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Apparent 'sufficiently similar' degemination in Catalan is due to coalescence

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Abstract. Cameron et al. (2010) and Fruehwald & Gorman (2011) present the pattern of homorganic consonant cluster reduction in Catalan as a challenge to Baković's (2005) theory of antigemination, which predicts that any feature ignored in the determination of consonant identity for the purposes of antigemination in a given language must independently assimilate in that language. I argue that the pattern in Catalan is not a counterexample to this prediction if the reduction process is analyzed as coalescence, following Wheeler (2005), rather than as deletion.

Keywords. antigemination; assimilation; identity; coalescence; deletion; Catalan

1. Introduction. Some languages exhibit patterns that may be described as the avoidance of adjacent consonants that are 'sufficiently similar'. A simple and familiar example of such a pattern is found in the allomorphy of the English past tense suffix. This suffix is realized as voiced [d] after voiced obstruents, sonorant consonants, and vowels, as shown by the examples in (1)a.[1] When attached to a stem ending in a 'sufficiently similar' consonant /t/ or /d/, there is epenthesis of a vowel between the consonants, as shown by the examples in (1)b. To describe the conditions that effect epenthesis in this case, it appears that 'sufficient similarity' must be defined as 'identical, except that differences in voicing may be ignored'.

(1) English past tense allomorphy

a.	/weɪv+d/	→	[weɪvd]	'waved'
	/weɪn+d/	→	[weɪnd]	'waned'
	/weɪ+d/	→	[weɪd]	'weighed'
b.	/weɪd+d/	→	[weɪdəd]	'waded'
	/weɪt+d/	→	[weɪtəd]	'waited'
c.	/sæp+d/	→	[sæpt]	'sapped'
	/sæk+d/	→	[sækt]	'sacked'

The examples in (1)c further show that the past tense suffix also assimilates in terms of voicing to a preceding stem-final voiceless obstruent. The epenthesis process specifically ignores voicing and the assimilation process specifically acts on this same feature, which led me to claim in Baković (2005) that patterns of 'sufficiently similar' adjacent consonant avoidance involve an interaction between *completely identical* adjacent consonant avoidance and assimilation.

Specifically, the claim is that voicing is ignored by epenthesis (1)b *because* voicing independently assimilates (1)c; if not for epenthesis, near-identical /…t+d/ *would otherwise be expected* to assimilate, becoming identical *[…tt]. In other words, there's no need to describe the conditions that effect epenthesis in terms of 'sufficient similarity' because the applicability of voicing assimilation independently accounts for the sufficiency of all-but-voicing identity.

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[1] Because there is a contrast between word-final /t/ and /d/ after sonorant consonants (e.g. [weɪnd] 'waned' vs. [peɪnt] 'paint') and vowels (e.g. [weɪd] 'weighed' vs. [weɪt] 'weight'), the underlying representation of the past tense suffix is standardly taken to be voiced /d/.

This dependency between ‘sufficient similarity’ avoidance and assimilation critically requires parallel comparison of the outputs of assimilation and epenthesis as in Optimality Theory. The tableaux in (3) summarize the analysis; the constraints are first defined in (2).

(2) Constraints

NO-GEM:	Assign a violation to each pair of adjacent identical consonants (= geminate).
AGREE(voi):	Assign a violation to each pair of adjacent obstruents that disagree in voicing.
DEP-V:	Assign a violation to each output vowel lacking an input correspondent.
IDENT(voi):	Assign a violation to each pair of input-output correspondents that disagree in voicing.

The tableau in (3)a, illustrating identity avoidance (/…d+d/ → […dəd]), establishes that NO-GEM dominates DEP-V and that either AGREE(voi) or IDENT(voi) also dominates DEP-V. The tableau in (3)b, illustrating assimilation (/…p+d/ → […pt]), establishes that both AGREE(voi) and DEP-V dominate IDENT(voi); this resolves the disjunction from the tableau in (3)a, further establishing that AGREE(voi) dominates DEP-V. Note that this final ranking automatically renders the right result in the tableau in (3)c, illustrating similarity avoidance (/…t+d/ → […təd]), without the need to appeal to ‘sufficient similarity’ directly. In short, ‘sufficient similarity’ results from the joint satisfaction of NO-GEM, strictly penalizing identity, and AGREE(voi), penalizing disagreement in terms of the feature that is ignored in the calculation of ‘sufficient similarity’.

(3) Tableaux for English past tense suffix allomorphy

a. *Identity avoidance* /…d+d/	NO-GEM	AGREE(voi)	DEP-V	IDENT(voi)	***Remarks***
☞ […dəd]			*		epenthesis
[…dt]		W	L	W	devoicing
[…dd]	W		L		faithful

b. *Assimilation* /…p+d/	NO-GEM	AGREE(voi)	DEP-V	IDENT(voi)	***Remarks***
☞ […pt]				*	devoicing
[…pd]		W		L	faithful
[…pəd]			W	L	epenthesis

c. *Similarity avoidance* /…t+d/	NO-GEM	AGREE(voi)	DEP-V	IDENT(voi)	***Remarks***
☞ […təd]			*		epenthesis
[…tt]	W		L	W	devoicing
[…td]		W	L		faithful

2. Further support. Other attested cases of apparent ‘sufficient similarity’ avoidance support this analysis, and the typology of patterns predicted by the free interaction of the key constraint types hews closely to the descriptive typology provided by Odden (1988).

2.1. ENGLISH PLURAL. Consider the allomorphy of the English plural suffix, where both voicing and anteriority are ignored in avoidance of adjacent sibilants: stems ending in /s, z, ʃ, ʒ, ʧ, ʤ/

followed by the plural /z/ undergo epenthesis.[2] Anteriority is only contrastive among sibilants, but as Baković & Kilpatrick (2005) demonstrate using static palatography, the past tense suffix in *mashed* [mæʃt̠] is significantly more retracted than it is in *(a)massed* [mæst]. This suggests that anteriority also independently assimilates in related contexts in English, due to a further ranking of constraints analogous to those required for voicing assimilation: AGREE(ant) over IDENT(ant). The full ranking of relevant constraints in English is thus as shown in (4).

(4) English ranking

AGREE(voi) NO-GEM AGREE(ant)

DEP-V

IDENT(voi) IDENT(ant)

2.2. LITHUANIAN VERBAL PREFIXES. Consider also the allomorphy of the Lithuanian verbal prefixes /at/ and /ap/ (Baković 2005, 2007). These assimilate in voicing (/at/ → [ad], /ap/ → [ab]), palatalization (/at/ → [at^j], /ap/ → [ap^j]), or both (/at/ → [ad^j], /ap/ → [ab^j]), but there is epenthesis of a vowel (/at/ → [at^ji], /ap/ → [ap^ji])[3] when the following stem-initial consonant is one of the 'sufficiently similar' consonants /t, d, t^j, d^j/ (in the case of /at/) or /p, b, p^j, b^j/ (in the case of /ap/). The full ranking of relevant constraints accounting for identity avoidance, assimilation, and 'sufficient similarity' avoidance in Lithuanian is thus as shown in (5).[4]

(5) Lithuanian ranking

AGREE(voi) NO-GEM AGREE(pal)

DEP-V

IDENT(voi) IDENT(pal)

2.3. POLISH PROCLITICS. A somewhat more complex and interesting case is the allomorphy of the Polish proclitics /z/ and /v/ (Pająk & Baković 2010). Both proclitics assimilate in voicing (/z/ → [s], /v/ → [f]), and /z/ also optionally assimilates in coronal place (/z/ → [ʐ] or [ʑ]) or both voicing and coronal place (/z/ → [ʂ] or [ɕ]). There is epenthesis of a vowel (/z/ → [zɛ], /v/ → [vɛ]) when a following cluster-initial consonant[5] is 'sufficiently similar' — i.e., when it differs from the proclitic consonant at most in voicing and, in the case of /z/, coronal place. And, because coronal place assimilation is optional, epenthesis is also optional in 'sufficiently similar' contexts where coronal place assimilation would have been expected. Pająk & Baković (2010) call this *contingent optionality*, and analyze it with a cloned AGR(cor-pl) constraint that is activated in its higher-ranked position by the conditions that favor assimilation and/or epenthesis, as the case

[2] We assume here that the trailing edges of the affricate /ʧ, ʤ/ are identical to the corresponding fricatives /ʃ, ʒ/ in all relevant respects, as reflected in the IPA transcription of affricates as stop+fricative articulations.

[3] Because the epenthetic vowel is high front /i/, there is automatic palatalization of the prefix consonant before it.

[4] As first noted by Albright & Flemming (2013) and discussed further by Adler & Zymet (2016), the fact that there are two assimilating features here (and in the English plural suffix case above and the Polish proclitic case below) means that this analysis represents a case of 'irreducible parallelism' in the sense of McCarthy (2013).

[5] The fact that the consonant must be cluster-initial motivates the more specific NO-GEM+C constraint shown in (6). See Pająk & Baković (2010) and also Pająk (2009, 2013) for more discussion.

may be. The full ranking of relevant constraints accounting for identity avoidance, assimilation, 'sufficient similarity' avoidance, and the optionality of the latter two in Polish is shown in (6).

(6) Polish ranking

AGREE(voi) NO-GEM+C AGR(cor-pl)

DEP-V

IDENT(voi) IDENT(cor-pl)

AGR(cor-pl)

2.4. FACTORIAL TYPOLOGY. Baković (2005) further shows that Odden's (1988) full catalog of patterns of 'antigemination' (= triggering of epenthesis or blocking of deletion *that specifically avoids* identical or 'sufficiently similar' adjacent consonants) and 'anti-antigemination' (= triggering of epenthesis or blocking of deletion *that specifically creates* identical or 'sufficiently similar' adjacent consonants) is generated by the factorial typology of the key constraints called on in this analysis. The relevant parts of the factorial typology are summarized in (7).

(7) Factorial typology of constraint types in Baković (2005)

Epenthesis patterns		*Deletion patterns*	
insert *only if* Cs are similar[a]	∃AGR NO-G ΣID DEP-V ΣAGR ∃ID	delete *unless* Cs are similar[e]	∃AGR NO-G ΣID NO-V ΣAGR MAX-V ∃ID
insert *only if* Cs are identical[b]	NO-G ∀ID DEP ∀AGR	delete *unless* Cs are identical[f]	NO-G ∀ID NO-V MAX-V ∀AGR
insert *unless* Cs are identical[c]	∀AGR ∀ID DEP-V NO-G	delete *only if* Cs are identical[g]	∀AGR ∀ID NO-V MAX-V NO-G
insert *unless* Cs are similar[d]	ΣAGR ΣID ∃ID DEP-V NO-G ∃AGR ΣAGR ΣID ∃AGR DEP-V NO-G ∃ID	delete *only if* Cs are similar[h]	ΣAGR ΣID ∃ID NO-V NO-G MAX-V ∃AGR ΣAGR ΣID ∃AGR NO-V NO-G MAX-V ∃ID
[a]English/Lithuanian/Polish; Modern Hebrew. [b]Tondano (lexical). [c]Tondano (postlexical). [d]Yir Yoront. [e]Hindi. [f]Afar. [g]Maliseet-Passamaquoddy. [h]Telugu (top), Koya (bottom).			

For the epenthesis patterns summarized on the left-hand side of (7), the constraint types are NO-GEM, AGREE, IDENT, and DEP-V; for the deletion patterns summarized on the right-hand side, DEP-V is replaced by the corresponding faithfulness constraint penalizing vowel deletion (MAX-V) and a stand-in for a markedness constraint favoring vowel deletion (NO-V). '∀X' means 'all constraints of type X', '∃X' means 'some constraint(s) of type X', and 'ΣX' means 'remaining constraints of type X'; these prefixes also function as mutually-binding variables such that, for example, '∃AGREE' and '∃IDENT' in the same ranking diagram denote pairs of such constraints mentioning the same feature; e.g., AGREE(voi) and IDENT(voi), and so on.[6]

3. Strong claim and prediction. The positive results of the foregoing analyses lead to the strong claim that 'sufficiently similar' antigemination is *always* enforced by joint satisfaction of both the total-identity antigemination-driving constraint NO-GEM and assimilation-driving constraints like AGREE(*f*), where *f* is any feature ignored in the determination of adjacent consonant identity. The prediction of this claim is that for any feature *f* ignored for the purposes of 'sufficiently similar' antigemination, *f* must independently assimilate in relevant contexts.[7] A challenge to this prediction would be a language in which 'sufficiently similar' adjacent consonants are avoided, but there is no evidence of assimilation in the relevant set of contexts.

4. The challenge. Cameron et al. (2010) and Fruehwald & Gorman (2011) independently present the pattern of homorganic consonant cluster reduction in Catalan as a challenge to the prediction just noted. The relevant pattern is this: word-final obstruents in Catalan appear to be deleted after homorganic sonorants (8)a, but not after heterorganic sonorants (8)b.

(8) Catalan homorganic cluster reduction

a.	/alt/	→ [al]	'tall (m. sg.)'	*cf.* [altə]	'tall (f. sg.)'
	/kuɾt/	→ [kuɾ]	'short (m. sg.)'	*cf.* [kuɾtə]	'short (f. sg.)'
	/blaŋk/	→ [blaŋ]	'white (m. sg.)'	*cf.* [blaŋkə]	'white (f. sg.)'
	/pɾufund/	→ [pɾufun]	'deep (m. sg.)'	*cf.* [pɾufundə]	'deep (f. sg.)'
b.	/əskeɾp/	→ [əskeɾp]	'shy'		
	/pɔɾk/	→ [pɔɾk]	'pig'		

The argument can be summarized as follows. If the avoidance of homorganic clusters in (8)a counts as an example of 'sufficiently similar' antigemination in the relevant sense, then NO-GEM and AGREE(¬pl) (where '¬pl' is a shorthand for 'all non-place features') must be satisfied at the expense of the anti-deletion constraint MAX-C. Therefore, it must be the case that both NO-GEM and AGREE(¬pl) dominate MAX-C. But if AGREE(¬pl) dominates MAX-C, then heterorganic (= 'sufficiently *dis*similar') clusters are independently expected to be avoided by assimilation, under the further ranking of MAX-C above IDENT(¬pl). Heterorganic clusters are clearly *not* avoided, by assimilation or otherwise, as evidenced by (8)b. Therefore, we incorrectly predict the pattern of 'sufficiently similar' antigemination in Catalan to be impossible, contrary to fact.

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[6] Note that the four sets of rankings at the bottom of the table in (7) are somewhat more articulated than the corresponding rankings given in Baković (2005). The availability of ever more sophisticated tools for studying factorial typologies in OT (e.g. Prince, Tesar, & Merchant 2007-2017) makes it possible to improve on past results.

[7] Furthermore, any conditions on completely identical antigemination or on *f*-assimilation will also be conditions on 'sufficiently similar' antigemination. Thus in Polish, the fact that completely identical antigemination only applies before other consonants (hence NO-GEM+C in (6)) means that 'sufficiently similar' antigemination also only applies before other consonants; likewise, the fact that coronal place assimilation is optional means that 'sufficiently similar' antigemination is also optional (in contexts where coronal place assimilation is otherwise expected to apply).

5. Analysis. The challenge presented by the Catalan pattern in (8) relies on the assumption that the process responsible for consonant cluster reduction in (8)a is deletion of the second consonant, violating MAX-C. However, Wheeler (2005) convincingly argues that the responsible process is not deletion but *coalescence* of the two underlying consonants to one on the surface.

In addition to violating a faithfulness constraint penalizing many-to-one correspondence (UNIFORMITY), a coalescence mapping /x_1y_2/ → [$z_{1,2}$] violates IDENT(f) for every f on which /x_1/ and /y_2/ differ (Keer 1999). This formal fact about coalescence mappings thus has the power to impose a similarity requirement on coalescence that is reminiscent of, but entirely independent of, the requirement imposed by the NO-GEM + AGREE(f) analysis of 'sufficiently similar' anti-gemination reviewed in §§1-3 above: for every IDENT(f) that dominates the coalescence-driving markedness constraint, two consonants that differ by f will not coalesce.

For Catalan, the coalescence-driving markedness constraint is one against syllable-final consonant clusters, called NO-CC$ here. Coalescence rather than deletion is compelled by both NO-CC$ and MAX-C being ranked above UNIFORMITY. The restriction to homorganic clusters is due to IDENT(pl) being ranked higher than NO-CC$, which together with MAX-C is in turn ranked higher than IDENT(¬pl) (again, where '¬pl' is a shorthand for 'all non-place features').

The following tableaux illustrate the analysis of homorganic cluster coalescence (9) and tolerance of NO-CC$ violation due to faithful realization in the case of heterorganic clusters (10).

(9) Coalescence of homorganic clusters

	/al$_1$t$_2$/	MAX-C	IDENT(pl)	NO-CC$	IDENT(¬pl)	UNIF	***Remarks***
☞	al$_{1,2}$				*	*	coalescence
	al$_1$t$_2$			W	L	L	faithful
	al$_1$	W			L	L	deletion

(10) Faithful realization of heterorganic clusters

	/əskeɾ$_1$p$_2$/	MAX-C	IDENT(pl)	NO-CC$	IDENT(¬pl)	UNIF	***Remarks***
☞	əskeɾ$_1$p$_2$			*			faithful
	əskeɾ$_{1,2}$		W	L	W	W	coalescence
	əskeɾ$_1$	W		L			deletion

It is thus not the avoidance of (near-)identity that is principally at stake in the analysis of Catalan; it is the avoidance of heterorganic coalescence. Looked at another way, the avoidance of 'sufficiently similar' adjacent consonants evidenced in English, Lithuanian, Polish, and so on requires identity up to but not including the ignored (because assimilating) feature(s), whereas the avoidance of coalescence evidenced in Catalan simply requires disagreement in terms of place features. The analysis in (9)-(10) does not implicate any AGREE(f) constraints (nor NO-GEM, for that matter); therefore, the prediction noted in §3 does not apply in this case.

6. Feature value preservation. The main reason why it is possible (and tempting) to analyze the Catalan case in terms of deletion of the second consonant is because only the feature values of the first consonant are preserved in the output. In a coalescence map /x_1y_2/ → [$z_{1,2}$], any feature values shared between /x_1/ and /y_2/ will survive in [$z_{1,2}$], but for each feature value that differs between /x_1/ and /y_2/, some decision about which value to preserve in [$z_{1,2}$] must be made. There is thus no *a priori* guarantee that all and only the feature values of one of the two input segments will be preserved in the coalesced output, as they are in Catalan.

I propose to make sense of why only the features of the first consonant are preserved in Catalan in terms of Steriade's (2008) licensing by cue framework. Specifically, I maintain here that whether the value of a given f is retained in [$z_{1,2}$] from /x_1/ or from /y_2/ depends on which *input context* provides better cues for f. In Catalan, the values of all features from the first input consonant will be retained in the coalesced form because the first input consonant is the one that is all-around better-cued in its postvocalic position; by contrast, the second input consonant is very poorly-cued in between the rock of the preceding consonant and the hard place of the following word boundary. In the output, of course, the coalesced correspondent for both of these input consonants is in the coveted postvocalic position.[8] I thus propose that the relevant cue-based faithfulness constraint schema, IDENT(f)/V__, is defined as follows.

(11) IDENT(f)/V__: Assign a violation to each pair of input-output correspondents (i, o) such that both i and o are preceded by a vowel and disagree in voicing.

The requirement that *both* the output segment *and* (one of) its input correspondent(s) be preceded by a vowel in order to be subject to this cue-based faithfulness constraint guarantees that the postvocalic input consonant's feature values are preserved at the expense of any disagreeing feature values of the word-final input consonant with which it coalesces, regardless of the ranking of each cue-based IDENT(f)/V__ constraint relative to its more general/stringent IDENT(f) counterpart. This is illustrated in the tableau in (12).

(12) Preservation of postvocalic feature values in coalescence

/al_1t_2/	IDENT(f)/V__	IDENT(f)	***Remarks***
☞ $al_{1,2}$		***	all postvocalic features faithful
$at_{1,2}$	W		no postvocalic features faithful
$ad_{1,2}$	W		some postvocalic features faithful

Suppose that the input consonants /l_1/ and /t_2/ here differ in terms of their values for the three non-place features [±son], [±lat], and [±voi]. The optimal coalescence candidate [$al_{1,2}$], preserving all of the feature values of the postvocalic input consonant, satisfies all cue-based constraints but violates three of their more general counterparts, IDENT(son), IDENT(lat), and IDENT(voi). The first alternative coalescence candidate [$at_{1,2}$], preserving all of the feature values of the word-final input consonant, still violates IDENT(son), IDENT(lat), and IDENT(voi) and in addition violates each of their cue-based counterparts, IDENT(son)/V__, IDENT(lat)/V__, and IDENT(voi)/V__. The second alternative coalescence candidate [$ad_{1,2}$], attempting to split the difference between the two input consonants' feature values, still violates IDENT(son), IDENT(lat), and IDENT(voi) and in addition violates two of their cue-based counterparts, IDENT(son)/V__ and IDENT(lat)/V__. Thus there is no choice but to preserve all of the feature values of the better-cued consonant, no matter how the cue-based and general faithfulness constraints are ranked.

It is perhaps important to point out that the other examples we have discussed in this paper must also involve reference to cue-based faithfulness constraints, or at least some equivalent. In English, for example, the postconsonantal, word-final suffix consonants assimilate to preceding

[8] Thanks to Joe Pater for challenging me on this particular point.

stem consonants that are in better-cued postvocalic contexts. In Lithuanian, the postvocalic, preconsonantal prefix consonants assimilate to following stem consonants that are in better-cued prevocalic contexts. And in Polish, the word-initial, preconsonantal proclitic consonants assimilate to following stem consonants that are in better-cued prevocalic contexts. All three of these examples are consistent with the proposed definition of cue-based constraints in (11), assessing faithfulness only between correspondents that are both in the same well-cued position.

7. Conclusion. Homorganic consonant cluster reduction in Catalan appears to pose a challenge to Baković's (2005) NO-GEM + AGREE(f) analysis of 'sufficiently similar' antigemination, that any feature(s) ignored for the purposes of 'sufficiently similar' antigemination independently assimilate in the relevant set of contexts. However, once reduction is properly understood as coalescence rather than as deletion, as already argued by Wheeler (2005), the challenge vanishes. This is because reduction-as-coalescence measures relative similarity in its own way: features ignored for the purposes of 'sufficient similarity' are regulated by IDENT(f) constraints ranked lower than the markedness driver of coalescence (NO-CC$ in our analysis); other IDENT(f) constraints are ranked higher. The strong claim and prediction of Baković (2005) thus hold, but what we've learned from this challenge is that the prediction can technically be circumvented at least to the extent that coalescence is available as an alternative analysis to degemination as deletion.

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