

Voicing contrast: licensed by prosody or licensed by cue?

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In recent phonological work two approaches to neutralization have been developed, labelled *licensing by prosody* and *licensing by cue* (Steriade 1997). The licensing-by-prosody approach is developed by Beckman (1998) and Lombardi (1999, 2001). The central element is the universal difference between onsets and codas when it comes to realizing consonantal contrasts. Contrasts that may be realized in onsets may be neutralized in codas.

The licensing by-cue-approach is developed by Steriade (1997, 1999). This approach bases constraints licensing specific features not just on hierarchies derived from cross-linguistic typologies, but more specifically on differences in perceptual cues to be found in different phonetic contexts. Steriade (1997: 6) identifies seven phonetic properties known to be available as cues to voicing contrast in obstruent stops: closure voicing, closure duration, duration of preceding sonorant, F_1 values in preceding vowel, burst duration and amplitude, voicing onset time (VOT), and F_0 and F_1 values at onset of voicing in a following sonorant. On this basis V_V and V_Sonorant contexts favour voicing contrasts.

The licensing-by-cue approach is attractive since it seeks to explain the differential distribution of phonetic properties such as voicing directly in terms of the articulatory and perceptual characteristics of different phonetic environments. Licensing by prosody appeals rather to elements of prosodic organization —specifically, syllable structure— which is held to be psychologically real, but only indirectly manifest in the stream of speech. Steriade asks (1997: 50) ‘what would count as genuine evidence for syllable-final devoicing?’ She goes on: ‘The simple answer is: any system that allows us to compare voicing maintenance in onset O[obstruent]R [=sonorant] sequences with voicing neutralization in heterosyllabic O.R. Thus the hypothetical language ... distinguishes voiced obstruents in the OR sequences functioning as onsets, but neutralizes voicing in every other obstruent-C sequence, including in heterosyllabic O[.]R.’

I show that Catalan is a language that provides such evidence, as Steriade suspected. For example the word *poc* ‘little’ has the UR /pɔk/ and is realized [ˈpɔk] in utterance final position. However, the phrase *poc lògic* ‘not very logical’ must be realized with a voiced stop [ˌpɔg.ˈlɔ.ʒik]. In such a phrase /k/ is in coda position, where voicing is neutralized, and any coda obstruent agrees in voice with a following consonant. This is so despite the fact that /kɫ-/ , like /gɫ-/ , is a well-formed sequence in Catalan, *provided it is in onset position* —as in *clar* [ˈkla] ‘clear’ versus *gla* [ˈgla] ‘acorn’; *tecla* [ˈte.klə] ‘key’ versus *regla* [ˈreg.glə] ~ [ˈre.ɣlə] ‘rule’. I also give an account of the constraint ranking that governs postlexical resyllabification, which means that a phrase like *poc lògic* may not be resyllabified *[ˌpɔ.ˈkɫɔʒik] to preserve input voiceless /k/. The conclusion is that the theoretical option of licensing by prosody, in the case of voicing contrasts, must be retained.

1. Introduction

It is a familiar fact that phonological contrasts are often not available in all positions—we find neutralization of contrast in certain environments. Nasal place neutralization before obstruents is very familiar, as is vowel reduction: the neutralization of vowel quality contrasts in unstressed syllables. Contrasts of laryngeal features are well known to be subject to neutralization in various languages. Among such laryngeal features are aspiration, glottalization, and voicing: German, Polish and Russian are familiar as languages that do not license voicing contrasts in word-final position. A question for phonologists is: how are the positions in which voicing neutralization takes place cross-linguistically to be characterized? Or equivalently, how can we characterize the positions in which contrast is licensed?

2. Licensing by prosody

The established approach to voicing is to characterize the neutralizing environment by referring to elements of the prosodic hierarchy. Voicing neutralization is observed in *final position in the prosodic word*, or, more generally, *in coda position*. (Similarly, in the case of alveolar-obstruent flapping in American English, the context can be identified as *medially within the prosodic foot*.) This approach has been developed within OT by Beckman (1998) and Lombardi (1999, 2001), for example. The central element is the universal difference between onsets and codas when it comes to realizing consonantal contrasts. Contrasts that may be realized in onsets may be neutralized in codas. Coda laryngeal contrasts are typologically more marked than onset laryngeal contrasts. This approach has been labelled *licensing by prosody* by Steriade (1997). It seeks to formalize for phonological descriptions the typological implicational universals in (1).

- (1) a. The presence of voiced obstruents in an inventory implies the presence of voiceless obstruents.
 b. Voice contrast in codas implies voice contrast in onsets.

From an OT perspective, the difference between the environments can be interpreted as *positional* faithfulness. Faithfulness (to underlying featural specifications such as $[\pm\text{voice}]$) in onsets outranks Markedness constraints which penalize the realization of features, either generally, or in specific contexts such as codas. The flavour of this approach within OT can be illustrated by table (2) from Beckman (1998: §1.3.3), in which the constraint rankings derive from typological universals such as those in (1).

(2) Voicing contrast and neutralization: Licensing by prosody

Ranking	Result
*VOICEDOBSTR	Free-standing coda obstruents must be voiceless.
IDENT _{Onset} [voice] » *VOICEDOBSTR	Onset obstruents may be voiced or voiceless.
AGREE[voice] » *VOICEDOBSTR	Clusters agree in voicing, even if voiced obstruents are derived from underlying voiceless segments.
AGREE[voice] » IDENT[voice]	Clusters agree in voicing, even if deviations from the underlying [voice] specifications are required.
IDENT _{Onset} [voice] » IDENT[voice]	When unfaithfulness is compelled, coda obstruents, rather than onsets, will be unfaithful.

(after Beckman 1998 §1.3.3)

3. Licensing by cue

The licensing-by-cue approach is developed by Steriade (1997, 1999, 2001) and Blevins (2003), and is applied to Catalan voicing neutralization and assimilation by Llach (1998). This approach aims to base constraints licensing specific features not just on hierarchies derived from cross-linguistic typologies, but more specifically on differences in perceptual cues to be found in different phonetic contexts. Steriade convincingly shows that, although, for many features, onsets provide better cues than codas (because many consonant contrasts such as place or voicing are strongly signalled in consonant-vowel transitions, or more generally in consonant-sonorant transitions), other features, for example retroflexion or pre-aspiration, are preferentially signalled in vowel-consonant transitions, that is, typically in codas. Steriade (1997: 6) identifies seven phonetic properties known to be available as cues to voicing contrast in obstruent stops:

- (3) Phonetic properties known to be available as cues to voicing contrast in obstruent stops (Steriade 1997: 6)
1. Closure voicing
 2. Closure duration
 3. Duration of preceding sonorant
 4. F₁ values in preceding sonorant
 5. Burst duration and amplitude
 6. Voicing onset time (VOT)
 7. F₀ and F₁ values at onset of voicing in a following sonorant

Table (4) (after Steriade 1997: 6) indicates which of these features are available for obstruent stops in a series of contexts.

(4) Availability in various contexts of cues to obstruent voicing contrast (after Steriade 1997: 6)

Context	Internal cues		Offset cues		Onset cues		
	Closure voicing	Closure duration	Son ₁ duration	F ₁ values in Son ₁	Burst duration/ amplitude	VOT	F ₀ and F ₁ transitions to Son ₂
Son ₁ __Son ₂	✓	✓	✓	✓	✓	✓	✓
Obs__Son ₂	✓	✓			✓	✓	✓
#__Son ₂	✓				✓	✓	✓
Son ₁ __#	✓	✓	✓	✓	(✓)		
Son ₁ __Obs	✓	✓	✓	✓			
Obs__Obs	✓	✓					
Obs__#	✓	✓					
#__Obs	✓						

Son₁ = preceding sonorant; Son₂ = following sonorant; Obs = obstruent.

Although as a general rule, more cues are better than fewer cues, Steriade remarks (1997: 9) that the cues should also be weighted, inasmuch as evidence suggests that onset cues have primacy over offset cues, and also over a combination of offset and internal cues. This ‘weighted cue’ approach is what is supported by the cross-linguistic implicational hierarchy of contexts for obstruent stop voicing contrasts reported by Steriade (1997: 8) which runs as in (5).

(5) Cross-linguistic implicational hierarchy of contexts for obstruent stop voicing contrasts (Steriade 1997: 8)

#__Obs, Obs__# ⊃ Son__Obs ⊃ Son__# ⊃ #__Son ⊃ Son__Son
 e.g. bsa vs psa, absa vs apsa ab vs ap ba vs pa aba vs apa
 asb vs asp

In (4) and (5) Sonorant includes both vowels and sonorant consonants. Steriade also investigates differences between vowels and sonorant consonants in the facilitation of cues to voicing in a preceding obstruent (though her investigation does not make a distinction among sonorants between nasals and liquids). Based on comparison of various Polish and Russian sequences, she concludes that a perceptibility scale can be established distinguishing three contexts:

- (6) Voicing perceptibility context scale (Steriade 1997: 30-36)
- (a) a following V, RV or syllabic R (where R = sonorant consonant)
 - (b) a following R# (word-final sonorant)
 - (c) a following non-syllabic R and another obstruent (RO).

Neither Russian nor Polish neutralizes voice in context (a); in context (b) Polish neutralizes but Russian does not; in context (c), both Russian and Polish neutralize.

As regards different classes of following sonorants, Llach observes in her account of stop onset cues that following nasals obscure the cues without masking them altogether, while following liquids behave much the same as vowels do in this respect. In particular, she notes that opening the velum lowers the oral pressure and reduces the stop burst, while the low intensity of the nasal segment and the presence of antiformants may mask the remaining onset cues. That is to say, we should expect an implication for obstruent stop voicing contrasts between the different $_Son$ contexts: as in (7).

- (7) Implication for obstruent stop voicing contrasts between the different $_Son$ contexts
(after Llach 1998: 27-28)
- $$_Nasal \supset _Liquid, _Vowel$$

A further issue to investigate from the licensing-by-cue perspective is that of the direction of voicing assimilation. If we consider just obstruent sequences for the moment, we will want to express the fact that sequences dissimilar in voicing, such as [kz] or [gs] are more marked than sequences of the same voicing: [ks], [gz]. This markedness will follow from the implicational observation: if a language has obstruent clusters disagreeing in voicing, then it also has clusters agreeing in voicing, but not conversely (Greenberg 1978). So we have a universal markedness constraint hierarchy (8).

- (8) Universal markedness constraint hierarchy for voicing within obstruent clusters
(Greenberg 1978)
- $$*[\alpha\text{voice}, -\text{son}][-\alpha\text{voice}, -\text{son}] \gg *[\alpha\text{voice}, -\text{son}][\alpha\text{voice}, -\text{son}]$$

Given (8), I further need to explain why regressive voicing assimilation is less marked than progressive assimilation. This, in fact, follows from the greater strength of onset voicing cues than offset voicing cues (see (4) above, and Steriade 2001: 35-36; 1997: 43-44). Deriving the hierarchy again from the cues, the following ranking (9) is seen, in which faith to pre-sonorant voice outranks faith to pre-obstruent voice.

- (9) a. Unmarked regressive voicing assimilation in obstruent clusters: faith to pre-sonorant voice outranks faith to pre-obstruent voice

IDENT[±voice]/__[+son] » IDENT[±voice]/__[-son]

- b. /kzV/ : [gzV] > [ksV]
 /gsV/ : [ksV] > [gzV]

Given inputs /kzV/ and /gsV/, the markedness constraint * $[\alpha\text{voice}, -\text{son}][-\alpha\text{voice}, -\text{son}]$ ('no voice contour in obstruent clusters'), together with the ranking in (9) will declare the respective outputs [gzV] and [ksV] superior to the progressively assimilated [ksV] and [gzV], as is appropriate.

The licensing-by-cue approach is, in principle, an attractive one, since it seeks to explain the differential distribution of phonetic properties—in this case voicing—directly in terms of different phonetic environments, considering their articulatory and perceptual characteristics. It is properties of these environments that favour or disfavour the realization of voicing contrasts, or the direction and extent of voicing assimilation. Licensing by prosody appeals rather to elements of prosodic organization—specifically, syllable structure—which is held to be psychologically real, but which is only indirectly manifest in the stream of speech. Of course, there is good evidence that syllable structure is itself organized on the basis of contrast cues. However, syllable organization is one step removed from the data that motivate it. It would not be surprising, then, if prosodic structure were organized on the basis of generalizations from contextual cues, but came to have properties that were partly independent of the phonetic facts that originally motivated them (Blevins 2003: 390-392). Comparing the two approaches, Steriade asks (1997: 50):

- (10) 'What would count as genuine evidence for syllable-final devoicing? ... The simple answer is: any system that allows us to compare voicing maintenance in onset O[bstruent]R [=sonorant] sequences with voicing neutralization in heterosyllabic O.R. Thus the hypothetical language ... distinguishes voiced obstruents in the OR sequences functioning as onsets, but neutralizes voicing in every other obstruent-C sequence, including in heterosyllabic O[.]R' (Steriade (1997: 50)

She mentions Catalan in a footnote at this point as such a possible language, but does not pursue the issue in the absence to her of sufficient data. It will be seen that Catalan does indeed illustrate the syllable-final devoicing pattern (strictly, syllable-final voicing neutralization) whose existence she seeks to cast doubt on.

4. Voice contrast and neutralization in Catalan

4.1 Obstruent voice contrast

NB lenition: voiced non-strident obstruents are realized as fricatives between continuants.

(11) Obstruent voice contrasts before vowels

	_vowel	
	Voiceless	Voiced
Labial non-strident	<i>pota</i> [ˈpotə] ‘paw’	<i>bota</i> [ˈbotə] ~ [ˈβotə] ‘barrel’
Dental non-strident	<i>tona</i> [ˈtonə] ‘ton’	<i>dóna</i> [ˈdonə] ~ [ˈðonə] ‘woman’
Velar non-strident	<i>cas</i> [ˈkas] ‘case’	<i>gas</i> [ˈgas] ~ [ˈɣas] ‘gas’
Alveolar strident	<i>sona</i> [ˈsɔnə] ‘sounds’	<i>zona</i> [ˈzonə] ‘zone’
Alveolo-palatal strident	<i>xerra</i> [ˈʃerə] ‘chatters’	<i>gerra</i> [ˈʒerə] ‘jar’
	<i>metxa</i> [ˈmetʃə] ‘wick’	<i>metge</i> [ˈmeddʒə] ‘doctor’

(12) Obstruent voice contrasts before liquids and glides

	_liquid, _glide	
	Voiceless	Voiced
Labial	<i>prou</i> [ˈprɔw] ‘enough’	<i>brou</i> [ˈbrɔw] ~ [ˈβrɔw] ‘broth’
non-	<i>sempre</i> [ˈsem.prə] ‘always’	<i>sembra</i> [ˈsem.brə] ‘sows’
strident	<i>plau</i> [ˈplaw] ‘pleases’	<i>blau</i> [ˈblaw] ~ [ˈβlaw] ‘blue’
	<i>simple</i> [ˈsim.plə] ‘easy’	<i>sembla</i> [ˈsem.blə] ‘seems’
	<i>sípia</i> [ˈsi.pjə] ‘cuttlefish’	<i>ràbia</i> [ˈra.βjə] ‘rage’
Dental	<i>truita</i> [ˈtruj.tə] ‘trout’	<i>druida</i> [ˈdruj.ðə] ~ [ˈðruj.ðə] ‘druid’
non-	<i>centre</i> [ˈsen.trə] ‘centre’	<i>cendra</i> [ˈsen.drə] ‘ash’
strident	<i>llàntia</i> [ˈlan.tjə] ‘lamp’	<i>òndia!</i> [ˈɔn.djə] ‘gosh!’
Velar	<i>creu</i> [ˈkrew] ‘cross’	<i>greu</i> [ˈgrew] ~ [ˈɣrew] ‘serious’
non-	<i>pollancre</i> [puˈlan.krə] ‘poplar’	<i>congre</i> [ˈkon.ɡrə] ‘conger’
strident	<i>classe</i> [ˈklasə] ‘class’	<i>glaça</i> [ˈglasə] ~ [ˈɣlasə] ‘freezes’
	<i>oncle</i> [ˈoŋ.klə] ‘uncle’	<i>ungla</i> [ˈuŋ.ɡlə] ‘nail’
	<i>qualla</i> [ˈkwa.lə] ‘congeals’	<i>guatlla</i> [ˈgwa.l.lə] ~ [ˈɣwa.l.lə] ‘quail’
	<i>propinqua</i> [pruˈpin.kwə] ‘nearby’	<i>llengua</i> [ˈlen.ɡwə] ‘tongue’
Alveolar strident	<i>gràcia</i> [ˈgra.sjə] ‘humour’	<i>afàsia</i> [əˈfa.zjə] ‘aphasia’

4.2. Obstruent voice neutralization

In environments different from those illustrated in (11)-(12) there is neutralization of voice contrasts in obstruents. This neutralization has major morphophonemic consequences when obstruents stand in word-final position (alternating with contrasting obstruents in prevocalic onset position). In (13) are examples of word-final neutralization of voicing in obstruents. The forms in the left hand column, in which the stem is followed by a vowel-initial suffix, demonstrate the underlying voice value.

(13) Word-final neutralization of voicing contrast

	Contrast / __ V	Neutralization/ __ #
/b/	<i>sabem</i> [sə'βɛm] 'know.1PL.PRS.IND'	<i>sap</i> ['sap] 'knows'
/p/	<i>tipa</i> ['ti.pə] 'fed up.F'	<i>tip</i> ['tip] 'fed up.M'
/d/	<i>verda</i> ['bɛr.ðə] 'green.F'	<i>verd</i> ['bɛrt] 'green.M'
/t/	<i>forta</i> ['fɔr.tə] 'strong.F'	<i>fort</i> ['fɔrt] 'strong.M'
/g/	<i>fangós</i> [fəŋ'gos] 'muddy'	<i>fang</i> ['faŋ(k)] 'mud'
/k/	<i>ronca</i> ['roŋ.kə] 'hoarse.F'	<i>ronc</i> ['roŋ(k)] 'hoarse.M'
/z/	<i>casos</i> ['ka.zus] 'cases'	<i>cas</i> ['kas] 'case'
/s/	<i>braços</i> ['bra.sus] 'arms'	<i>braç</i> ['bras] 'arm'
/dʒ/	<i>mitja</i> ['mid.ðʒə] 'half.F'	<i>mig</i> ['mitʃ] 'half.M'
/tʃ/	<i>despatxos</i> [dəs'pat.tʃus] 'offices'	<i>despatx</i> [dəs'patʃ] 'office'

Examples of voice neutralization of obstruents in internal codas are given in (14); (14a) shows obstruents before obstruents, (14b) shows obstruents before nasals.

(14) Medial neutralization of voicing contrast before obstruents (a), and nasals (b)

Observe that in all of (14a-b) coda obstruents agree in voicing with a following onset consonant.

	Neutralization / __ voiceless obstruent	Neutralization / __ voiced obstruent
a.	<i>dubte</i> [p.t] 'doubt'	<i>súbdit</i> [b.d] 'subject'
	<i>capsa</i> [p.s] 'box'	
	<i>adscriure</i> [ts.k] 'assign'	<i>objecte</i> [b.ʒ] 'object'
	<i>acte</i> [k.t] 'act'	<i>futbol</i> [d.b] 'football'
	<i>sexe</i> [k.s] 'sex'	<i>addició</i> [d.d] 'addiction'
	<i>crespa</i> [s.p] 'curly.F'	<i>maragda</i> [g.d] 'emerald'
	<i>esfera</i> [s.f] 'sphere'	<i>eczema</i> [g.z] 'eczema'
	<i>tastar</i> [s.t] 'to taste'	<i>bisbe</i> [z.β] 'bishop'
	<i>fosca</i> [s.k] 'dark.F'	<i>esvera</i> [z.v] ~ [z.β] 'terrifies'
		<i>esdrúixol</i> [z.ð] 'proparoxytone'
		<i>pelasga</i> [z.ɣ] 'Pelasgian'
	Neutralization / __ [n]	Neutralization / __ [m]
b.	<i>hipnosi</i> [b.n] 'hypnosis'	<i>submarí</i> [b.m] 'submarine'
	<i>ètnic</i> [d.n] 'ethnic'	<i>ritme</i> [d.m] 'rhythm'
	<i>signe</i> [g.n] 'sign'	<i>dracma</i> [g.m] 'drachma'
	<i>esnob</i> [z.n] 'snob'	<i>maresma</i> [z.m] 'salt marsh'

Exactly the same pattern of voicing assimilation as in (14) is also seen in sandhi consonant groups, in contiguous words, whether in phrases or in compounds (15). Assimilatory voicing spreads in word-final obstruent clusters (16).

(15) Neutralization before consonant-initial words

Neutralization / __#voiceless

sap cantar [p.k] ‘knows how to sing’*m'ha fet pregar* [t.p] ~ [p.p] ‘has made me ask’*llarg camí* [k.k] ‘long road’*buf calent* [f.k] ‘warm puff’*cas terrible* [s.t] ‘terrible case’*mateix fil* [ʃ.f] ‘same thread’*mig cru* [tʃ.k] ‘half raw’Neutralization / __#voiced obstruents,
nasals*sap demanar* [b.d] ‘knows how to ask’*m'ha fet llegir* [d.ʎ] ~ [ʎ.ʎ] ‘has made me read’*llarg de cames* [g.d] ‘long-legged’*buf d'aire* [v.ð] ‘puff of air’*cas notable* [z.n] ‘remarkable case’*mateix dia* [ʒ.ð] ‘same day’*migdia* [dʒ.ð] ‘midday’

(16) Voicing agreement in word-final clusters

cops amagats [ˈkɔb.zəməˈgats] ‘hidden blows’*pots ajudar* [ˈpɔd.dʒəʒuˈða] ‘may.2SG help’*llargs anys* [ˈʎarg.ˈzajs] ‘long years’*saps limitar* [ˈsabs.limiˈta] ‘know.2SG.PRS.IND how to restrict’*saps nedar* [ˈsabs.nəˈða] ‘know.2SG.PRS.IND how to swim’*pots triar* [ˈpɔts.triˈa] ‘may.2SG choose’*llargs períodes* [ˈʎarks.pəˈriuðəs] ‘long periods’**4.3. Interpreting voicing contrast and neutralization**

Observe that all the data in (11)-(16) is consistent with either a licensing-by-prosody account, or a licensing-by-cue account. In the first case, we say voice contrast is licensed in syllable onsets but not in codas. In the second case, we say voicing contrast is licensed by the presence of a following phonetic context with sufficient cues to voicing, namely, before vowels, glides and liquids. On the basis of this data alone, then, it would be legitimate to prefer the licensing-by-cue account, on the grounds that it offers a better founded explanation, in which the effect is linked to the cause.

There is one context of neutralization that offers a superficial challenge to the licensing-by-cue account. Word-final obstruent neutralization is maintained in sandhi environments before a word-initial vowel, despite the fact that vowels should license voice contrast in a preceding obstruent. Indeed the fact that a final consonant is resyllabified as an onset means that some account different from both licensing by cue and licensing by prosody is required here.

- (17) Obstruent neutralization before word-initial vowel: non-sibilants → voiceless, sibilants → voiced (the latter not illustrated, though the effect is visible in (16))

Contrast before internal vowel (cf. (12))	Word-final neutralization	Neutralization before initial vowel
Voiced non-sibilant obstruent / __+V	Voiceless obstruent / __#	Voiceless non-sibilant obstruent / __#V
/b/ <i>sabem</i> [sə ¹ βɛm] ‘know.1PL.PRS.IND’	<i>sap</i> [ˈsap] ‘knows’	<i>sap ajudar</i> [ˈsa.pəʒu ¹ ða] ‘knows how to help’
/d/ <i>podem</i> [pu ¹ ðɛm] ‘can.1PL.PRS.IND’	<i>pot</i> [ˈpɔt] ‘can.3SG’	<i>pot ajudar</i> [ˈpɔ.təʒu ¹ ða] ‘may.3SG help’
/g/ <i>llarga</i> [ˈʎar.γə] ‘long.F’	<i>llarg</i> [ˈʎark] ‘long.M’	<i>llarg any</i> [ˈʎar.ˈkaŋ] ‘long year’
Voiceless sibilant / __+V		Voiced sibilant / __#V
b. /s/ <i>braços</i> [ˈbra.sus] ‘arms’	<i>braç</i> [ˈbras] ‘arm’	<i>braç esquerre</i> [ˈbra.zəs ¹ kɛrə] ‘left arm’
/ʃ/ <i>mateixa</i> [mə ¹ teʃə] ‘same.F’	<i>mateix</i> [mə ¹ teʃ] ‘same.M’	<i>mateix element</i> [mə ¹ te.ʒələ ¹ men] ‘same element’
/tʃ/ <i>despatxos</i> [dəs ¹ pat.ʃus] ‘offices’	<i>despatx</i> [dəs ¹ patʃ]	<i>despatx elegant</i> [dəs ¹ pad.ɔʒələ ¹ ʎan] ‘smart office’

Neutralized word-final voiceless non-sibilant obstruents are maintained in pre-vocalic position in sandhi (17a), in spite of the opportunity provided by the phonetic context for reintroducing voicing contrast. This phenomenon without doubt illustrates an output-output correspondence effect governed by the Word-Phrase correspondence constraint in (18a). [The question of voicing of sibilants in this environment is considered in chap. 5 of Wheeler (2005).] The IDENT_{Wd-Phr}[±voice] constraint outranks any faithfulness constraint that might prefer underlying voicing to surface in a prevocalic environment, or indeed in an onset, e.g. (18b). The constraints in (18c) and (18d) are the ones governing resyllabification. ONSET (18c) favours resyllabification, at least to a sufficient degree. SYLLABIC UNIFORMITY (18d) is the correspondence constraint that opposes resyllabification.

- (18) a. IDENT_{Wd-Phr}[voice]: The value for [voice] in an element of a Phonological Phrase is the same as that of its correspondent in a Phonological Word.
- b. IDENT_{I-O}[voice]/__[+approx] (Underlying voice is preserved in an environment with adequately rich cues, namely, before vowels, glides, liquids.)
- c. ONSET: A syllable has an onset.
- d. SYLLABIC UNIFORMITY (UNIFORM_σ): The syllabic organization of elements of a Phonological Phrase is the same as the syllabic organization of the corresponding elements in Phonological Words (after Jiménez 1999)

The Word-Phrase correspondence constraint $\text{IDENT}_{\text{Wd-Phr}}[\text{voice}]$ (18a) is seen to outrank the I-O faithfulness constraint $\text{IDENT}_{\text{I-O}}[\text{voice}]/__[+\text{approx}]$ (18b) in the case of a word-final neutralized stop before a vowel-initial word, as in the example from (17) *sap ajudar* ‘knows how to help’. The ranking of the constraints in (18) is illustrated in tableau (19) (which also includes $\text{IDENT}_{\text{I-O}}[\text{voice}]$ for completeness). Though the prevocalic, onset, position of the root-final bilabial obstruent /b/ is one that could, in principle, permit the realization of underlying voicing, it is in fact realized as a voiceless stop, as corresponds to the citation or utterance-final form *sap* [‘sap]. Thus this output, with neutralization in an environment favourable to voice contrast (onset, prevocalic) is explainable for reasons independent of either the prosodic or the phonetic environment. The resyllabification into Onset of a word-final neutralized obstruent shows, incidentally, why the details of Beckman’s ‘positional faithfulness’ approach (with $\text{IDENT}_{\text{Onset}}[\text{voice}] \gg \text{IDENT}[\text{voice}]$) do not transfer to the Catalan case, provided we acknowledge that syllabification is a surface output property, rather than an input property (to which an output might or might not be faithful).

(19)

<i>sap ajudar</i> ‘knows how to help’ /‘sab#aʒu‘dar/ [‘sap] + [əʒu‘ða]		ONSET	$\text{IDENT}_{\text{Wd-Phr}}[\text{voice}]$	$\text{IDENT}_{\text{I-O}}[\text{voice}]/__[+\text{approx}]$	UNIFORM σ	$\text{IDENT}_{\text{I-O}}[\text{voice}]$
a.	☞ 'sa.p əʒu'ða			*	*	*
b.	'sa.b əʒu'ða		*!		*	
c.	'sab. əʒu'ða	*!	*			
d.	'sap. əʒu'ða	*!		*		*

$\text{ONSET}, \text{IDENT}_{\text{Wd-Phr}}[\text{voice}] \gg \text{IDENT}_{\text{I-O}}[\text{voice}]/__[+\text{approx}], \text{UNIFORM}\sigma$

However, further facts of the distribution of voiced and voiceless obstruents in Catalan do indeed indicate, as Steriade suspected, that one cannot rely on a cues-based approach, to the exclusion of a prosodic approach. The examples in (20) are relevant here.

(20) Neutralization of voicing contrasts in cue-rich environments

- Neutralization / __ [l] Neutralization / __ [r]
- a. *legislar* [z.l] ‘to legislate’ *Israel* [z.r] ~ [r] ‘Israel’
atleta [d.l] ‘athlete’
- i.e. no voicing contrasts /sl/ – /zl/, /sr/ – /zr/, /tl/ – /dl/,
b. */.sl/, */.zl/, */.sr/, */.zr/
c. */.tl/, */.dl/

There are no voicing contrasts of sibilants before liquids: /sl/ – /zl/ /sr/ – /zr/, or of dentals before laterals /tl/ – /dl/; only the voiced obstruent occurs. Other obstruents do contrast before liquids, as seen in (12).¹ Since we have already observed that in Catalan a following liquid offers adequate cues to license a voicing contrast, the licensing-by-cue approach prompts us to look for characteristics of alveolar sibilants to explain why they might not adequately distinguish voice before liquids, or characteristics of dental obstruents to explain why they might not adequately distinguish voice before laterals. But this seems entirely to miss the point. The segment sequences admitting obstruent voicing contrasts in Catalan are all and only those that can occur in onsets. The sequences of (20b) do not occur in onsets inasmuch as no cluster of a sibilant and a consonant appears in a Catalan onset. Of course, it is legitimate to seek an explanation of why such onset sequences are ill-formed. But there is no reason at all to think it has anything to do with the realizability of voicing contrasts. Similarly the absence of dental–lateral onsets like those of (20c) in Catalan also requires an account — interaction of place and manner seems to be involved— but potential for voicing contrast does not plausibly contribute.

The relevant and distinctive fact about the absence of voicing contrast in clusters with liquids of the type in (20) is that they are all syllabified as coda+onset, whereas all those of (12) are syllabified as complex onsets. Catalan does not allow contrastive voice in codas in any circumstances. A plausible reason for not allowing contrastive voice in codas is that *in general* coda environments offer poor cues (or weaker cues) to voicing, since prototypical codas necessarily lack most or all of the privileged onset cues listed in (4). Languages can not unnaturally generalize to prosodic contexts as a whole, abstracting from the more specific phonetic facts which directly license contrasts.

¹ Blevins (2003: 391-392) acknowledges that this distribution of voicing contrast and neutralization favours a licensing-by-prosody account of the Catalan facts.

An even more telling point against exclusive reliance on a licensing-by-cue account arises from the sandhi data in (21). Within words, most clusters with a liquid or a glide as second element permit a voicing contrast, inasmuch as they are syllabified as onsets, as shown earlier by the data in (12). But when such sequences of obstruent + liquid or glide arise in sandhi the obstruent remains in a coda, and has to be voiced (agreeing with the voicing of a following onset consonant). This is so despite violation of Word-Phrase correspondence, which has already been seen to be a high-ranking constraint in (20). Observe that glides are included among the voiced consonants triggering voicing assimilation of final stops, even though glides have the same articulatory characteristics as high vowels in Catalan. Thus the difference between two outcomes of obstruent stop neutralization in word-final position — voiceless before vowels, voiced before glides— must be attributed entirely to the prosodic difference, which is the only difference present.

(21) Voicing neutralization before word-initial liquids and glides

a. Neutralization / __#voiced liquids

- sap riure* /'sab#riwrə/ ['sab.'riwrə] ‘knows how to laugh’
 (cf. *sap ajudar* ['sa.pəzu'ða] ‘knows how to help’)
poc lògic /'pək#lɔʒik/ ['pɔg.'lɔʒik] ‘not very logical’
 (cf. *poc amable* ['pɔ.kə'mab.blə] ‘not very friendly’)
mateix líquid [ʒ.l] ‘same liquid’

b. Neutralization / __#voiced glides

- poc whisky* /pək#wiski/ ['pɔg.'wiski] ‘not much whisky’
 (cf. *poc usual* ['pɔ.ku'zwal] ‘not very usual’)
poc iogurt /'pək#jugurt/ ['pɔg.ju'ɣurt] ‘not much yoghurt’
 (cf. *poc irònic* ['pɔ.ki'rɔnik] ‘not very ironic’)

4.4. Accounting for voicing neutralization in cues-rich sandhi environments in Catalan

At first thought it might look as if all that is required to account for the word-final voicing data in (21) is to rank the constraint AGREE[voice] ‘clusters agree in voicing’ as in (2) above the correspondence constraint IDENT_{Wd-Phr}[voice] (18a). This would work as in the tableau (22), which also includes segmental markedness constraints that penalize voiceless sonorants and voiced obstruents, together with some candidates that violate them.

(22)

	AGREE[voice]	*[-vce, +son]	ONSET	IDENT _{Wd-Phr} [voice]	UNIFORM σ	IDENT _{I-o} [voice]/__ [+approx]	*[+vce, -son]
<i>poc lògic</i> 'not very logical' /'pɔk# ^l lɔʒik/ ['pɔk] + ['lɔʒik]							
a. 'pɔk.'lɔʒik	*!						*
b. 'pɔg.'lɔʒik				*		*	**
c. 'pɔk.'lɔʒik		*!		*		*	*
d. 'pɔ.'gɫɔʒik				*	*!	*	**
e. 'pɔ.'kɫɔʒik		*!		*	*	*	*
f. 'pɔ.'klɔʒik	*!				*		*

AGREE[voice] » IDENT_{Wd-Phr}[voice] (» IDENT_{I-o}[voice]/__ [+approx])

In tableau (22) candidate (22b) has one violation of IDENT_{Wd-Phr}[voice] inasmuch as the word ['pɔk] is realized as ['pɔg]. Candidate (22c) has an equivalent violation in that ['lɔʒik] is realized with an initial voiceless liquid [ɫ]. The same candidates violate input-output faithfulness in the same way, since in the word *poc* /k/ is underlying. However, the constraint ranking in (22) cannot be correct: AGREE[voice] together with *[-vce, +son] standing above faithfulness would rule out all onset clusters involving a voiceless obstruent and an approximant consonant. These are precisely the clusters that are quite grammatical, in syllable onsets (12).

What (22) shows is that the correspondence constraint IDENT_{Wd-Phr}[voice] (19a) must be outranked by the *some*-voicing assimilation constraint, but it cannot be simply AGREE[voice] 'clusters agree in voicing'. What exactly needs to agree in voicing? It would be attractive to adopt the licensing-by-cue perspective on voicing assimilation, using constraints of the form of (23).

(23) * $[\alpha\text{voice}, -\text{son}][-\alpha\text{voice}, -\text{son}]$ 'adjacent obstruents agree in voice' (Steriade 2001: 33)

Indeed, this particular constraint (23) is, in fact undominated in Catalan, as illustrated in (14) and (16). The direction of voicing assimilation in obstruent clusters would follow from

constraints enforcing the underlying voice of the second obstruent, in a pre-sonorant position that licenses contrast preservation, or before unmarked word-final voiceless. But such a constraint is not sufficient for the cases in (21) where obstruents assimilate in voicing not only to other obstruents but also to sonorant consonants. In Catalan, an obstruent agrees with a following segment in voicing not only before another obstruent, but also before a nasal, before a liquid, and, indeed before a glide, *provided the obstruent is in a coda*. This is what the examples in (14), (15), (16), (20) and (21) show. By contrast, no obstruent that is in an onset has to agree in voicing with a following segment. Thus, as far as voicing agreement is concerned, the context of the constraint relevant to Catalan is ineluctably prosodic. It is also undominated; that is, there are no surface exceptions. The required constraint is formulated in (24).

- (24) AGREECoda[voice]: *[-son, αvoice]_{Coda}[-αvoice] (A coda obstruent and a following segment must agree in voicing.)

Note that syllabification of the ‘following segment’ is unspecified, so voice agreement spreads in codas.

The role of AGREECoda[voice] is illustrated in tableau (25) with a revised account of *poc lògic* from (22).

(25)

	AGREECoda[voice]	*[-vce, +son]	ONSET	UNIFORMσ	IDENT _{Wd-Phr} [voice]	IDENT _{T-o} [voice]/_ [+approx]	*[+vce, -son]
a. <i>poc lògic</i> ‘not very logical’ /pək#lɔʒik/ [pək] + [lɔʒik]							
a. 'pək.lɔʒik	*!						*
b. ↗ 'pəg.lɔʒik					*	*	**
c. 'pək.lɔʒik		*!			*	*	*
d. 'pə.glɔʒik				*!	*	*	**
e. 'pə.klɔʒik		*!		*	*	*	*
f. 'pə.klɔʒik				*!			*

AGREECoda[voice], *[-vce, +son], UNIFORMσ » IDENT_{Wd-Phr}[voice]

Now in (25) it is AGREECoda[voice] that eliminates candidate (25a) which is faithful both to underlying voicelessness and to the voicelessness of the coda of the phonological word *poc*

[¹pək]. The resyllabified candidates, (25d) and (25f), both with and without voice assimilation, are eliminated by SYLLABIC UNIFORMITY, which is seen to outrank IDENT_{Wd-Phr}[voice] (otherwise resyllabified (25f) would win). This reranking, relative to what was proposed in (19) reveals that ONSET outranks IDENT_{Wd-Phr}[voice]. Thus the corrected constraint ranking for word-final prevocalic voice neutralization illustrated previously in (19) is now as in (26i), with the basic word-final voice neutralization shown in (26.ii).

(26) i.

		AGREECoda[voice]	*[-vce, +son]	ONSET	UNIFORMσ	IDENT _{Wd-Phr} [voice]	IDENT _{I-O} [voice]/__[+approx]	*[+vce, -son]	IDENT _{I-O} [voice]
a.	[☞] 'sa.p əʒu'ðə				*		*	**	*
b.	'sa.b əʒu'ðə				*	*!		***	
c.	'sab. əʒu'ðə			*!		*		***	
d.	'sap. əʒu'ðə	*!		*			*	**	*
ii.	<i>sap</i> 'knows' /'sab#/								
a.	'sab							*!	
b.	[☞] 'sap								*

AGREECoda[voice], *[-vce, +son], ONSET » UNIFORMσ » IDENT_{Wd-Phr}[voice] » IDENT_{I-O}[voice]/__[+approx] » [*vce, -son] » IDENT_{I-O}[voice]

5. Conclusion

The distribution of voiced and voiceless obstruents in Catalan displays precisely those effects that Steriade identified as requiring a licensing-by-prosody account. Catalan distinguishes voiced obstruents in the obstruent–sonorant sequences functioning as onsets, but neutralizes voicing in every other obstruent-C sequence, including in heterosyllabic obstruent–sonorant sequences. Thus licensing by prosody has not been shown to be reducible to licensing by cue in all cases, even though such a move is attractive where the facts permit.

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