for an additional support for the prosody-based, as opposed to the cue-based, approach. They investigated Korean listeners' perception of non-native sequences, and argue that only syllable-based, not string-based, phonotactic constraints can explain their experimental results.

6 Conclusion

From the literature on phonological typology, we know that it is common for phonological processes not to apply in all positions, and more generally for phonological contrasts not to be licensed in all positions. Such positional effects are characterized by reference to certain pairs of prominent and non-prominent positions such as word-initial *vs.* non-initial, stressed *vs.* unstressed, root *vs.* affix, and prevocalic C_2 *vs.* preconsonantal C_1 positions. Among these, this chapter has been mainly concerned with the C_2 dominance effect in which preconsonantal C_1 in intervocalic C_1C_2 clusters is likely to be targeted for neutralization, whereas prevocalic C_2 is likely to trigger or resist such neutralization. This C_2 dominance effect is quite robust in laryngeal and place neutralization and consonant deletion. I have looked at the relevant data patterns, ranging from well known and common to less known and relatively exceptional, while comparing the cue-based and prosody-based approaches. Common data patterns can be explained equally well by both approaches. In contrast, less common or somewhat exceptional patterns may distinguish the two approaches. However, the evidence so far is mixed. Not only neutralization patterns in which there is no connection between neutralization sites and syllable positions, but also apical neutralization patterns, may form evidence against the prosody-based approach. In contrast, obstruent—sonorant sequences in which the voicing of C_1 obstruent may be licensed or neutralized, arguably depending on syllable structure, may form evidence against the cue-based approach. Any adequate theory of positional effects, including the C_2 dominance effect, should be able to account for all these patterns, common or exceptional.

Notes

[1] In Korean, which has a three-way laryngeal contrast among obstruents, i.e. lenis, aspirated, and tense, lenis obstruents become tense after an obstruent (Post-obstruent tensing), and voiced between sonorants (Inter-sonorant voicing). See **Kim-Renaud (1986)** and **Ahn (1998)** for details of these automatic processes.

2 See **Steriade (1999)** for a discussion of the phonetic realization of the neutralized obstruents and **Blevins (2006)** for an in-depth discussion of final devoicing and the related survey.

3 **Blevins (2006**: 143) discusses data from Dhaasana, Chadic Araic, and Maltese in which devoicing occurs exclusively at

the end of the word, not in C_1 position. This word-final, but not syllable-final, devoicing can be a problem not only for the prosody-based approach but also for the cue-based approach.

4 Although Wheeler does not provide details of syllabification in Catalan, **Blevins (2003**: 399), who also argues that voicing neutralization in Catalan occurs syllable-finally, suggests that Catalan syllabification is quite predictable by stating that "Catalan syllabification judgments were entirely consistent across speakers."

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