

MID FRONT VOWEL LOWERING BEFORE RHOTICS IN IBERO-ROMANCE

TRAVIS G. BRADLEY
University of California, Davis

This paper surveys the distribution of mid front vowels before rhotics in five different varieties of Ibero-Romance and identifies typological patterns of vowel lowering. An analysis is proposed in Optimality Theory that employs a fixed ranking of phonetically grounded markedness constraints against closed mid front /e/ in different pre-rhotic contexts, organized in an implicational hierarchy. Faithfulness constraints on vowel place features interact with this ranking to generate a factorial typology of /e/-lowering that matches the distribution observed in the data and makes predictions about possible and impossible languages. The paper also discusses theoretical implications for the status of intervocalic trills in Ibero-Romance as singleton versus geminate segments.

1. *Introduction*

Across languages, liquids can interact with an adjacent vocalic nucleus in different types of phonological processes or sound changes, e.g. deletion of coda liquids with coloring, lowering, or lengthening of the preceding vowel. In recent experimental work based on ultrasound imaging, Proctor (2009) shows that coronal liquids in Spanish and Russian involve the coordination of a primary consonant-like tongue tip gesture with a secondary vowel-like tongue body gesture. For example, the Spanish tap /r/, trill /r/, and lateral /l/ have in common a dorsal articulatory component whereas the stop /d/ is produced with a tongue tip gesture alone. A characterization of the class of liquids in terms of the coordination of articulatory gestures (Browman & Goldstein 1989) provides a phonetically motivated explanation of vowel-liquid interactions, which can be understood as the consequence of overlap and blending of the adjacent tongue body gestures of the vowel and the liquid.

This paper investigates a particular case of vowel lowering in Ibero-Romance, whereby closed mid front /e/ becomes open /ɛ/ or low /a/ before rhotics in different phonological contexts. I survey the distribution of mid front vowels in Castilian Spanish, Aragonese, Astur-Leonese, Judeo-Spanish, and Central Catalan. The data reveal an implicational hierarchy of contexts, shown in (1), where lowering in position x entails lowering in position y iff $y < x$.

$$(1) \quad _rV < _r[+cor] < _r[-cor] < _rV$$

Drawing upon laboratory work on Ibero-Romance rhotics, I show how the hierarchy in (1) is phonetically grounded in the articulatory properties of vowel-rhotic sequences. In the framework of Optimality Theory (OT; Prince & Smolensky 1993/2004), this hierarchy is formalized as a fixed ranking of markedness constraints against the adjacent tongue body gestures of closed mid front /e/ and a following rhotic in different contexts. These constraints interact with faithfulness constraints on vowel place features to generate patterns of mid front vowel lowering, which match the distribution presented in the empirical survey.

The OT analysis of vowel lowering has theoretical implications for the phonological representation of the intervocalic tap-trill contrast in Ibero-Romance. Some researchers analyze the trill in [VrV] sequences as an underlying singleton, /VrV/, while others propose a geminate structure, /VrrV/. In accordance with OT's Richness of The Base, the present analysis is compatible with either input representation. An alternative account of Catalan by Wheeler (2005) assumes the geminate but cannot account for all of the languages in the typological survey.

2. Mid front vowel lowering in Ibero-Romance

2.1 Data

Castilian Spanish (CS) has a five-vowel inventory /i,e,a,o,u/ which includes the closed mid vowels /e,o/ but not open /ɛ,ɔ/. In the early 1900s, the renowned Spanish phonetician Tomás Navarro Tomás claimed that non-low vowels in CS exhibit open allophones in contact with [r], before [x], and in certain types of closed syllables and diphthongs (Navarro Tomás 1918:§52). Since then, experimental studies using spectrographic analysis have shown mid vowel realizations to be much more variable and less systematic than originally claimed. In an acoustic study of mid vowel production by two CS speakers from Madrid, Morrison (2004) finds little statistical support for Navarro Tomás's distribution of open versus closed allophones of /e/ and /o/. However, /e/ is found to have an open-retracted allophone before prevocalic trills and after word-initial trills (e.g. /pera/ "bitch" and /reta/ "s/he challenges"), which Morrison (2004:34) attributes to coarticulation: "the tip of the tongue is raised and the tongue dorsum lowered in order to articulate the apicoalveolar trill, and this tongue configuration affects the articulation of the vowel." Using articulatory measurements from electropalatography, Martínez Celdrán & Fernández Planas (2007:183-188) find that CS /e/ does involve greater palatal contact in those contexts described by Navarro Tomás as favoring the closed allophones. However, these articulatory differences are not reflected in the

acoustic record, which may explain the failure of previous spectrographic studies to confirm his description of mid vowel allophony.¹

Aragonese and Astur-Leonese developed as Ibero-Romance languages in the eastern and western regions, respectively, of the northern dialect continuum of the Iberian Peninsula (Hualde 2005:281-293). Both languages share the five-vowel inventory of CS. Quintana (2001:168, 2006:67) cites examples from Aragonese of /e/ lowering to /a/ before prevocalic trills in several lexical items (2a) and toponyms (2b).

(2)	<u>Aragonese</u>	<u>CS</u>	
a.	<i>tarraza, tarriego, tarrau</i>	<i>terraza</i>	“terrace”
	<i>zarralla</i>	<i>cerrojo</i>	“bolt”
b.	<i>Sarrato, Sarato, Sarratón,</i>		
	<i>Sarrambiana, Sarrataz,</i>		
	<i>Sarratello, Sarratolito</i>		

Also attested in Aragonese is the tendency, most likely of Basque origin, to insert /a/ before word-initial trills (Quintana 2001:170). This tendency was carried through in many varieties of Judeo-Spanish (JS), as shown by the examples in (3). It is significant that epenthesis favors /a/ in this context, since otherwise /e/ is the preferred epenthetic vowel: JS *esfuelto, esfuego, esfuelo* versus CS *suelto* “loose”, *suegro* “father-in-law”, *suelo* “ground” (see Bradley 2009 on JS /e/-epenthesis).

(3)	<u>JS</u>	<u>CS</u>	
	<i>arrasgar</i>	<i>rasgar</i>	“to tear, rip”
	<i>arraskar</i>	<i>rascar</i>	“to scratch”
	<i>arredondear</i>	<i>redondear</i>	“to round up”
	<i>arrefreskar</i>	<i>refrescar</i>	“to cool”
	<i>arregar</i>	<i>regar</i>	“to water”
	<i>arrepozar</i>	<i>reposar</i>	“to rest”

Examples of /e/-lowering before prevocalic trills are observed in Astur-Leonese (4). Quintana (2006:67) cites only two examples of lowering before taps followed by noncoronal consonants, i.e. *sarbilleta* “napkin”, *xargón* “straw mattress” (cf. CS *servilleta, jergón*), and none illustrating precoronal

¹ The lowering of mid vowels is attested in Southern Peninsular Spanish before word-final /s/, which is frequently deleted in popular speech (Hualde 2005:130). There are also alternations between mid and low vowels in Italian (Lepschy & Lepschy 1977). A full treatment of these cases is beyond the scope of the present paper, whose focus is on /e/-lowering in pre-rhotic contexts in Ibero-Romance.

contexts. To be sure, more data are needed to know the fuller distribution of /e/-lowering in this variety.

(4)	<u>Astur-Leonese</u>	<u>CS</u>	
	<i>sarrianu</i>	<i>serrano</i>	“mountain”
	<i>tarrén</i>	<i>terreno</i>	“land”
	<i>tarrón</i>	<i>terrón</i>	“lump”
	<i>zarrár</i>	<i>cerrar</i>	“to close”

Like CS, Aragonese, and Astur-Leonese, the JS dialect spoken in early 20th century Bosnia had a five-vowel system. According to Baruch’s (1930:123) description, stressed mid vowels in Bosnian JS had a closed timbre, which may have been influenced by the raising of /e,o/ to /i,u/ in word-final position. In this dialect, as well as the JS spoken in Kastoria (Greece), the lowering of /e/ to /a/ is attested before prevocalic trills (5) and before taps followed by coronals (6a-e), but /e/ is maintained before taps followed by noncoronals (7) and before prevocalic taps (8) (data from Baruch 1930:123-125,143,145,148, Kovačec 1972:513-514, 1986:159, Quintana 2001:168-169, 2006:61-69).² As shown in (5), intervocalic trills eventually neutralized to taps in Bosnian JS after the preceding mid vowel had already lowered to /a/ (Quintana 2006:64). Regular sound correspondences with CS show /e/ in all of the contexts in (5)-(8).

(5)	<u>JS</u>	<u>CS</u>	
	paru (> paru)	<i>perro</i>	“dog”
	gara (> gara)	<i>guerra</i>	“war”
	sarar (> sarar)	<i>cerrar</i>	“to close”
	jaru (> jaru)	<i>yerro</i>	“mistake”
	fjaru (> fjaru)	<i>hierro</i>	“iron”
	tjara (> tjara)	<i>tierra</i>	“earth”

(6)	<u>JS</u>	<u>CS</u>	
a.	avjartu	<i>abierto</i>	“open”
	dispartar	<i>despertar</i>	“to wake up”
	fwarti	<i>fuerte</i>	“strong”
	mwartu	<i>muerto</i>	“dead”

² An anonymous reviewer asks how we know that what has been transcribed as [a] is really a low as opposed to a mid vowel in Bosnian JS. Based on recorded oral interviews with three remaining JS speakers from Dubrovnik, the narrow phonetic transcriptions presented by Kovačec (1972, 1986) are quite detailed and include the symbol [a] in contexts of /e/-lowering. Although primarily a feature of the spoken language, use of the low vowel was the subject of metalinguistic commentary in the *costumbrista* literature of early 20th century Sarajevo and is also attested orthographically in subsequent JS publications (Quintana 2006:65-66).

	twartu	<i>tuerto</i>	“twisted”
	gwarta	<i>huerta</i>	“garden”
b.	ɟarnu	<i>yerno</i>	“son-in-law”
	pjarna	<i>pierna</i>	“leg”
	vjarnis	<i>viernes</i>	“Friday”
	kwarnu	<i>cuerno</i>	“horn”
c.	varda	<i>verdad</i>	“truth”
	kwarda	<i>cuerda</i>	“rope”
	parder	<i>perder</i>	“to lose”
d.	fwarsa	<i>fuerza</i>	“force”
	parsona	<i>persona</i>	“person”
e.	parla	<i>perla</i>	“pearl”
(7)	<u>JS</u>	<u>CS</u>	
	kwerpu	<i>cuerpo</i>	“body”
	ermozura	<i>hermosura</i>	“beatuy”
	ermanik ¹ a	<i>hermanita</i>	“little sister”
	pwerku	<i>puerco</i>	“pig”
(8)	<u>JS</u>	<u>CS</u>	
	afwera	<i>afuera</i>	“outside”
	vinjeron	<i>vinieron</i>	“they came”
	dereɟu	<i>derecho</i>	“straight”
	truɟerun	<i>trajeron</i>	“they brought”

Unlike the five-vowel inventory of the languages surveyed thus far, Central Catalan has a seven-vowel inventory in stressed syllables /i,e,ɛ,a,ɔ,o,u/ that includes open mid vowels along with their closed counterparts. Wheeler (2005:38-39,50) observes a restriction on the lexical distribution of mid front vowels whereby only /ɛ/ appears before prevocalic trills (9) and before rhotics followed by coronals (10). Otherwise, /e/ and /ɛ/ contrast before rhotics followed by noncoronals (11) and before prevocalic taps (12).³

³ Wheeler considers the intervocalic trill to be a geminate /RR/, which allows him to unify the phonological contexts RRV and R[+cor]. The realization of coda rhotics in Central Catalan varies between a tap [r] and a short trill consisting of two lingual contacts (Recasens & Espinosa 2007:20-22, Wheeler 2005:25). In the underlying forms presented here, preconsonantal /R/ abstracts away from such phonetic variation.

(9)	_ RRV	*	/tɛRRa/ <i>terra</i> “earth”								
(10)	_ R[+cor]	*	/obɛRt/ <i>obert</i> “open”								
(11)	_ R[-cor]		<table border="0"> <tr> <td>/eRba/ <i>herba</i> “grass”</td> <td>/bɛRba/ <i>verba</i> “jest”</td> </tr> <tr> <td>/teRme/ <i>terme</i> “boundary”</td> <td>/izoteRm/ <i>isoterm</i> “isotherm”</td> </tr> <tr> <td>/seRkle/ <i>cercle</i> “circle”</td> <td>/tubɛRkle/ <i>tubercle</i> “tuber”</td> </tr> <tr> <td>/beRga/ <i>Berga</i> (toponym)</td> <td>/bɛRga/ <i>verga</i> “stick”</td> </tr> </table>	/eRba/ <i>herba</i> “grass”	/bɛRba/ <i>verba</i> “jest”	/teRme/ <i>terme</i> “boundary”	/izoteRm/ <i>isoterm</i> “isotherm”	/seRkle/ <i>cercle</i> “circle”	/tubɛRkle/ <i>tubercle</i> “tuber”	/beRga/ <i>Berga</i> (toponym)	/bɛRga/ <i>verga</i> “stick”
/eRba/ <i>herba</i> “grass”	/bɛRba/ <i>verba</i> “jest”										
/teRme/ <i>terme</i> “boundary”	/izoteRm/ <i>isoterm</i> “isotherm”										
/seRkle/ <i>cercle</i> “circle”	/tubɛRkle/ <i>tubercle</i> “tuber”										
/beRga/ <i>Berga</i> (toponym)	/bɛRga/ <i>verga</i> “stick”										
(12)	_ RV		<table border="0"> <tr> <td>/estRatosfeRa/ <i>estratosfera</i> “stratosphere”</td> <td>/ʃɛRa/ <i>xera</i> “spree”</td> </tr> </table>	/estRatosfeRa/ <i>estratosfera</i> “stratosphere”	/ʃɛRa/ <i>xera</i> “spree”						
/estRatosfeRa/ <i>estratosfera</i> “stratosphere”	/ʃɛRa/ <i>xera</i> “spree”										

In a study of the pronunciation of unfamiliar neologisms (i.e. borrowings and acronyms) by Central Catalan speakers, Pi-Mallarach (1997) mostly confirms the distribution of mid front vowels described by Wheeler (2005). There is a contrast between [e] and [ɛ] before prevocalic taps (12), and only [ɛ] is found before prevocalic trills (9) and before rhotics followed by coronals (10). However, [ɛ] is also found categorically before rhotics followed by noncoronals, e.g. *iceberg* “iceberg” and *paquiderm* “pachyderm” (cf. the contrast in (11)). See Kenstowicz (to appear) on the general preference for open mid vowels over closed ones in stressed position in Catalan, Brazilian Portuguese, and Italian, based on evidence from loanwords and morphologically derived words, among other forms.

Table 1 summarizes the patterns of mid front vowel lowering in different pre-rhotic contexts in Ibero-Romance and provides confirmation of the implicational hierarchy in (1). The outlined area indicates the contexts in which lowering neutralizes the contrast between /e/ and a lower vowel. Before prevocalic trills, lowering is allophonic in CS (transcribed here as [ɛ̃]) but neutralizing in all other varieties. /e/ is most resistant to change before prevocalic taps.

Ibero-Romance variety	_rV	_r[+cor]	_r[-cor]	_rV
CS	ɐ	e	e	e
Aragonese, Astur-Leonese	a	e	e	e
Bosnian JS	a	a	e	e
Central Catalan (lexicon)	ɛ	ɛ	e	e
Central Catalan (neologisms)	ɛ	ɛ	ɛ	e

Table 1: *Implicational typology of /e/-lowering before rhotics in Ibero-Romance*

2.2 Phonetic grounding

I argue that the implicational typology of /e/-lowering in Table 1 is phonetically grounded in the articulatory properties of vowel-rhotic sequences across different contexts. The aerodynamic requirements of lingual trilling in /r/ necessitate tongue dorsum lowering and retraction (Recasens 1991, Recasens & Pallarès 1999, Solé 2002), which are antagonistic with the dorsal articulation of closed mid front /e/. As explained by Morrison (2004:34), conflicting articulatory requirements are responsible for the open-retracted allophone of /e/ found in contact with trills in CS.

In an ultrasound imaging study of lingual articulation involving five speakers of Latin American Spanish varieties, Proctor (2009) finds that controlled tongue dorsum activity is not limited to trills but is an articulatory property shared by the entire class of coronal liquids, including the tap /r/ and the lateral /l/.⁴ Figure 1 (adapted from Proctor 2009:90) shows the midsagittal lingual profiles of a female speaker of Puerto Rican Spanish pronouncing /d/, /r/, and /r/ in three vowel contexts: [e_e], [a_a], and [u_u]. The highest points of each curve are connected by a triangle, whose area serves “as a means of quantifying gross dorsal positional differences between vocalic contexts for each consonant” (Proctor 2009:90).

Figure 1 demonstrates three important points. First, the area of the triangle is greater for /d/ than for either rhotic (107.35mm² versus 8.39mm² and 6.49mm²). This suggests that /r/ and /r/ are produced with a controlled dorsal gesture that is less susceptible to coarticulatory effects exerted by adjacent vowels. /d/ is produced with a tongue tip gesture alone, which allows the tongue dorsum to vary as a function of vowel context. Second, the lingual profiles for /r/ in both the [e_e] and [a_a] contexts are nearly identical in shape, which suggests that the affinity between /e/ and /a/ in patterns of mid front vowel lowering has an articulatory basis. Third, the mean location of dorsal

⁴ The secondary dorsal gesture has remained unacknowledged in studies of Spanish rhotics based on acoustic data (e.g. Bradley 2004, 2006, Willis & Bradley 2008) and electropalatography (e.g. Martínez Celdrán & Fernández Planas 2007), as neither type of measurement is well suited for investigating dorsal articulation.

targets is more retracted for the trill than for the tap, which implies that trills are more antagonistic with a preceding /e/ than are taps.

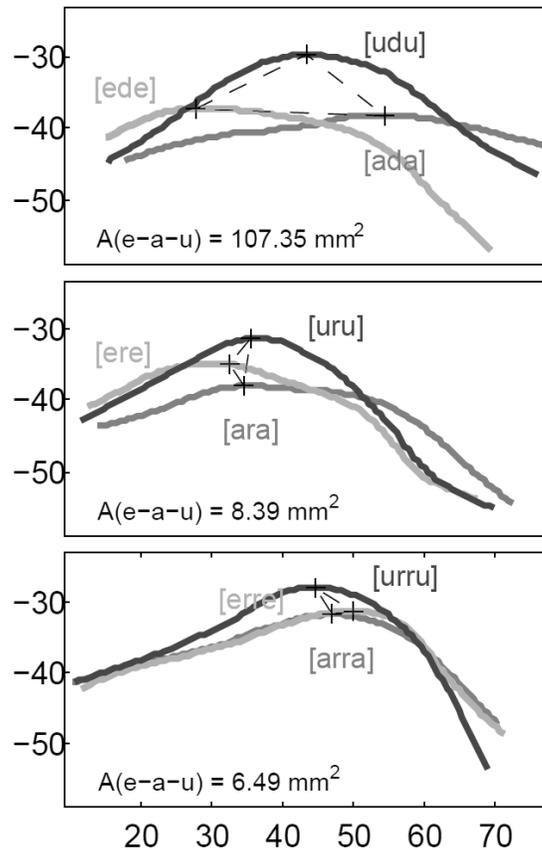


Figure 1: *Midsagittal lingual articulation of /d/, /r/, and /r/ in three intervocalic contexts. Values indicate spatial displacement in millimeters.*

Figure 2 (adapted from Proctor 2009:104-116) shows articulatory specifications for the tongue tip and tongue body gestures of Spanish stops and rhotics, using the gestural representations of Articulatory Phonology (Browman & Goldstein 1989; see Hall 2010 for a recent introduction to the theory). /d/ and /g/ have a single oral closure gesture, while both /r/ and /r/ have a primary tongue tip narrowing gesture coupled with a secondary tongue body widening gesture. The tongue body constriction location is more posterior for the trill than for the tap (uvular-pharyngeal versus uvular). Although not indicated in the figure, the tongue tip gesture is specified for a faster movement in /r/ than in /r/.

Figure 3 (adapted from Proctor 2009:99-100) shows the acoustic image and midsagittal lingual articulation of /r/ and /d/ in [a_ma] contexts as produced by a female speaker of Miami Cuban Spanish. Lingual profiles are shown at three points in time, as indicated by the vertical lines in the acoustic image. In coda

taps, the secondary tongue body gesture begins prior to its associated tongue tip gesture and continues throughout the production of the tap, giving rise to the svarabhakti vowel fragment that is visible in the acoustic image after the tap's contact (Proctor 2009:102). In contrast, the coda stop in [adma] lacks a secondary tongue body gesture, so dorsal position during the stop is influenced by the adjacent vowels. Coda laterals (not shown here) lack svarabhakti but show the same controlled dorsal movement as coda taps.

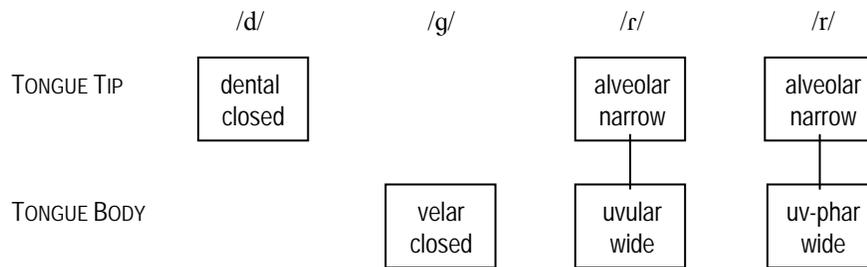


Figure 2: Tongue tip and tongue body gestures in Spanish stops and rhotics.

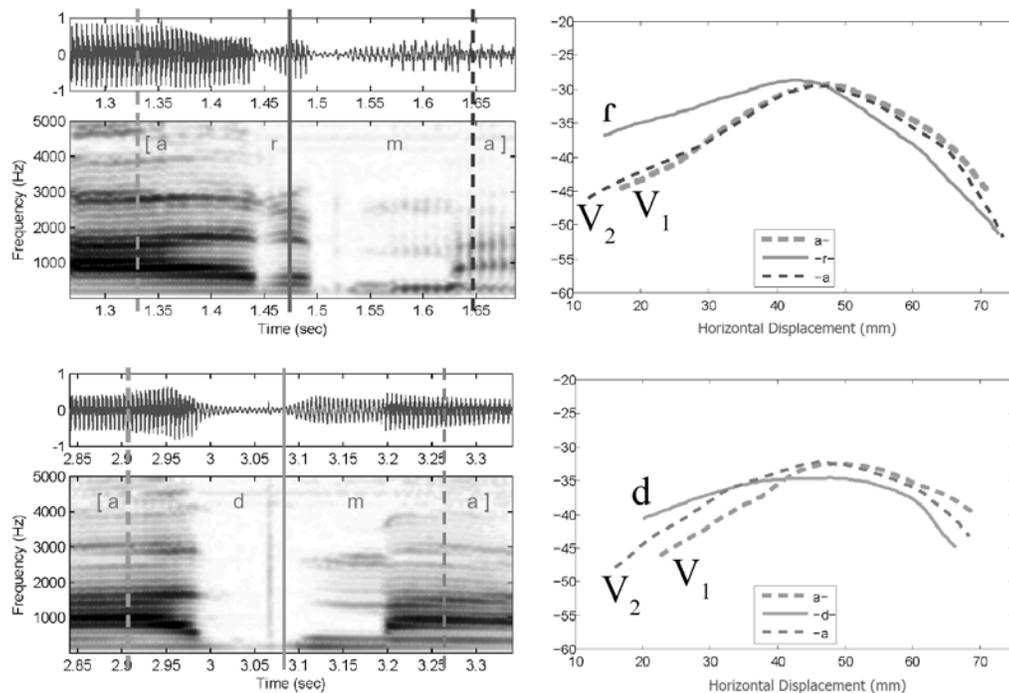


Figure 3: Acoustic analysis and midsagittal lingual articulation of /r/ and /d/ in [a_ma].

Why should /e/-lowering be least common before /rV/ sequences and more common before /r[+cor]/ than before /r[-cor]/? Wheeler (2005:39-40) suggests that the articulatory conflict between closed front vowels and a following rhotic is more acute with trills and in preconsonantal contexts than it is with intervocalic taps,

since intervocalic position allows a fast targeting and withdrawal of the tongue tip whatever the position required for the adjacent vowels; for the trill or for a rhotic before another consonant involving the front of the tongue, a preceding [high or closed mid – TGB] front vowel allows rather little space for organizing the controlled vibration of the tongue tip (Wheeler 2005:39-40).

Svarabhakti vowels are known to appear more commonly with /r/ in heterorganic clusters than in homorganic ones (see Bradley 2004, 2006 for Spanish and Recasens & Espinosa 2007 for Catalan; see Hall 2006 for a cross-linguistic survey). This suggests that heterorganic clusters involve an open transition between the tongue tip gesture of /r/ and the lips or tongue body gesture of the following consonant, whereas homorganic clusters involve a close transition between two tongue tip gestures (Catford 1988:116-117, Gafos 2002:283-287). It stands to reason that the ballistic tongue tip movement of /r/ is facilitated by the open transition, which decreases the likelihood of /e/-lowering in /r[-cor]/ contexts as compared to /r[+cor]/.

3. *An OT analysis of mid front vowel lowering before rhotics*

The implicational hierarchy of /e/-lowering in Table 1 can be formalized in OT as a universal ranking of articulatory markedness constraints. Inspired by Boersma (1998:150) and Hamann (2003:180), the constraint in (13a) penalizes the spatial displacement of the tongue body in sequences containing the closed mid front vowel followed by a rhotic. The fixed ranking of positional constraints in (13b) is phonetically grounded in the articulatory differences observed across different pre-rhotic contexts, as argued in Section 2.2. (Note: T and P stand for coronal and noncoronal consonants, respectively.)

- (13) a. *DISTANCE(e-R)
The tongue body does not move from the position for [e] to the position for a following rhotic.
b. *DIST(e-rV) » *DIST(e-rT) » *DIST(e-rP) » *DIST(e-rV)

Two anonymous reviewers ask whether the present account applies only to front as opposed to back vowels and whether the analysis would still be relevant for a language with approximant or fricative rhotics instead of trills. While the constraints in (13) refer specifically to /e/, /r/ and /r/, *DISTANCE constraints in other languages and/or dialects could target different vowels and consonants, provided that the relevant configurations involve antagonistic articulatory requirements.⁵ Cross-linguistically, trills are often realized as

⁵ Central Catalan /ɛ/ appears to the exclusion of /e/ before velarized coda laterals, e.g. /sɛl/ *cel* ‘sky’ (Wheeler 2005:39), which suggests an additional *DISTANCE constraint on tongue body displacement.

approximants or fricatives (Solé 2002). If these variants possess the same secondary tongue body gesture as the trill, then *DIST(e-rV) is still a relevant constraint.

Faithfulness constraints on vowel place features can be ranked at different points along (13b) to generate a factorial typology of /e/-lowering patterns. For the purposes of this paper, and due to space limitations, the inventory of mid vowels in each language can simply be stipulated. Following Kenstowicz (to appear), I employ the feature [open] as a way of distinguishing between closed and open mid vowels in seven-vowel systems like Central Catalan. The faithfulness constraints in (14) are relevant to the analysis proposed here.

- (14) a. IDENT(low)
Corresponding input and output segments have identical values for the feature [low].
- b. IDENT(open)
Corresponding input and output segments have identical values for the feature [open].

In CS, /e/ has an open-retracted allophone in contact with a following or a preceding trill, but there is no neutralization with the low vowel /a/. As shown in Tableau 1, IDENT(low) ranks above the highest constraint of the markedness hierarchy, which selects candidates (a) and (c) over (b) and (d), respectively.

		IDENT(low)	*DIST(e-rV)
☞	a. /pera/ p̄era		*
	b. para	*!	
☞	c. /reta/ r̄eta		
	d. rata	*!	

Tableau 1: Lowered allophones of mid front /e/ in contact with trill in CS [p̄era] “bitch” and [r̄eta] “s/he challenges”

The Aragonese and Astur-Leonese pattern is generated by ranking faithfulness just below the markedness constraint against [erV] sequences. In Tableau 2, this ranking maps input /e/ to [a] before the prevocalic trill in candidate (b).

		*DIST(e-rV)	IDENT(low)
	a. /serato/ s̄erato	*!	
☞	b. sarato		*

Tableau 2: Lowering of mid front /e/ to [a] before prevocalic trill in Aragonese [sarato] (toponym)

Space limitations preclude a full account of /a/-epenthesis before word-initial trills in Aragonese and JS (3), which would involve an additional markedness constraint against word-initial rhotics and a faithfulness constraint against vowel epenthesis. In conjunction with other markedness constraints on vowel place features, *DIST(e-rV) would favor [a] in this context.

In Bosnian JS, IDENT(low) ranks below the top two constraints of the markedness hierarchy. Tableau 3 shows that /e/ maps to [a] before both the prevocalic trill in candidate (b) and the precoronal tap in (d).

		*DIST(e-rV)	*DIST(e-rT)	IDENT(low)
a.	/peru/ p̄eru	*!		
☞ b.	paru			*
c.	/avjertu/ avjertu		*!	
☞ d.	avjartu			*

Tableau 3: Lowering of mid front /e/ to [a] before prevocalic trill and before /ɾ/ in Bosnian JS [paru] “dog” and [avjartu] “open”

The faithfulness constraint IDENT(open) is necessary to account for patterns of /e/-lowering in Central Catalan. To prevent lowering of /e/ all the way to [a], IDENT(low) is assumed to be high ranking and is not shown in the following tableau. As in Bosnian JS, the relevant faithfulness constraint ranks just below *DIST(e-rT). Tableau 4 accounts for the lexical restriction in Central Catalan whereby only /ɛ/ appears before precoronal rhotics, as in candidate (b). /e/ is maintained before rhotics followed by noncoronals, as in candidate (c). Lowering in the latter context in neologisms suggests a re-ranking of IDENT(open) below *DIST(e-rP), favoring candidate (d) instead of (c).

		*DIST(e-rT)	IDENT(open)	*DIST(e-rP)
a.	/obert/ obert	*!		
☞ b.	obert		*	
☞ c.	/erba/ erba			*
d.	ɛrba		*!	

Tableau 4: Lowering of mid front /e/ to [ɛ] before /ɾ/ but not before /ɾb/ in Central Catalan [obert] “open” and [erba] “grass”

The factorial typology of constraint rankings for Ibero-Romance is summarized in Table 2. In each variety, the highest ranked markedness constraints correspond to the contexts of /e/-lowering shown in the implicational hierarchy in Table 1. This analysis correctly predicts the impossibility of a language in which /e/-lowering targets a less marked context without also targeting the more marked contexts. For example, if /e/ lowers

before taps followed by coronals, then it also lowers before prevocalic trills, but the opposite does not hold.

- a. **IDENT** » *DIST(e-rV) » *DIST(e-rT) » *DIST(e-rP) » *DIST(e-rV)
- b. *DIST(e-rV) » **IDENT** » *DIST(e-rT) » *DIST(e-rP) » *DIST(e-rV)
- c. *DIST(e-rV) » *DIST(e-rT) » **IDENT** » *DIST(e-rP) » *DIST(e-rV)
- d. *DIST(e-rV) » *DIST(e-rT) » *DIST(e-rP) » **IDENT** » *DIST(e-rV)

Table 2: *Factorial typology of constraint rankings: (a) CS, (b) Aragonese and Astur-Leonese, (c) Bosnian JS and Central Catalan (lexicon), and (d) Central Catalan (neologisms)*

4. *Theoretical implications*

The OT analysis of mid front vowel lowering in Ibero-Romance has implications for the phonological representation of the contrast between taps and trills in word-medial intervocalic position, e.g. CS [pero] *pero* “but” versus [pero] *perro* “dog”, Central Catalan [sɛra] *cera* “wax” versus [sɛra] *serra* “saw”. Some researchers analyze the trill as an underlying singleton, /VrV/, while others propose a geminate structure, /VrrV/. With respect to the absence of /e/ before prevocalic trills and before rhotics followed by coronals in Central Catalan, Wheeler (2005:39) argues that “[i]f one interprets /r/ as geminate /RR/ ... these two contexts become one and the same.” This interpretation allows Wheeler to formulate a single markedness constraint responsible for vowel lowering in both contexts. On the assumption that /i,e/ are [+high] and [-back], the constraint *[+hi,-bk]R[+cor] is ranked below faithfulness to the place features of /i/ but above faithfulness to other vowel place features. This ranking prevents lowering in forms like *mirra* “myrrh” and *herba* “grass” but favors lowering in *terra* “earth” and *obert* “open”.

There are some problems with this approach. The geminate representation of intervocalic trills is questionable, at least in Spanish (see Baković 2009 for a recent summary and critique of the arguments for and against geminates). In OT, Richness of The Base forbids placing any language-specific constraints on the input. Rather, the interaction of markedness and faithfulness constraints in the grammar determines how inputs are mapped to outputs in a given language (see Prince & Smolensky 1993/2004). This forces an OT analysis to consider nongeminate /r/ in any event. However, /e/ before a singleton prevocalic trill cannot violate the constraint *[+hi,-bk]R[+cor], so the analysis would undergenerate in this context. Furthermore, there are Ibero-Romance varieties that show lowering of /e/ before prevocalic trills but not before taps followed by coronals, which suggests that the two contexts do not always pattern together. The constraint *[+hi,-bk]R[+cor] would overgenerate in precoronal contexts in Aragonese and Astur-Leonese.

The analysis proposed in this paper is consistent with Richness of The Base. *DIST(e-rV) accounts for /e/-lowering before prevocalic trills in the output regardless of whether intervocalic [r] is represented as a singleton /r/ or as a geminate /rr/ in the input. Furthermore, recall Morrison's (2004) finding that CS /e/ has an open-retracted allophone not only before prevocalic trills but also after word-initial trills (see Section 2.1). Since the geminate structure is posited only for word-medial contexts, the fact that /e/ is affected after word-initial trills suggests that mid front vowel lowering does not depend on the presence of a geminate structure but is rather a property of singleton trills.

5. Conclusion

This paper has documented empirical patterns of mid front vowel lowering before rhotics in several Ibero-Romance varieties. A phonetically grounded OT analysis was proposed to account for /e/-lowering across different phonological contexts. The analysis makes the correct typological predictions about possible versus impossible languages and is compatible with a nongeminate representation of intervocalic surface trills, in accordance with OT's Richness of The Base.

Acknowledgements

For questions and feedback leading to the improvement of this paper, I would like to thank the LSRL40 audience members and two anonymous reviewers. I am responsible for any shortcomings that remain.

References

- Baković, Eric. 2009. "Abstractness and Motivation in Phonological Theory". *Studies in Hispanic and Lusophone Linguistics* 2.183-198.
- Baruch, Kalmi. 1930. "El judeo-español de Bosnia". *Revista de filología española* 17.113-154.
- Boersma, Paul. 1998. *Functional Phonology. Formalizing the Interactions between Articulatory and Perceptual Drives*. Ph.D. dissertation, University of Amsterdam.
- Bradley, Travis G. 2004. "Gestural Timing and Rhotic Variation in Spanish Codas". *Laboratory Approaches to Spanish Phonology* ed. by Timothy Face, 197-224. Berlin: Mouton de Gruyter.
- . 2006. "Spanish Complex Onsets and the Phonetics-Phonology Interface". *Optimality-Theoretic Studies in Spanish Phonology* ed. by Fernando Martínez-Gil & Sonia Colina, 15-38. Amsterdam: John Benjamins.

- . 2009. "On the Syllabification of Prevocalic /w/ in Judeo-Spanish". *Romance Linguistics 2007: Selected Papers from the 37th Linguistic Symposium on Romance Languages (LSRL)* ed. by Pascual J. Masullo, Erin O'Rourke, and Chia-Hui Huang, 51-67. Amsterdam: John Benjamins.
- Browman, Catherine, & Louis Goldstein. 1989. "Articulatory Gestures as Phonological Units". *Haskins Laboratories Status Report on Speech Research*, SR-99/100.69-101.
- Catford, John. 1988. *A Practical Introduction to Phonetics*. Oxford: Clarendon Press.
- Gafos, Adamantios. 2002. "A Grammar of Gestural Coordination". *Natural Language & Linguistic Inquiry* 20.269-337.
- Hall, Nancy. 2006. "Cross-linguistic Patterns of Vowel Intrusion". *Phonology* 23.387-429.
- Hall, Nancy. 2010. "Articulatory Phonology". *Language and Linguistics Compass* 4.818-830.
- Hamann, Silke. 2003. *The Phonetics and Phonology of Retroflexes*. Ph.D. dissertation, Utrecht University.
- Hualde, José Ignacio. 2005. *The Sounds of Spanish*. Cambridge: Cambridge University Press.
- Kenstowicz, Michael. To appear. "Vocale Incerta, Vocale Aperta". To appear in *Studi e Saggi Linguistici* 48.
- Kovačec, August. 1972(-1973). "Un texto judeoespañol de Dubrovnik". *Studia Romanica et Anglica Zagrabiensia* 33(-36).501-531.
- . 1986(-1987). "Sobre el valor de las unidades [t̪] ([k̪, k̪', é, k̪]) y [d̪] ([g̪, g̪', đ, g̪]) en el judeo-español de Sarajevo y Dubrovnik". *Studia Romanica et Anglica Zagrabiensia* 31(-32).156-169.
- Lepschy, Anna Laura & Giulio Lepschy. 1977. *La Lingua italiana: storia, varietà dell'uso, grammatica*. Milano: Bompiani.
- Martínez Celdrán, Eugenio, & Ana María Fernández Planas. 2007. *Manual de fonética española: articulaciones y sonidos del español*. Barcelona: Ariel.
- Morrison, Geoffrey-Stewart. 2004. "An Acoustic and Statistical Analysis of Spanish Mid-vowel Allophones". *Estudios de fonética experimental* 13.11-37.
- Navarro Tomás, Tomás. 1918. *Manual de pronunciación española*. Madrid: Consejo Superior de Investigaciones Científicas.
- Pi-Mallarach, Josep. 1997. *L'obertura de les vocals mitjanes en una mostra de neologismes del català*. Ph.D. dissertation, Universitat Autònoma de Barcelona.
- Prince, Alan, & Paul Smolensky. 1993. "Optimality Theory: Constraint Interaction in Generative Grammar". Ms., New Brunswick & Boulder: Rutgers University & University of Colorado.

- , 2004. *Optimality Theory: Constraint Interaction in Generative Grammar*. Malden, MA: Blackwell.
- Proctor, Michael Ian. 2009. *Gestural Characterization of a Phonological Class: the Liquids*. Ph.D. dissertation, Yale University.
- Quintana, Aldina. 2001. "Concomitancias lingüísticas entre el aragonés y el ladino (judeoespañol)". *Archivo de Filología Aragonesa* 57-58.163-192.
- , 2006. *Geografía lingüística del judeoespañol*. Bern: Peter Lang.
- Recasens, Daniel. 1991. "On the Production Characteristics of Apico-alveolar Taps and Trills". *Journal of Phonetics* 19.267-280.
- , & Aina Espinosa. 2007. "Phonetic Typology and Positional Allophones for Alveolar Rhotics in Catalan". *Phonetica* 64.1-28.
- , & Maria Dolors Pallarès. 1999. "A Study of /r/ and /r̄/ in the Light of the 'DAC' Coarticulation Model". *Journal of Phonetics* 27.143-169.
- Solé, Maria-Josep. 2002. "Aerodynamic Characteristics of Trills and Phonological Patterning". *Journal of Phonetics* 30.655-688.
- Wheeler, Max. 2005. *The Phonology of Catalan*. Oxford: Oxford University.
- Willis, Erik W., & Travis G. Bradley. 2008. "Contrast Maintenance of Taps and Trills in Dominican Spanish: Data and Analysis". *Selected Proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology* ed. by Laura Colantoni & Jeffrey Steele, 87-100. Somerville, MA: Cascadilla Proceedings Project.