Syllabic structure and temporal organization of /sC/ sequences

insights from Spanish

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All together summary

Topic:

- The thesis indents to a better understanding of the link between **qualitative phonology** (linguistic representations) and **phonetics** (vocal tract action) during speech production through the example of syllabic structure.

Main objective:

- Explore if the linguistic representations of syllabic structure stipulate the syllabic organization during vocal tract action

HOW?

- Investigation of the relation between **syllabic structure** and **inter-segmental temporal coordination patterns** of /sC/ sequences in Spanish and English
- by employing the idea of **pleiotropy in phonetic indices** as claimed by Sotiropoulou (2019)

For this work we examine articulatory data from:

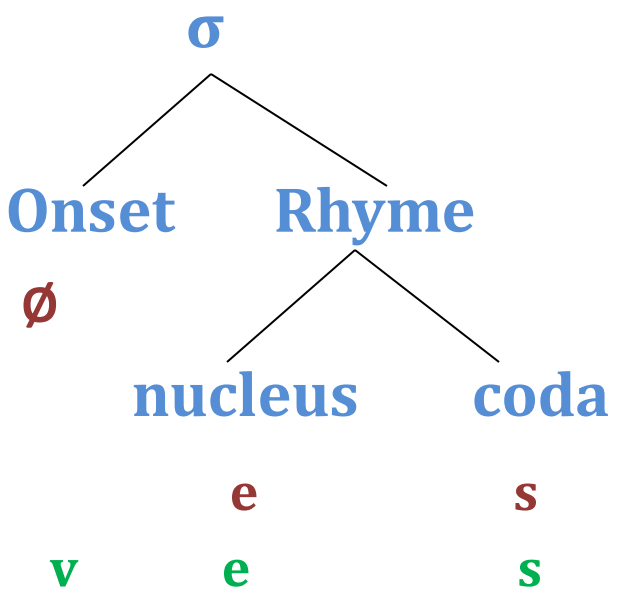
- Central Peninsular Spanish (henceforth, Spanish)
- American English (henceforth, English)

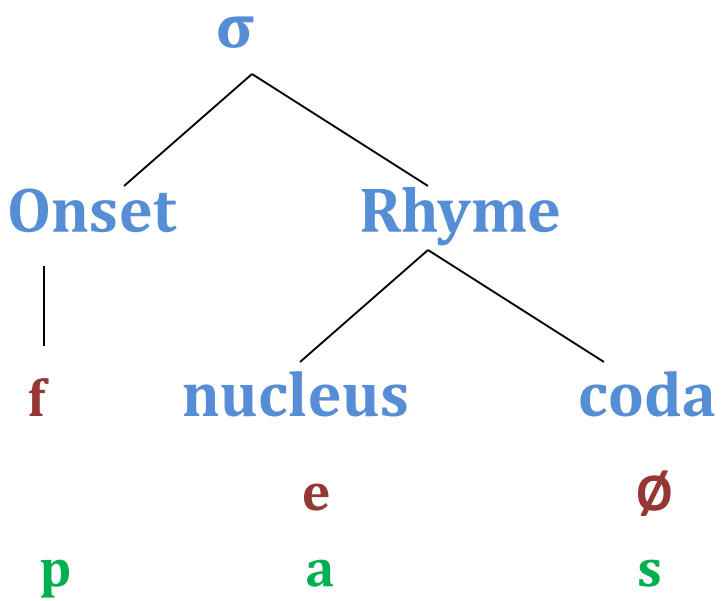
WHY Spanish? **WHY** English?

- Share shame (relevant) phonology; admit complex onsets
- BUT they differ with respect to /sC/ sequences
- Spanish disallows /sC/ sequences to be affiliated in the same syllable, hence to constitute word or syllable onsets
- English admits /sC/ sequences as complex onsets

Spanish

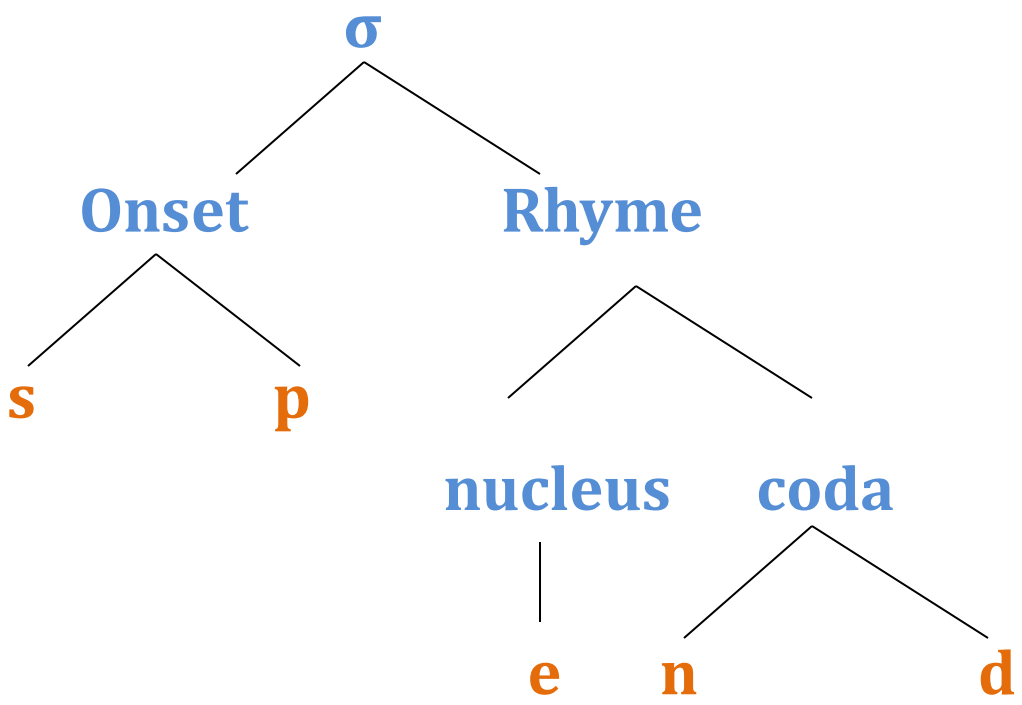
- word-initial: /*sfera/ → /esfera/ → /es.fe.ra/
- word-internal:/vespas/ → /ves.pas/ vs. /*ve.spas/





English

- word-initial: /spend/
- word-medial: /su.spend/



WHY Spanish? **WHY** English?

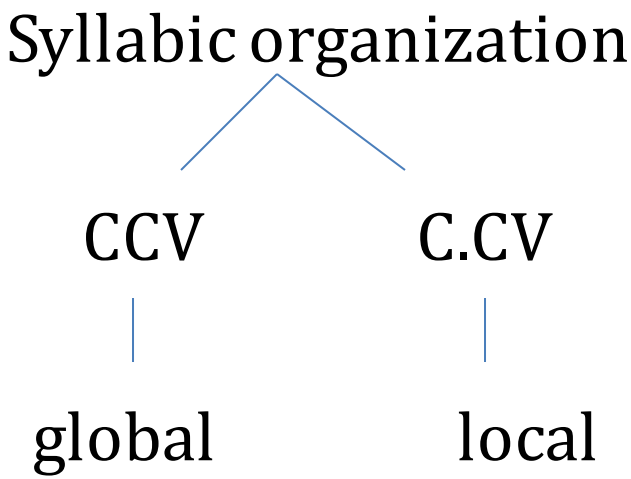
- Spanish exemplifies the local syllabic organization (simplex onset)
- English exemplifies the global syllabic organization (complex onset)

Hence:

- We can examine the effects of two contrasting syllabic organizations on the temporal coordination of segments and its relation with the phonetic record.

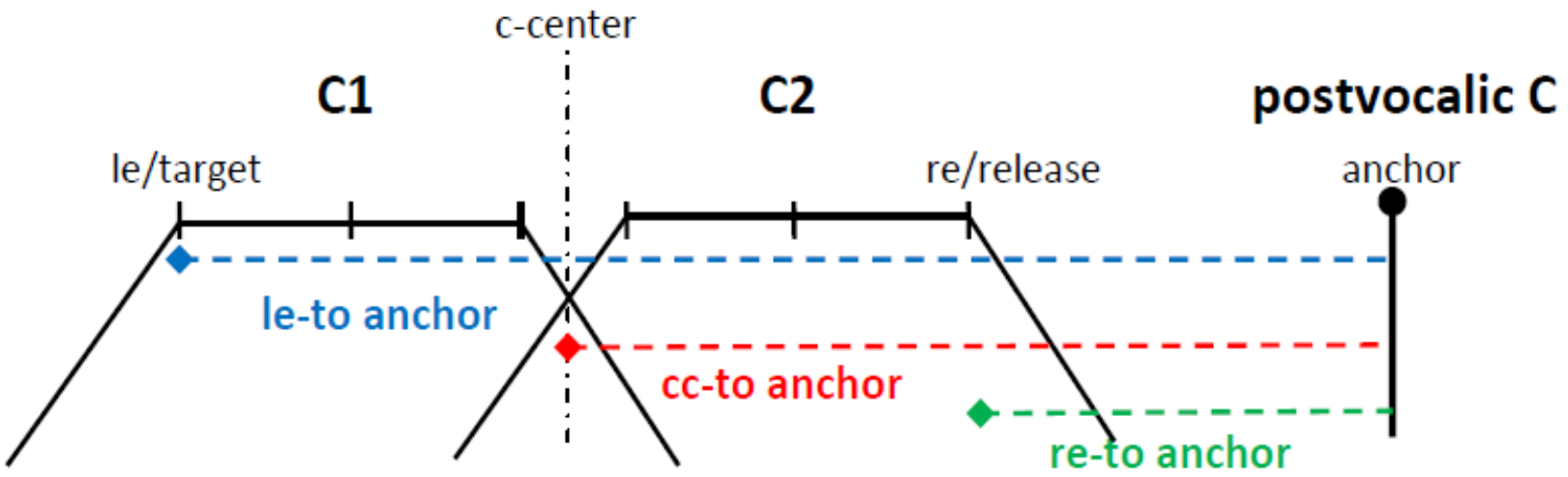
Articulatory Phonology Framework (Browman & Goldstein, 1986; et seq.)

- syllabic organization can be reflected on the temporal organization of the segments



Stability based heuristics as index of syllabic structure (Browman & Goldstein, 1988; et seq.)

- quantification of timing intervals stability



Stability based heuristics as index of syllabic structure (Browman & Goldstein, 1988; et seq.)

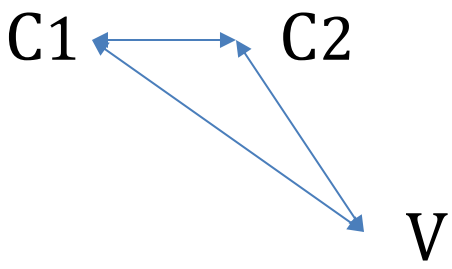
- Complex onset hypothesis (c-center effect)

→ complex onsets and thus, global organization have been claimed to be expressed in the c-center to anchor stability as more consonantal segments are attached to the onset, the c-center is the one that remains stable in a temporal relation with the vowel.

Phasing relations (Browman & Goldstein, 2000)

In a tautosyllabic CCV sequence:

- C-V phasing relation ("in-phase")
- C-C phasing relation ("anti-phase")



Phasing relations (Browman & Goldstein, 2000)

In a heterosyllabic VC.CV sequence:

- V-C phasing relation ("in-phase")

V1 ⟷ C1 C2 ⟷ V2

- C-V phasing relation ("in-phase")

Stability based heuristics as index of syllabic structure (Browman & Goldstein, 1988; et seq.)

- Simplex onset hypothesis

  → simplex onsets and thus, local organization have been claimed to be expressed in the right-edge to anchor stability as more consonants are appended in a CV, no rightward shift of the prevocalic C is expected, no overlap between CC and the vowel should be observed, in attestation of an organization where the consonants are simply left-adjoined in front of the CV

Browman & Goldstein's (1988) landmark study:

- inspired a lot of work
- interface syllabic structure – phonetics
- extensive use of stability based heuristics
- tested complex onset and simplex onset hypotheses

Languages that admit complex onsets:

- English: Honorof & Browman, 1995; Byrd, 1995; Goldstein et al., 2009; Marin & Pouplier, 2010
- German: Pouplier, 2012; Brunner et al., 2014
- Romanian: Marin, 2013
- Georgian: Ghitoran et al., 2002, Goldstein et al., 2009
- Polish: Pastätter & Pouplier , 2014; 2015

Languages that do not admit complex onsets:

- Berber: Goldstein et al., 2007; Hermes et al., 2011
- Moroccan Arabic: Shaw et al., 2009; 2011

- Many studies provided results in favour of Browman and Goldstein's (1988) hypothesis (e.g. Honorof & Browman, 1995; Byrd, 1995)

- BUT a number of studies revealed:
  - stability – based heuristics fail to diagnose consistently and successfully syllabic structure (e.g. Pouplier, 2012; Marin, 2013)
  - segmental identity of consonants and vowel that partake in the syllabic structure affect their timing patterns (e.g. Goldstein et al., 2009; Pastätter & Pouplier , 2014)

Pleiotropy of Phonetic Indices in the Expression of Syllabic Organization (Sotiropoulou, 2019)

- syllabic structure cannot be captured only by a single stability-based metric
- BUT is expressed in various phonetic indices

The pleiotropy claim (Sotiropoulou, 2019)

- how a number of phonetic measures react to alternations of a CCV
  - e.g. the segmental identity of C (labial vs. velar, voiced vs. voiceless) can affect C duration
- how the relation among segments' phonetic properties can reveal the patterns of syllabic organization

In this approach (Sotiropoulou, 2019) in a CCV sequence:

- if the effects of alternations to segments or the effects of segmental relations influence the rest of the whole, this is an indication of global organization

- if the alternations have no effects on the rest of the sequence, this points to a local organization

Data and Stimuli

- /sC/ sequences selected from a large articulatory dataset

Spanish

- 3 different sibilant + stop C combinations: /sp, sk, st/

Language	Cluster	#CV#	#sCV#	vowel
Spanish	/sp/	pe.pas	ves.pas	low /a/
		pe.pos	cres.pos	mid /o/
		co.pas	cos.pas	low /a/
	/sk/	ba.cas	vas.cas	low /a/
		pe.cas	pes.cas	low /a/
		pe.cos	pes.cos	mid /o/
	/st/	re.tos	res.tos	mid /o/
		ze.tas	ces.tas	low /a/
		po.tes	pos.tes	mid /e/

We examine:

- temporal coordination patterns of /sC/ sequences

- how different phonetic indices reflect temporal organization

Factors to be tested

- C2 place of articulation

- word position

Hypothesis

1. Spanish /sC/ sequences will not show neither reorganization, nor effects that ripple through the rest of the sequence, pointing to a local organization

Timing Analyses (following previous work: Sotiropoulou, 2019)

1. Inter-plateau Interval (IPI)
   - raw IPI: C2 target – C1 release in ms
   - normalized: IPI/ (C2 release – C1 target) total constriction duration of the cluster
     - negative values = high degree of overlap
     - positive values = low degree of overlap

2. C1 plateau duration
   - C1 plateau duration: interval between C release and C target
   - normalized value: C plateau normalized = C plateau duration/ (C2 release – C1 target)

Timing Analyses (following previous work: Sotiropoulou, 2019)

3. C2 plateau duration
   - C2 plateau duration: interval between C release and C target
   - normalized value: C plateau normalized = C plateau duration/ (C2 release – C1 target)

4. Compensatory relation between IPI and C2 duration values
   - how the C2 duration responds to an increase in duration of the IPI

Timing Analyses (following previous work: Sotiropoulou, 2019)

5. C2 shift patterns in CV ~ CCV (consonant – vowel timing)
   - lag between the release of the prevocalic C and the target of the postvocalic C in the CV~sCV contexts

6. Vowel initiation

- Sotiropoulou (2019) vowel initiation "as a window to possible effects of syllabic organization on articulation"
  - vowel initiation **in relation to the c-center** of the clusters was investigated in this data to gain a better picture of the syllabic organization in /sC/ clusters

Timing Analyses (following previous work: Sotiropoulou, 2019)

7. Stability based analysis

- two intervals for each stimulus observation, as defined in Browman & Goldstein (1988)
  - CC2A
  - RE2A
- anchor landmarks:
  - Ctar
  - Cmax

Spanish word – internal /sC/ (*N* = 387, 3 speakers)

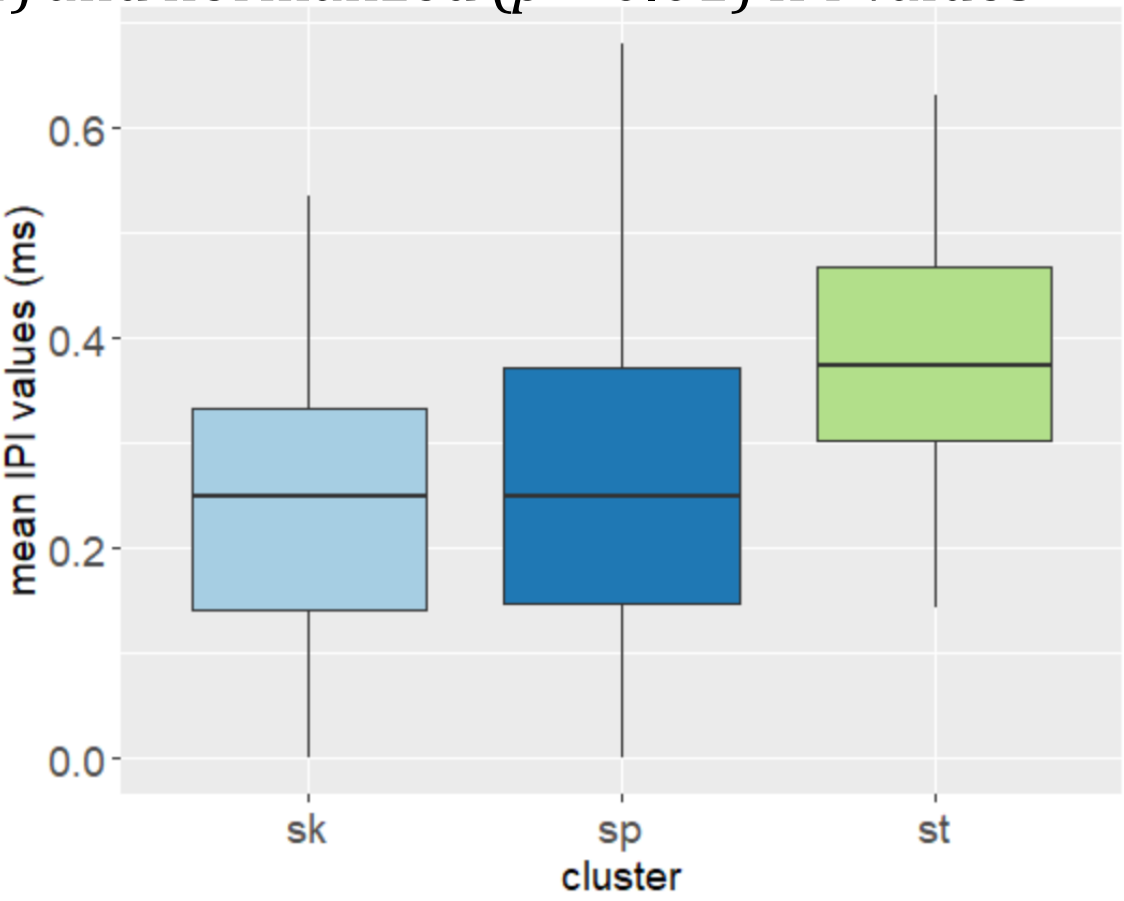
1. Inter-plateau Interval (IPI):

- significant main effect of C2 place of articulation

on both raw (p = 0.002) and normalized (p = 0.01) IPI values

IPI larger in:

- /st/ vs. /sk/ (13ms)
- /st/ vs. /sp/ (11ms)
- no significant difference between /sp/ and /sk/



Spanish word – internal /sC/ (*N* = 387, 3 speakers)

2. C1 plateau duration:

- significant effect of C2 place of articulation on C1 plateau duration for raw (p =0.004) and normalized (p = 0.03) C1 duration values

- C1 duration longer in:
  - /st/ vs. /sk/ (p = 0.04) (7ms)
  - no significant difference between /st/ and /sp/ (3ms)
  - no significant difference between /sp/ and /sk/ (4ms)

Spanish word – internal /sC/ (*N* = 387, 3 speakers)

3. C2 plateau duration:

- significant main effect of C2 place of articulation on C2 plateau duration for raw (p =0.0001) and normalized (p = 0.001) C2 duration values

- C2 duration shorter in:
  - /st/ vs. /sk/ (p = 0.001) (20ms)
  - /st/ vs. /sp/ (p = 0.002) (14ms)
  - no significant difference between /sp/ and /sk/ (6ms)

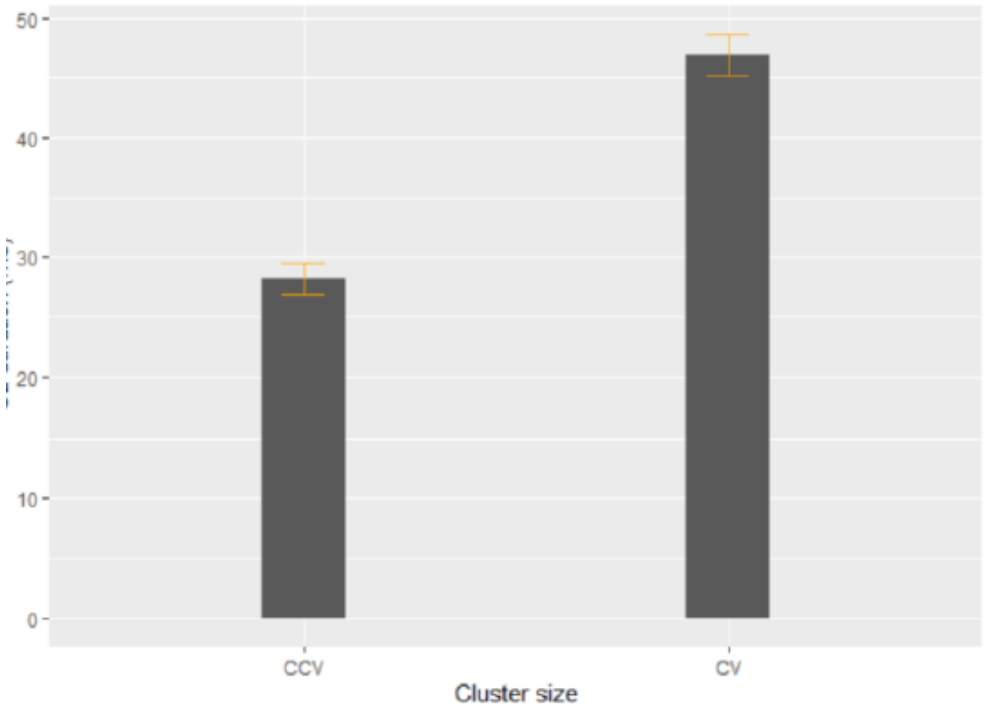
Spanish word – internal /sC/ (*N* = 387, 3 speakers)

4. C2 plateau duration in CV vs. CCV:

- significant interaction between cluster size and C2 place of articulation on C2 plateau duration (p = 0.000001)

Overall C2 duration shorter in CCV vs. CV (p < 0.0001) (19ms)

Figure 2; C2 duration as a function of cluster size



Spanish word – internal /sC/ (*N* = 387, 3 speakers)

4. C2 plateau duration in CV vs. CCV:

Table 4; Mean and standard deviations for C2 duration in CV and CCV

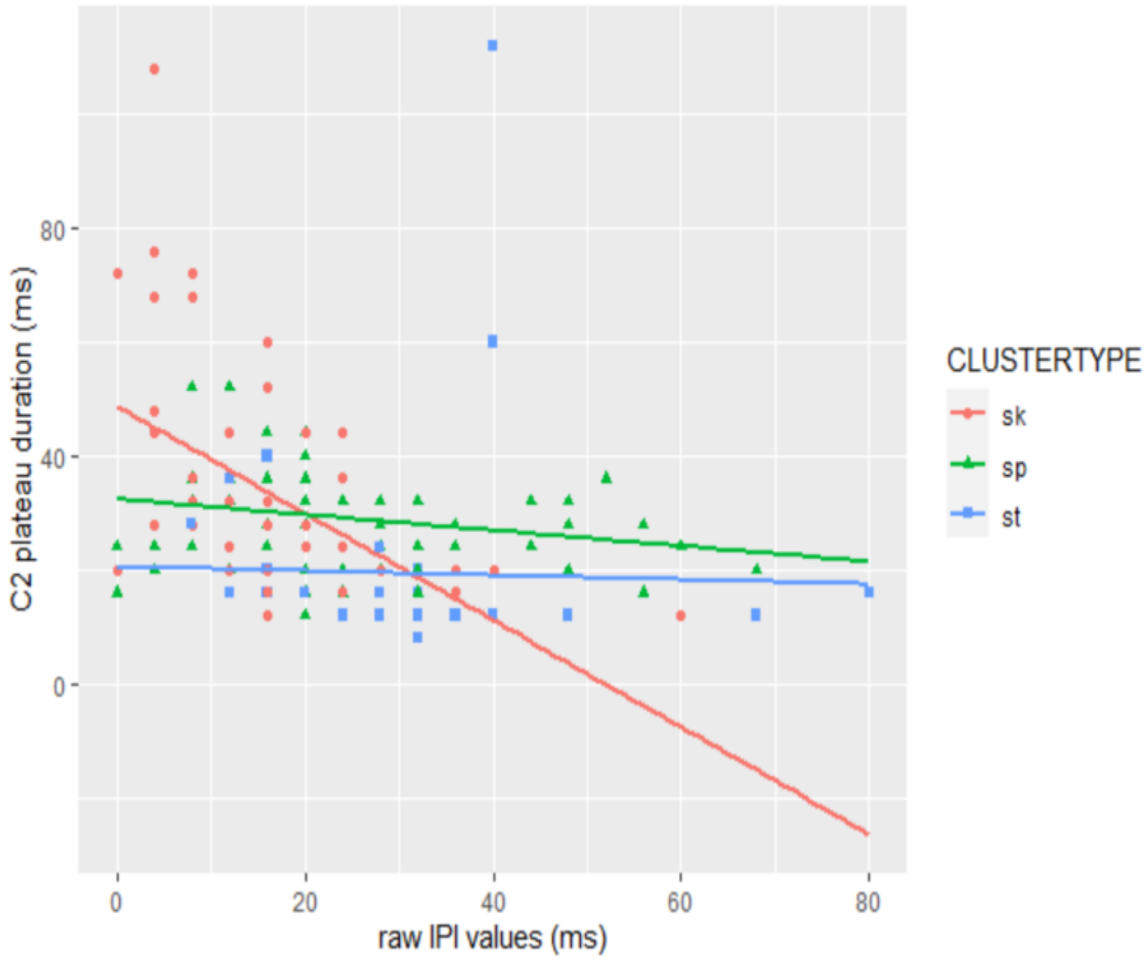
Duration C2 (ms)

	mean	sd
sC		
CV	47	16.62
CCV	28	25.88
sk		
CV	43	31.9
CCV	33	20.3
sp		
CV	32	9.74
CCV	29	9
st		
CV	67	16.7
CCV	19	18.8

Spanish word – internal /sC/ (N = 387, 3 speakers)

4. Compensatory relation between IPI and C2 duration values:

No compensatory relation between IPI and C2 duration



Spanish word – internal /sC/ (*N* = 387, 3 speakers)

5. C2 shift patterns (Consonant-vowel timing):

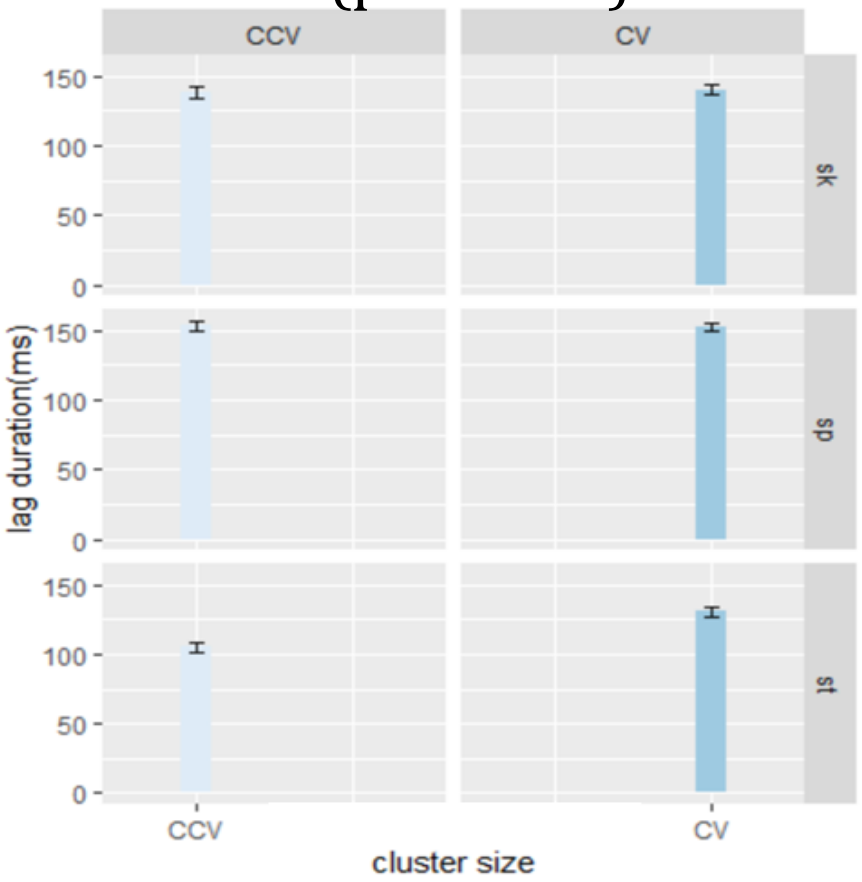
- no interaction between cluster size and cluster type
- only cluster type has a significant effect ($p < 0.001$)

For /sk/ and /sp/:

- C lag **does not** decrease when a C is added at a CV sequence (CV → CCV) ($p = 0.5$)

For /st/:

- **shorter** C lag duration in CCV vs. CV ($p < 0.05$)



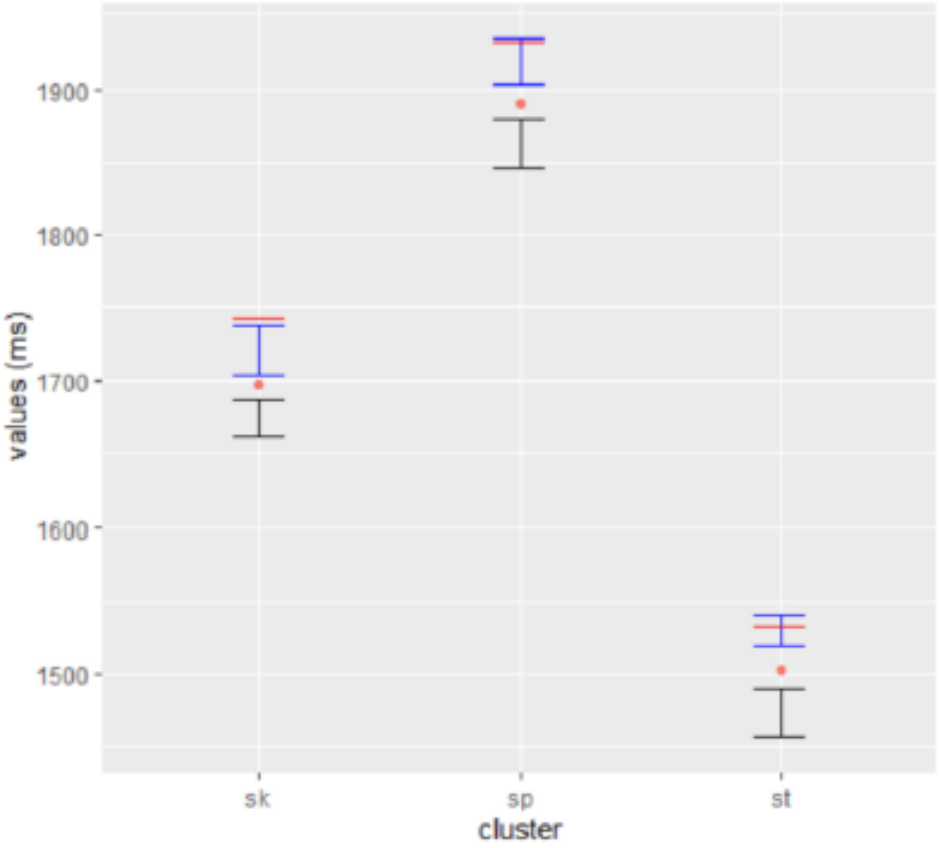
Spanish word – internal /sC/ (*N* = 387, 3 speakers)

6. Vowel initiation:

The vowel starts:

- for /sk/ after the release of C2
- for /sp/ at the release of C2
- for /st/ before the release of C2

Figure 9; vowel initiation as a function of C2 place of articulation

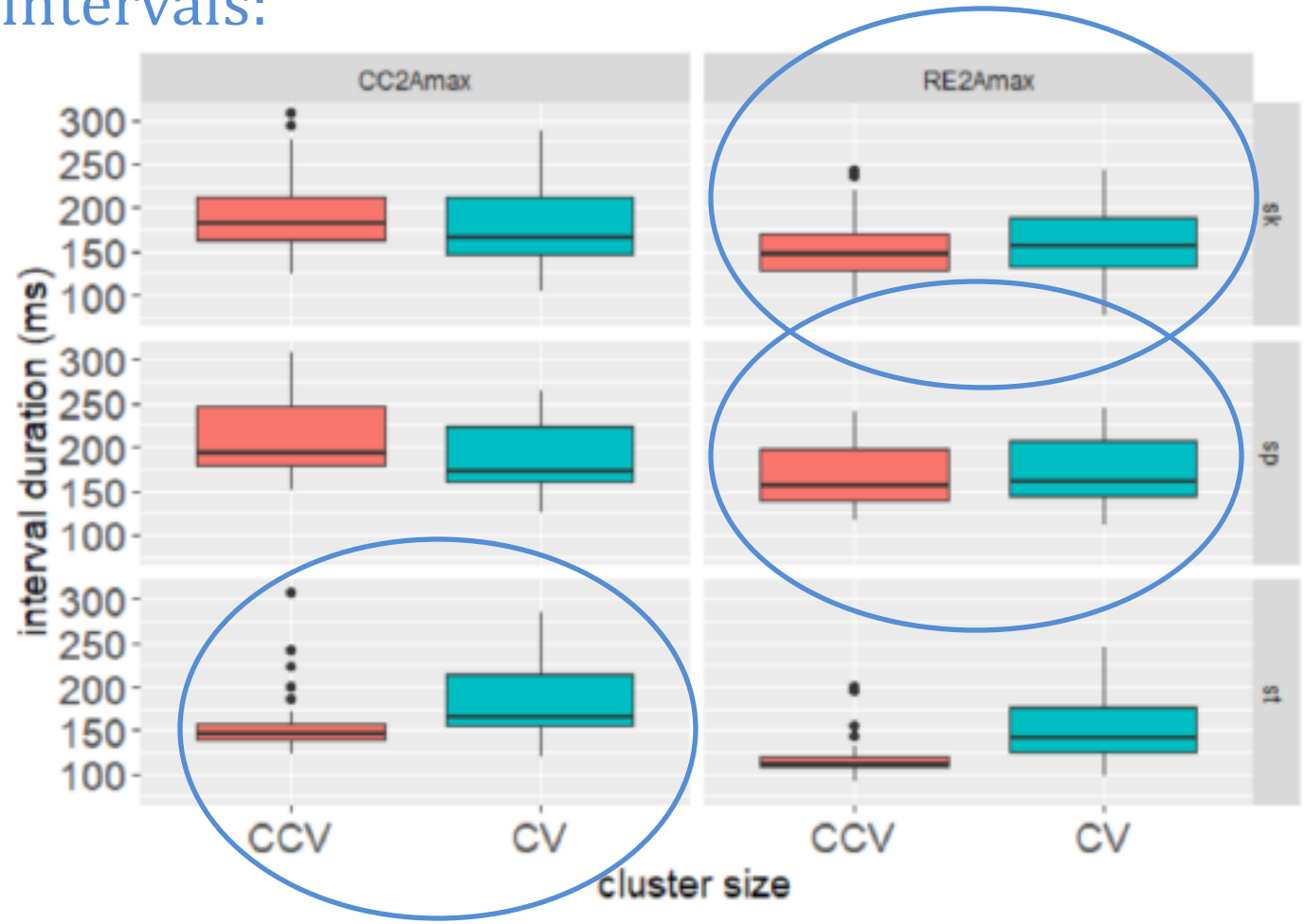


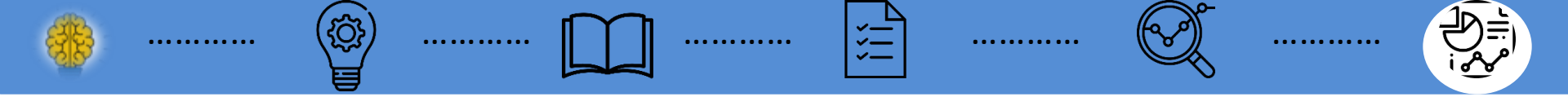
Spanish word – internal /sC/ (*N* = 387, 3 speakers)

7. Stability intervals:

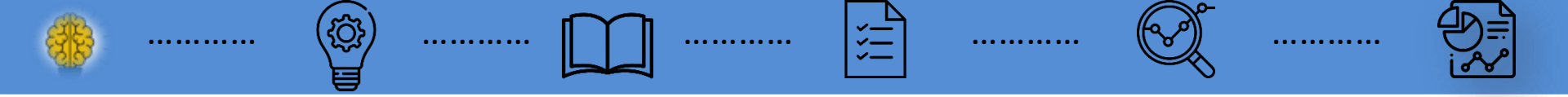
Across anchors:

- RE2A stability for /sk/ and /sp/
- CC2A stability for /st/





Cluster	IPI	C1	C2	C2 compression	C2 shift	IPI – C2	Vowel initiation	Stability
/sk/	0.25 ms	0.32 ms	0.43 ms	10 ms	no	no	after C2 release	RE2A
/sp/	0.27 ms	0.36 ms	0.37 ms	3 ms	no	no	at C2 release	RE2A
/st/	0.38 ms	0.39 ms	0.23 ms	48 ms	yes	no	before C2 release	CC2A



Thank you!