



Towards an Articulatory Characterization of Liquids – evidence from Spanish and Russian

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Goal

Aim of this study: compare dynamic articulation of liquid consonants in Spanish and Russian in pursuit of unifying phonetic properties which characterize the class, and differentiate liquids from obstruents.

The Class of Liquids

Liquids – rhotics and laterals – share many phonological properties which suggest that they form a phonological class.

Liquids pattern together in their distribution (clustering, syllabicity, *wd-initial), and behaviour (disimilation, metathesis, merger, allophony, post-vocalic, etc.)

Capturing phonological behaviour of rhotics, laterals and liquids under feature-based phonological theory has proven difficult. [1]

Most important phonotactic property: cluster-enabling segments:

- Romance: only liquid-internal clusters (Spanish: *pronto, pluma, crema, clima*)
- Germanic: only liquid-internal 3C clusters (Dutch: *spr-, spl-, str-, skr-, skl-, sxl-*)
- Slavic: only liquid-internal 4C onsets (Russian: *fspl-, fstr-, fskr-, fsxl-, etc.*) (but note also anti-SSP: *rta* 'mouth-GEN.SG', *lba* 'forehead-GEN.SG')

Phonetic Characterisation of Liquids

Phonetically diverse group of sounds – alveolar, retroflex, uvular & pharyngeal; trills, taps, flaps, approximants & fricatives [2]. Acoustically: lowered F3 characteristic of many rhotics [3], but not true of all types of /r/.

Liquids may share more in the articulatory domain; eg. English:
/l/: produced with coronal + dorsal constrictions [4]
/ɹ/: produced with tongue tip + pharyngeal approximation [5]

Lack of broad typological data: unclear whether similar common articulatory properties exist among different types of liquids which also pattern together.

Russian Liquids

Russian consonants in mutable pairs: palatalized / non-palatalized [6]

Two pairs of liquids:

/r/–/rʲ/, /l/–/lʲ/

Contrastive word-initially, intervocally, in heterorganic medial codas + word-finally:

- лук [luk] 'onion'
- люк [lʲuk] 'hatch'
- рад [rat] 'glad'
- ряд [rʲat] 'row'

Is there an articulatory basis to the class of liquids in a language with contrastive palatalization?

	LAB	LDEN	DEN	PA	PAL	VEL
Stop	p, b	t, d				k, g
Affricate		tʃ, dʃ	ts			kʲ, gʲ
Fricative	f, v	s, z	ʃ, ʒ			x
Nasal	m	n				
Rhotic		r	rʲ			
Lateral		l	lʲ			
Approximant			j			
Vowel				i	e	u
					a	o

Spanish Liquids

Three liquids: /r/ - /r/ - /l/

Contrastive intervocally.

Rhotics neutralize elsewhere: [7]

RHOTIC	ENVIRONMENT	EXAMPLE
Trill:	#	[ˈno.ka]
	C_	[ˈno.ka]
Tap:	[_]_C	[ˈɡra.mo]
	V_#V	[ˈse.ri.mi.ɡos]
Contrastive:	V_#	[ˈka.no] / [ˈka.no]
Variable:	V_#C	[ˈpa.ri] ~ [ˈpa.ri]
	V_#C	[ˈse.ri.ˈno.ˈta] ~ [ˈse.ri.ˈno.ˈta]
	V_#C	[ˈse.ri.ˈno.ˈta] ~ [ˈse.ri.ˈno.ˈta]

Lateral always 'clear': no [ʃ] allophone: does [l] have a dorsal gesture?

Is there an articulatory basis to rhotic neutralization?

	LAB	LD	DEN	ALV	PA	PAL	VEL
Stop	p		t				k
	b		d				g
Nasal			ɲ				
Affricate			ʎ				
Fricative	f		s				x
Rhotic			r				
Lateral			l				
Vowel				i	e		u
					a		o

Method – Corpora, Subjects

Liquids + voiced stop elicited in contrasting intervocalic environments: seek patterns of articulatory stability characterizing production. [8]

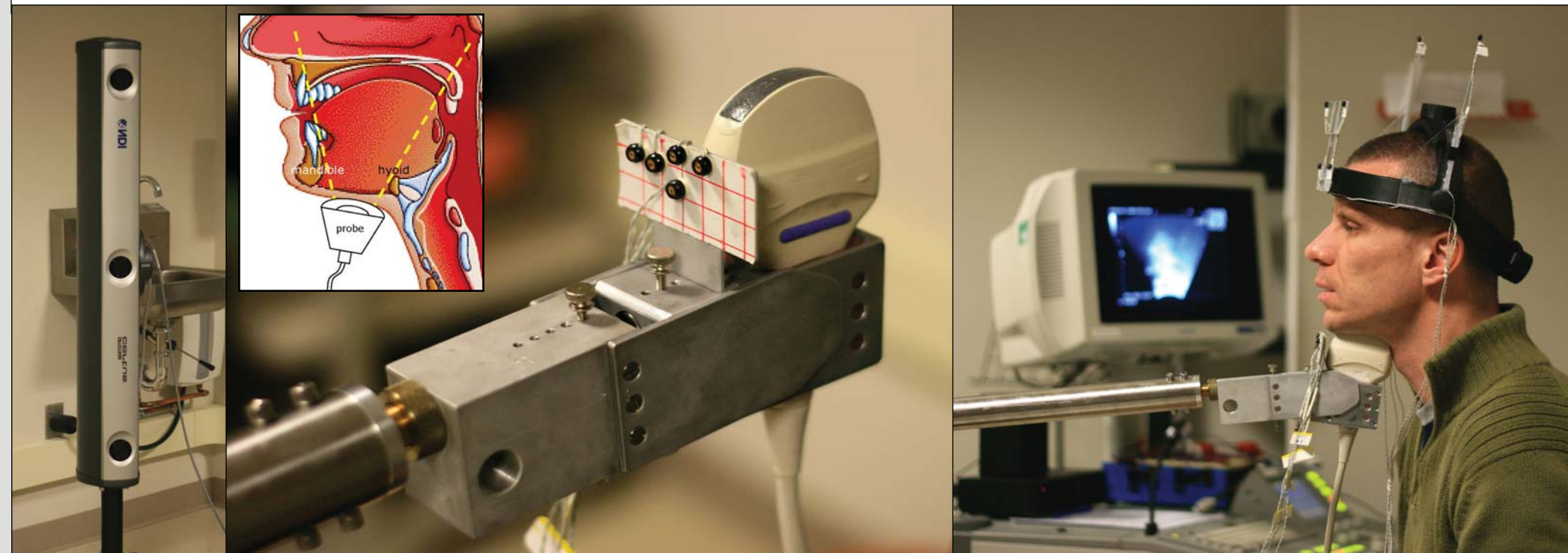
Environment	Russian Stimuli	Spanish Stimuli
front: [e _ e]:	эре, эре, элэ, элэ, эде, эде	ere, erre, ele, ede
low: [a _ a]:	ара, ара, ала, ала, ада, ада	para, parra, pala, capada
back: [u _ u]:	уру, уру, улу, улу, уду, уду	guru, acurruca, pulula, vudu

RUSSIAN SUBJECTS				SPANISH SUBJECTS			
ID	AGE	HOMETOWN	TIME IN US	ID	AGE	HOMETOWN	VARIETY
RM1	24	Kadamjay, Kyrgyzstan	2 years	SM1	25	Managua	Nicaraguan
RM2	25	Krasnodar, Russia	2.5 years	SM1	21	Guaynabo	Puerto Rican
RW1	32	Kiev, Ukraine	7 years	SW2	20	Quito	Ecuadorian
RW2	23	Bishkek, Kyrgyzstan	6 months	SW3	20	Miami, USA	Cuban
RW3	18	Zelenograd, Russia	16 years	SW4	19	Sto. Domingo	Dominican

Method – Ultrasound

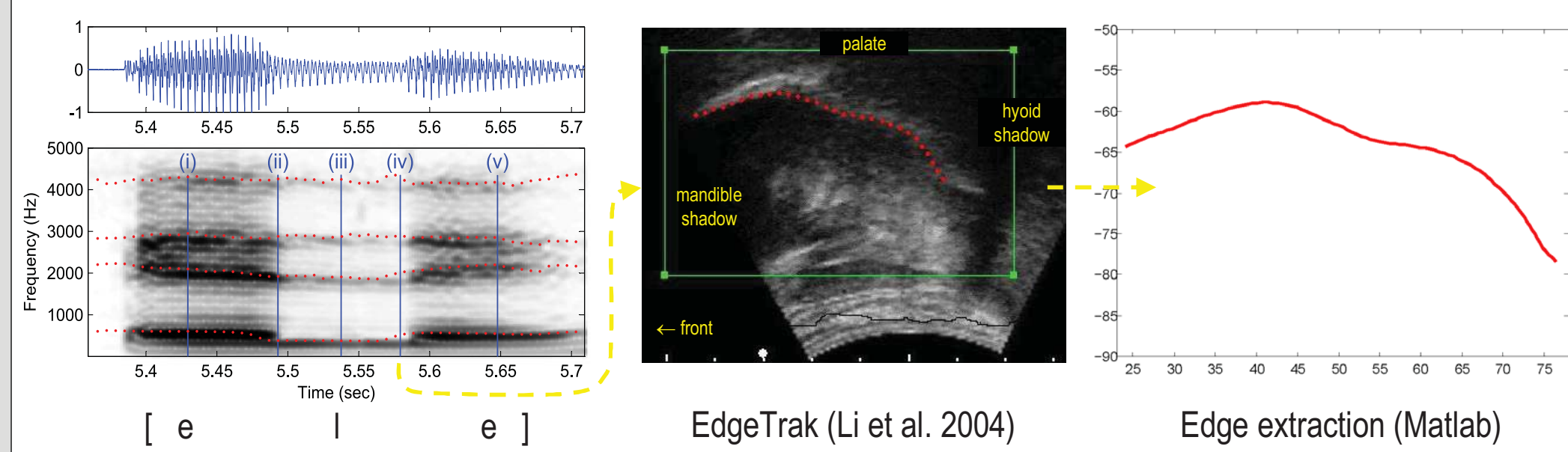
HOCUS: Haskins Optically-Corrected Ultrasound System. [9]

- ultrasound: 127 frames/sec. midsagittal lingual articulation
- audio: 22,000 Hz synchronized acoustic recording
- OptoTrak: 127 frames/sec. 3D location of anatomical markers



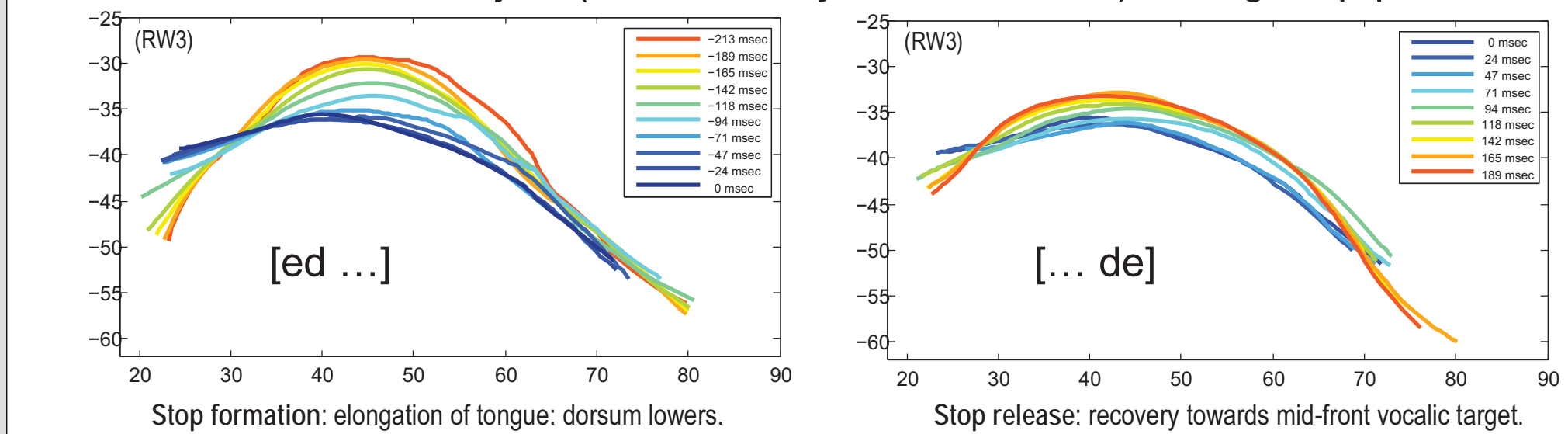
Method – Acoustic & Articulatory Analysis

For each consonant, acoustic landmarks selected as analysis pts:

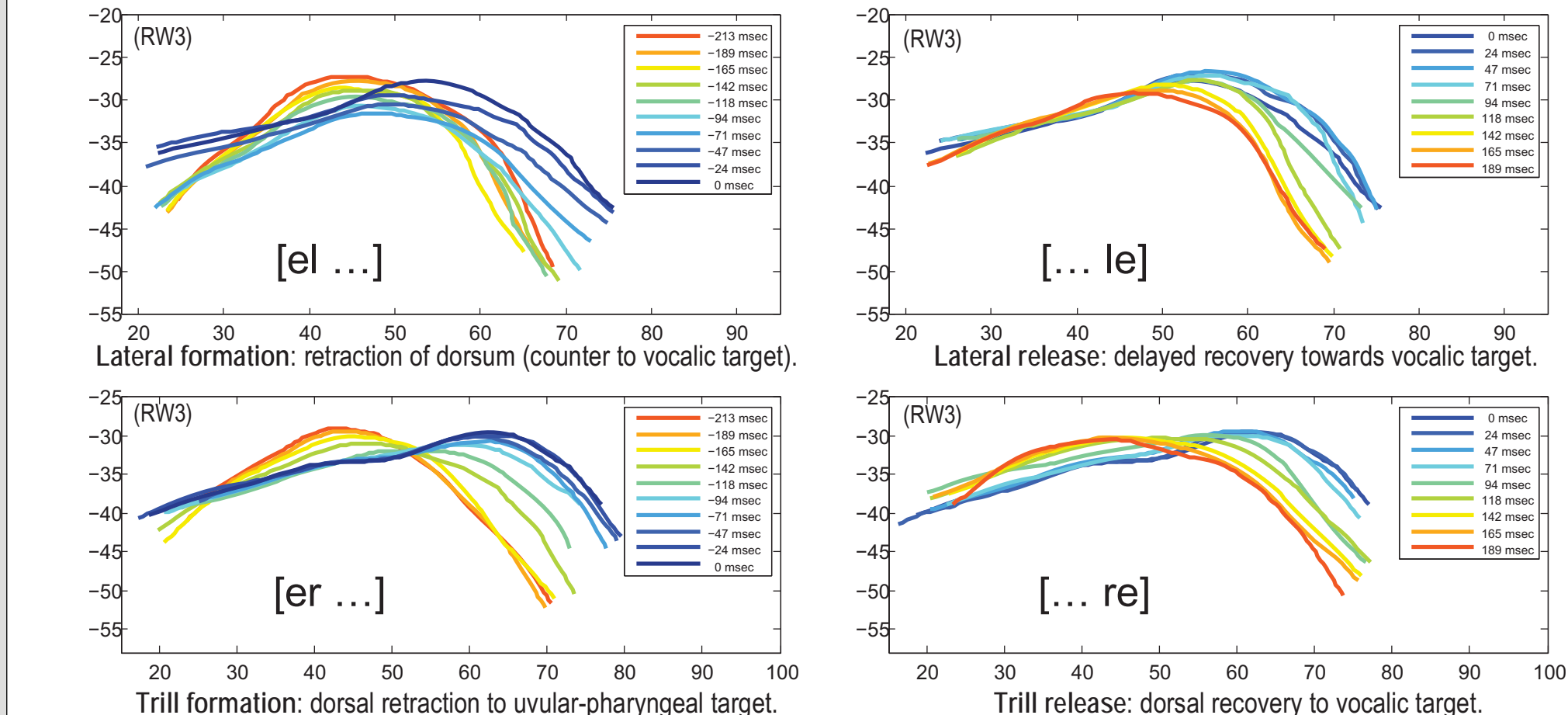


Results – Russian Liquid Articulation

Dorsum uncontrolled by C (controlled by context vowel) during stop production:

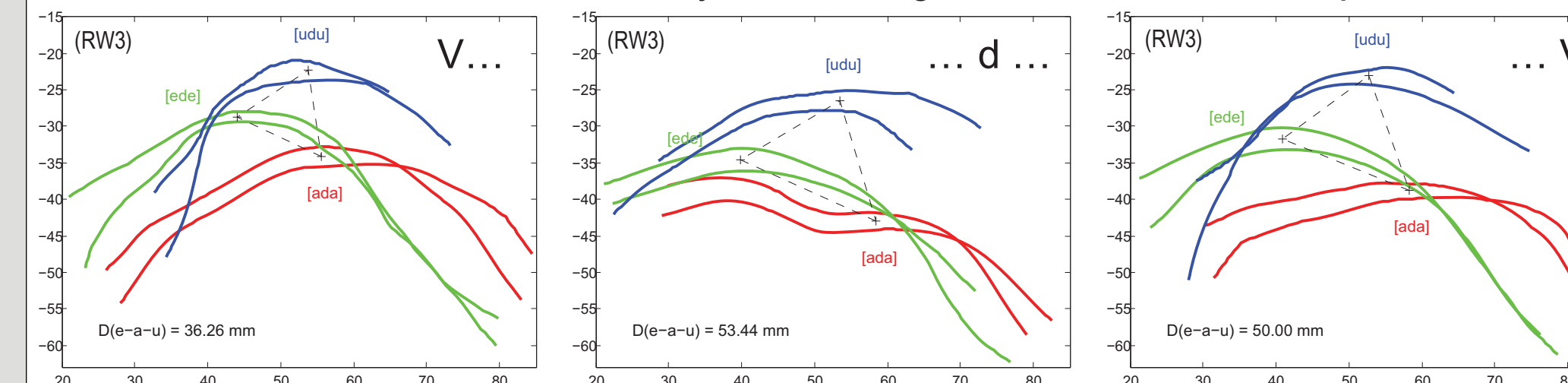


Distinct consonantal dorsal articulatory targets evident in liquid production:

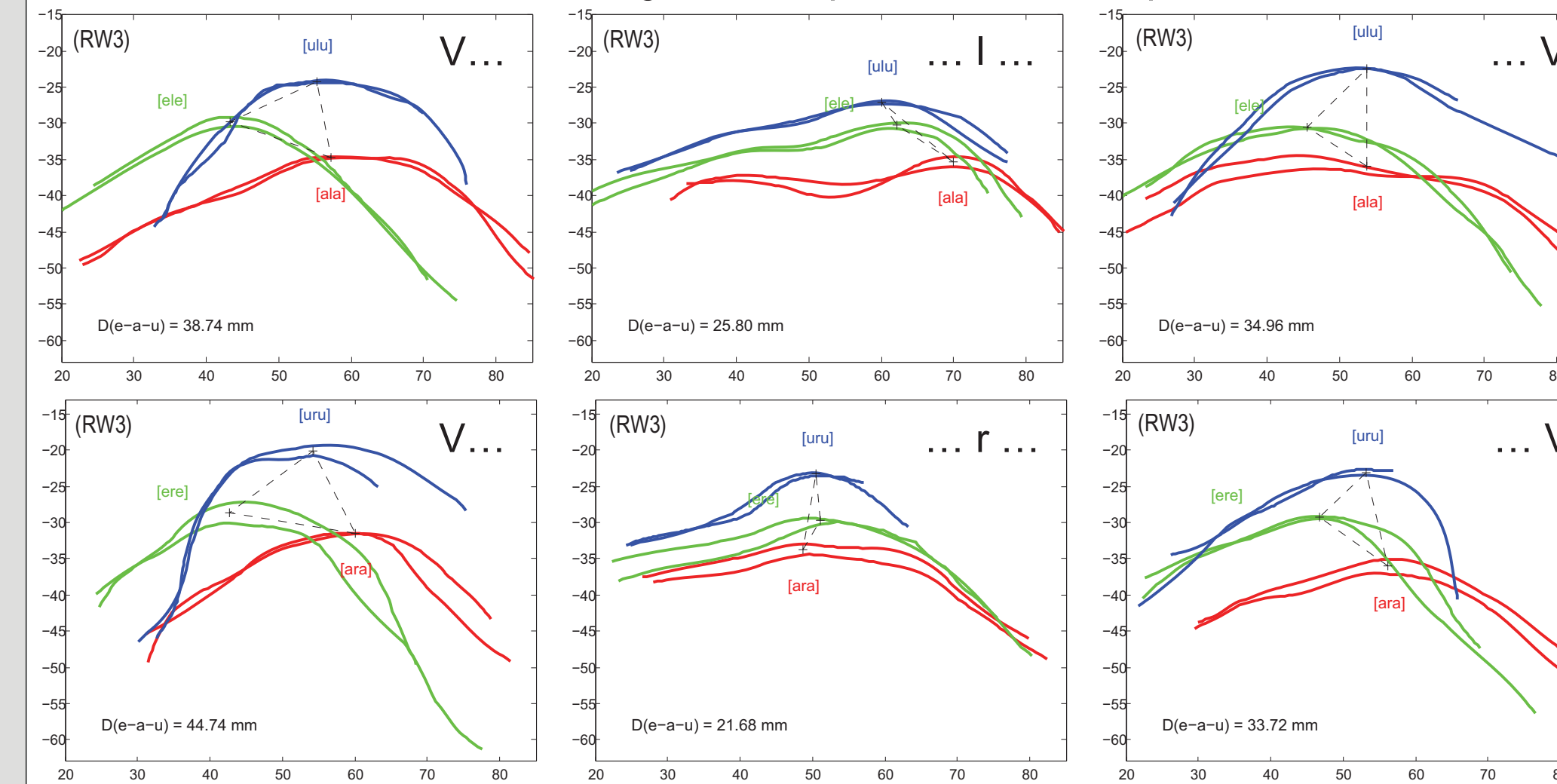


Results – Russian Coarticulation

V-to-C coarticulation estimated by calculating differential dorsal displacement:

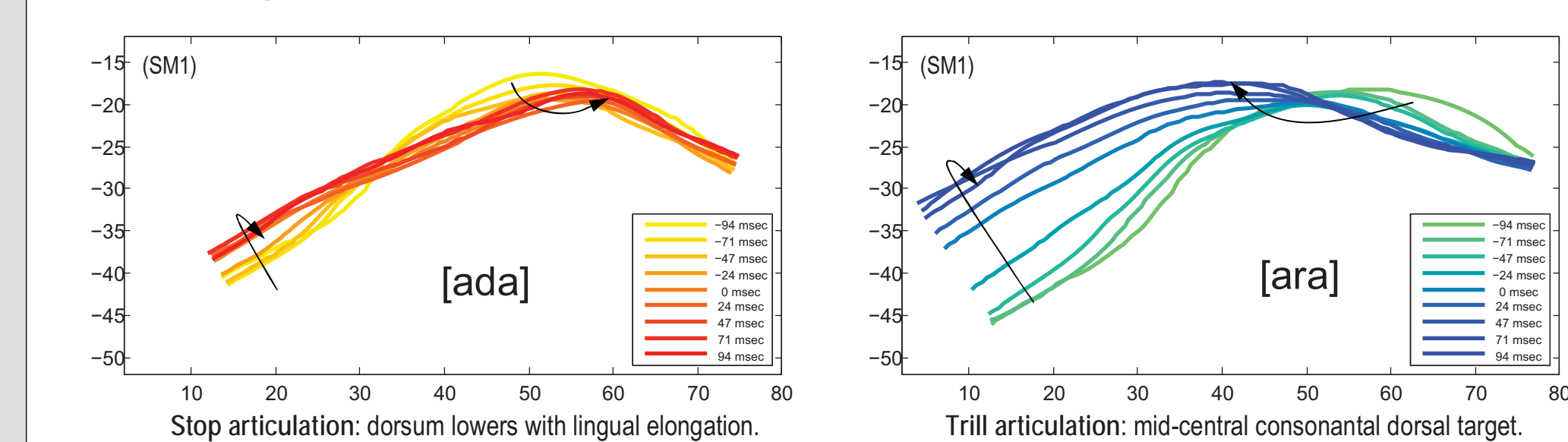


Resistance to coarticulation higher for liquids than for stops:

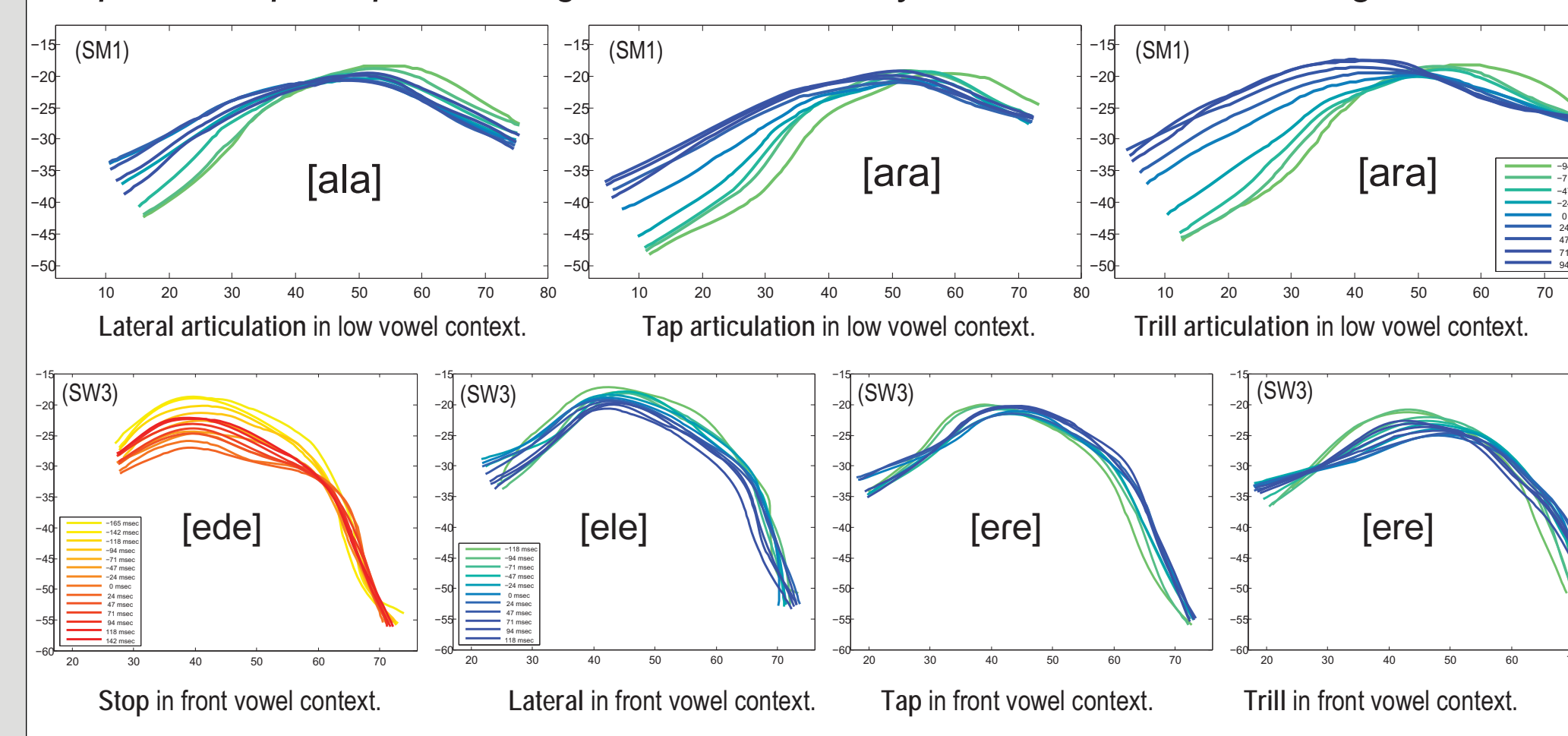


Results – Spanish Liquid Articulation

Dorsal target of trill evident in low vowel context, cf. uncontrolled stop dorsum:

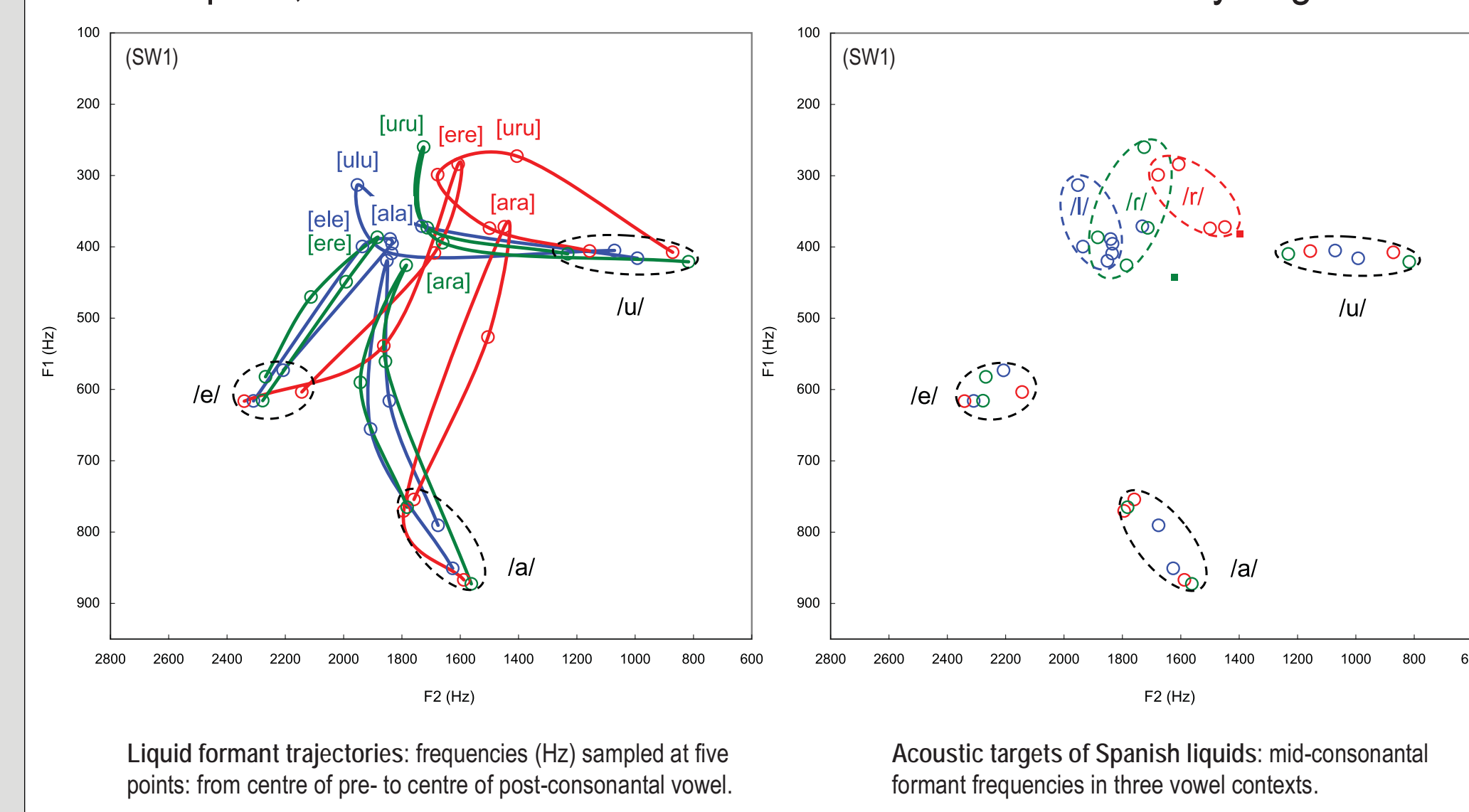


Spanish liquids pattern together articulatorily: mid-central dorsal target:



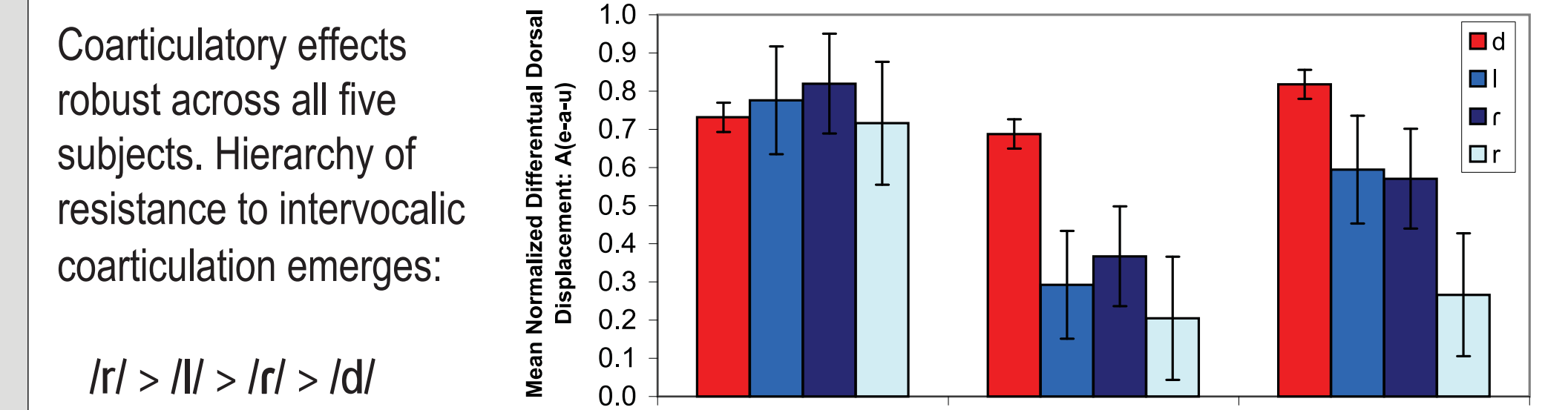
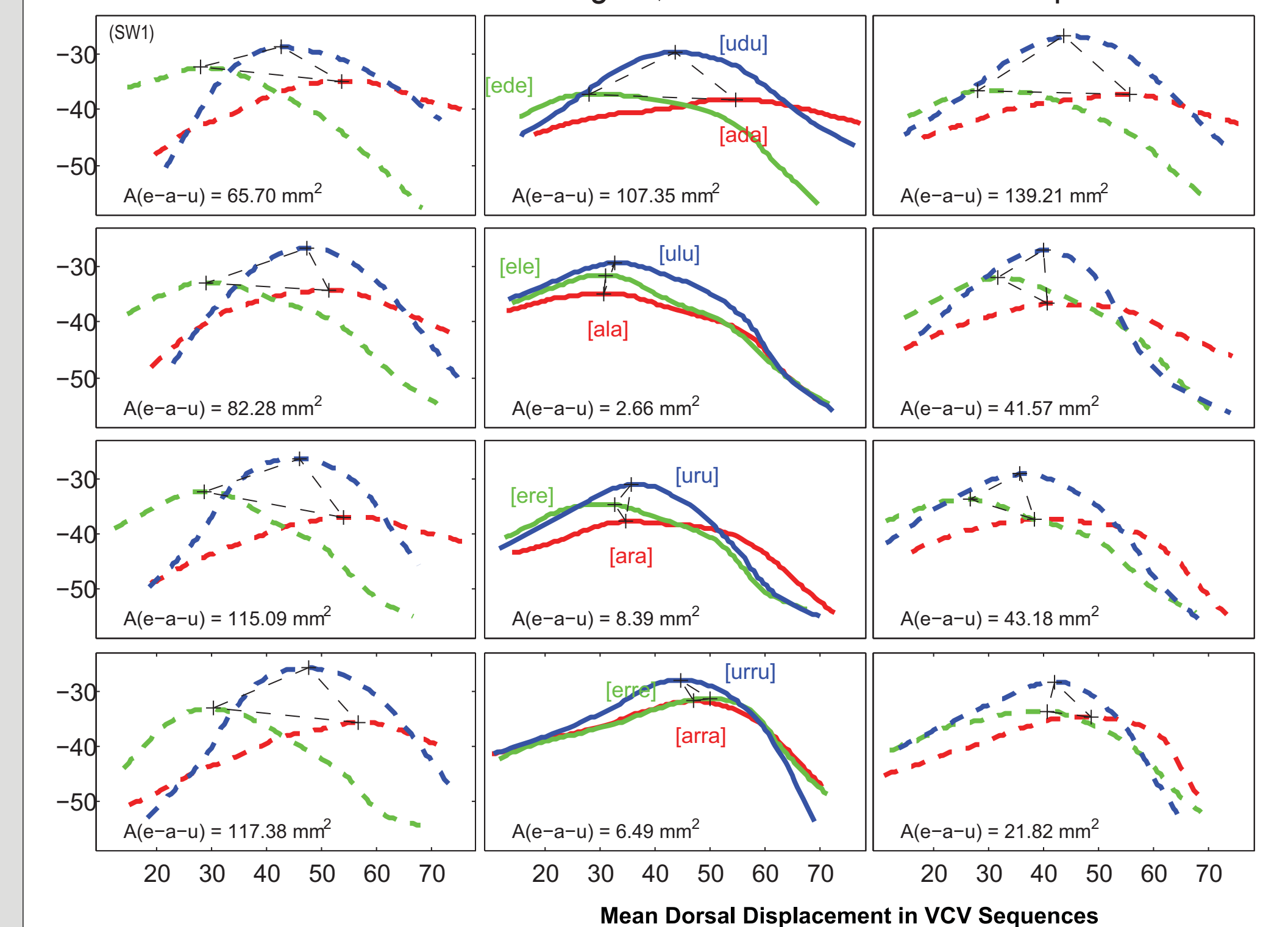
Results – Spanish Liquid Acoustics

Formant trajectories of intervocalic liquids convergent on acoustic targets in F1-F2 space, consistent with central vowel-like dorsal articulatory targets.



Results – Spanish Coarticulation

Spanish liquids – including the tap /r/ – characterized by resistance to vocalic coarticulation and distinct dorsal targets, unlike voiced coronal stop /d/:



Conclusions

Liquids differ from stops in both Russian & Spanish in their control of dorsum: distinct dorsal targets evident for each rhotic and lateral.

Spanish 'clear' lateral distinguished from Russian (& English) [ʃ] by location (not absence) of dorsal gesture (c.f. German [ʃ]).

Spanish tap /r/ shows less resistance to vocalic coarticulation than trill /r/ (c.f. Catalan [r]) but greater resistance than stop /d/ (c.f. [d]). For most speakers in study, dorsal gesture of tap resembles that of lateral.

Discussion

Class of liquids characterized by consonants whose production involves more global control of lingual articulation. When this takes form of a central dorsal gesture, characteristic phonological properties result: inherent sonority, potential for syllabicity, temporal-stability, allophony, asymmetry in clusters.

Vocalic nature of dorsal gestures may account for post-nuclear phenomena, eg. Dominican coda liquid vocalization: *algo* [aj.ɣo], *mujer* [mu.hej]. [13]

Similarity of gestural targets in Spanish liquids may account for coda neutralization (*puerta* → [pue.ɾ.ta]); dissimilation (L: *arbor* > *arbol*).

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