Temporal stability patterns of stop-liquid and stop-rhotic clusters in Spanish

Stavroula Sotiropoulou[1], Mark Gibson[2], Stephen Tobin[1,3] & Adamantios Gafos[1,3]

[1]University of Potsdam, Germany; [2]Universidad de Navarra, Spain; [3]Haskins Laboratories, USA

1 Spanish vs. German

- Spanish admits complex onsets, such as stop-liquid clusters [1], like German [2]
- However, the inter-segmental coordination is different in these languages

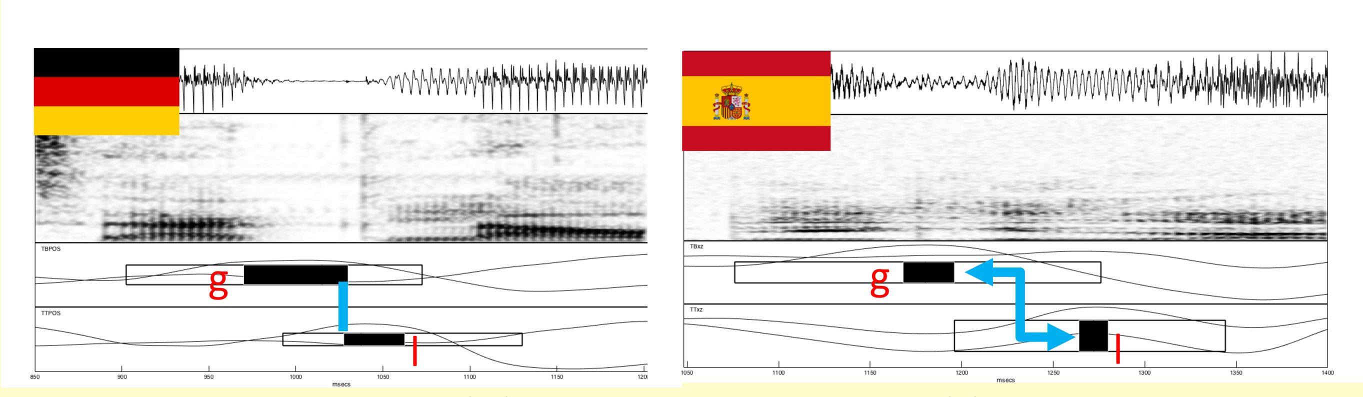

Fig. 1 – lower two panels: /g/ tongue body movement, /l/ tongue tip movement

2 Spanish vs. Moroccan Arabic

- Spanish admits complex onsets, but Moroccan Arabic does not [3]
- Spanish consonant clusters have been reported to show open transitions [4] just like Moroccan Arabic [5]
- The voicing systems of Spanish and Moroccan Arabic are similar: short lag vs. long lag [6,7]

We ask: What are the effects, if any, of phonological (syllabic) organization in Spanish, a language whose (relevant) inter-segmental phonetics are similar to Moroccan Arabic?

3 Methodology

- Kinematic data collected at the University of Potsdam using a Carstens 501 electromagnetic articulometer
- Simultaneous acoustic data collection
- Six subjects: native speakers of Central Peninsular Spanish
- Corpus with 38 items

low vowel			mid vowel	
cluster	ccv	cv	ccv	cv
pl	plato	lato	plena/plomo	lena/lomo
bl	blata/blanda	lato	bleque/bloque	leco/loco
kl	clapas	lapa	clema/clono	lema/lomo
gl	glato/glana	lato	gleba/globo	lema/lomo
pr	prato	rato	presa/promo	rena/romo
kr	crapa	rapa	crema/cromo	rema/romo
tr	trapo	rape	trecho/trono	recho/roto

- 10 repetitions per item
- Items embedded in the carrier phrase "Di [item] por favor."

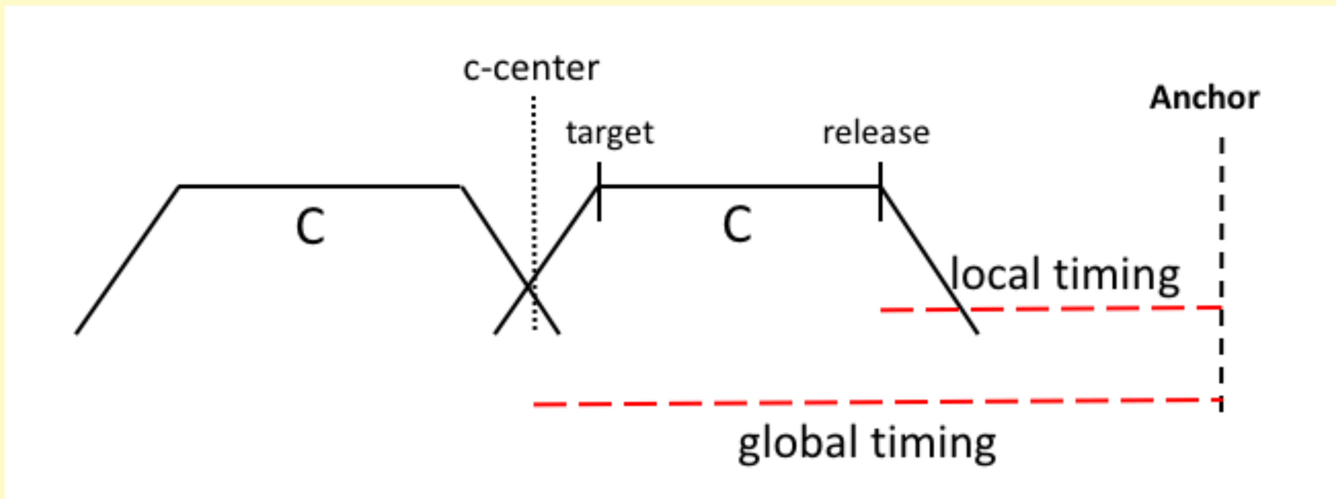

Fig. 2 – Global timing and local timing intervals in CCV

Quantified variables:

- Calculation of intervals: global timing, local timing in CV and CCV
- Three anchors used: target and maximum constriction of the postvocalic consonant (C^{tar}, C^{max}), maximum opening of the vowel (V^{max})
- **(new)** Vowel initiation relative to the consonants was quantified
- Plateau duration (C release – C target) of the prevocalic C in CV and CCV

4 Results

- Stop-liquid: local organization when C1 voiced, global organization when C1 voiceless across anchors
- Stop-rhotic: depending on anchor and clusters evidence for both local and global organization

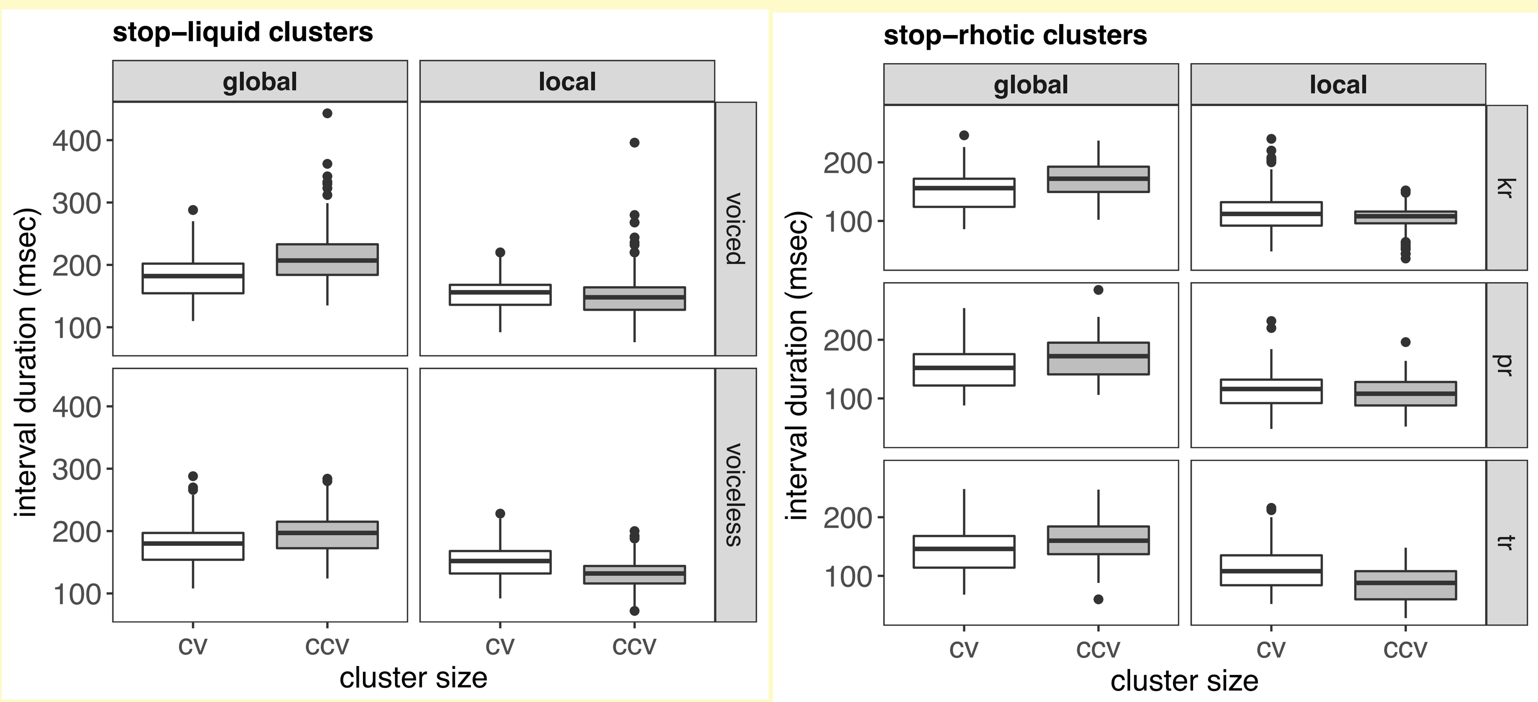

Fig. 3 – Duration of the intervals global timing, local timing for CV (white) and CCV (grey) words for stop-liquid clusters (left) and stop-rhotic clusters (right)

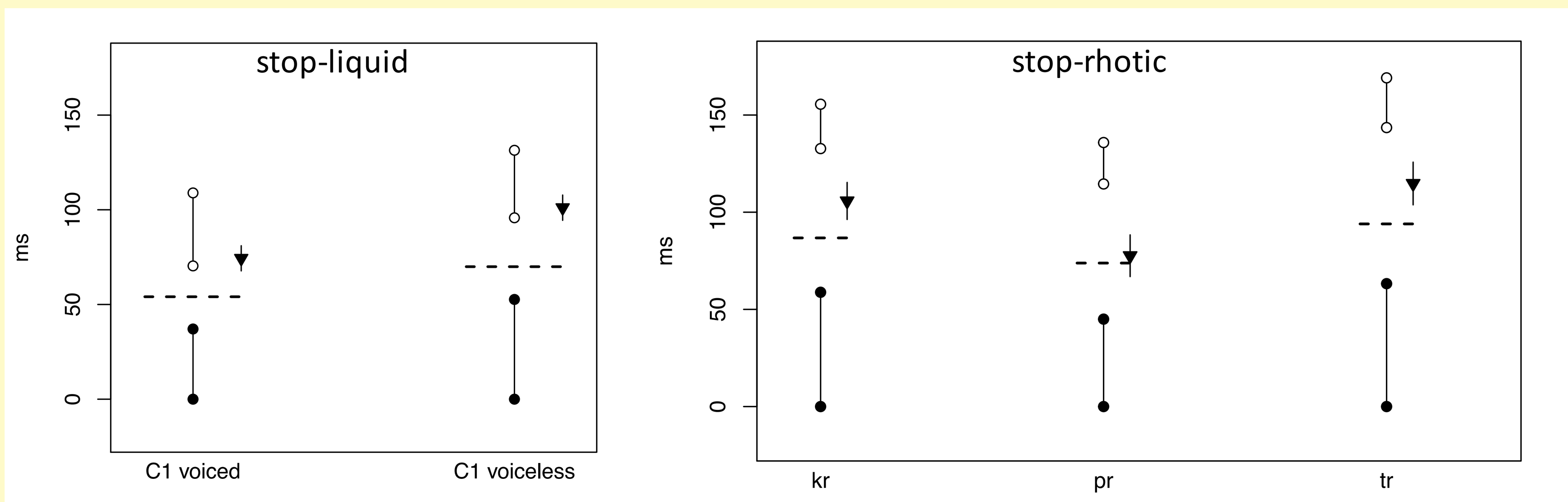

Fig. 4 – For C1 voiced and C1 voiceless stop-liquid clusters left and for stop-rhotic clusters right (x-axis), the vertical lines shown denote intervals corresponding to gestural plateaus. Intervals delimited by black dots indicate the plateau onset and offset timestamps (y-axis) of the initial consonant. Intervals delimited by white dots indicate the plateau onset and offset timestamps of the prevocalic consonant. The black triangle indicates the vowel start, plus-minus SE of mean, in relation to the plateaus of the two consonants. The horizontal dotted line indicates the c-center landmark of the cluster

- Vowel starts 20 msec after the c-center in voiced stop-liquid and 31 msec after the c-center in voiceless stop-liquid clusters
- Vowel starts 19 msec after the c-center of the /kr/ cluster, 6 msec after the c-center of the /pr/ cluster and 22 msec after the c-center of the /tr/ cluster

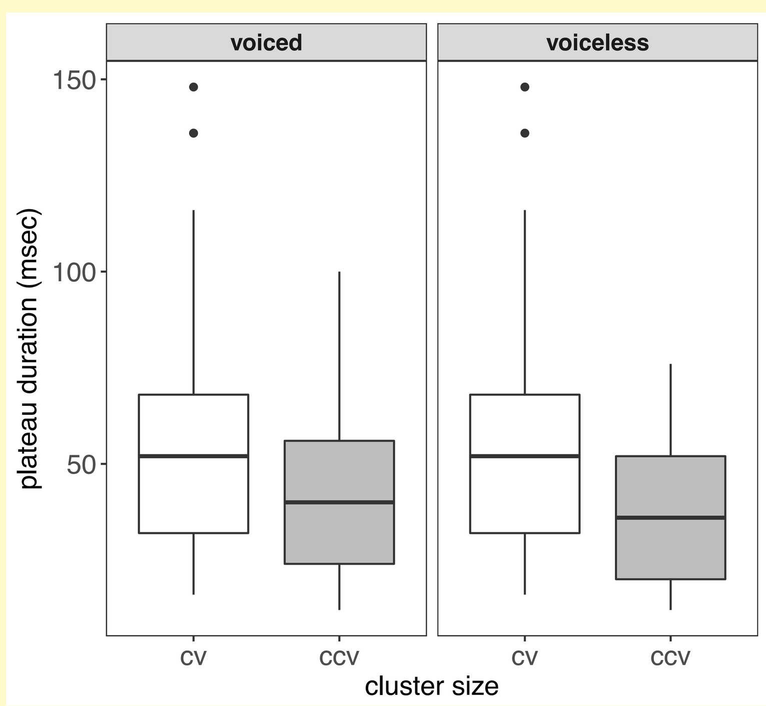

Fig. 5 – Duration of the prevocalic /l/ in CV and CCV with C1 voiced (left) and C1 voiceless stop (right)

- /l/ shortening from CV to CCV
- Greater /l/ shortening in C1 voiceless than in C1 voiced clusters (52 to 41 vs. 52 to 37.5 msec)

5 Conclusion

- Stability heuristics: C1 voicing affects temporal patterns in stop-liquid clusters
  - Evidence for local organization for C1 voiced stop-liquid clusters
  - Evidence for global organization for C1 voiceless stop-liquid clusters
  - Greater /l/ shortening in C1 voiceless than in C1 voiced stop-liquid clusters
- Vowel initiation: despite the stability heuristics, we find earlier vowel initiation in voiced stop-liquid than in voiceless stop-liquid clusters
- For stop-rhotic clusters, we find evidence for both local and global organization depending on anchor. However, we find early vowel initiation with respect to the c-center of the clusters

References:

[1] Hualde, J. I. 2005. The Sounds of Spanish. Cambridge, UK: CUP. [2] Wiese, R. 1996. The phonology of German. Oxford: Oxford University Press. [3] Dell, F. and M. Elmedlaoui. 2002. Syllables in Tashlhiyt Berber and in Moroccan Arabic. Dordrecht: Kluwer. [4] Gibson, M., Sotiropoulou, S., Tobin, S., and A. Gafos. 2017. On some temporal properties of Spanish consonant-liquid and consonant-rhotic clusters. In: M. Belz, S. Fuchs, S. Jannedy, C. Mooshammer, O. Rasskazova, M. Zygis (Eds.), Proceedings of the 13th Tagung Phonetik und Phonologie im deutschsprachigen Raum (PP13), 73-76. [5] Gafos, A. I., 2002. A grammar of gestural coordination. Natural Language & Linguistic Theory 20 (2), 269-337. [6] Lisker, L. and A. Abramson. 1964. A cross-language study of voicing in initial stops: Acoustical measurements. Word 20, 384-422. [7] Heath, J. 1987. Ablaut and Ambiguity: Phonology of a Moroccan Arabic Dialect. Albany: State University of New York Press.

This study was carried out under the auspices of the SFB 1297 project C04 (PI Adamantios Gafos)

Contact:
stsotiro@uni-potsdam.de