

# Romance lenition revisited: articulatory and model evidence from Spanish

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## From Latin to Romance

Latin intervocalic voiced stops spirantized and/or deleted in evolution of modern Romance varieties:

Latin	Italian	Portuguese	Spanish	Catalan	French
CABALLUS	ca[v]allo	ca[v]alo	ca[β]allo	ca[v]all	che[v]al
SUDARE	su[d]are	su[ð]ar	su[ð]ar	su[ð]ar	su[ð]er
NEGARE	ne[g]are	ne[g]ar	ne[ɣ]ar	ne[ɣ]ar	ni[ʃ]er

stop → spirant → ∅

- Why did these stops spirantize? Some proposals in the literature:
  - Push-chain effect caused initially by degemination of /pp/, /tt/, and /kk/, which led to voicing of /p/, /t/, and /k/. (e.g. Martinet 1952)
  - Voiced stops were deleted in all intervocalic positions then restored in word-initial position to avoid confusion (Weinrich 1958 cited in Cravens 2000)
  - Drag-chain caused by a drive to weaken articulation of all consonants (where weaker = shorter in duration) and a drive to maintain the same number of phonological contrasts in the system (Baker 2006)
  - "Segmental replacements resulting from a decrease in duration and in constriction degree" (Recasens 2002)

What mechanism underlies the change of voiced stops to spirants? That is, how does synchronic phonetic variation lead to diachronic sound change?

## How sounds change: a possible path

- Hypothesis: Some sound change is listener driven, caused by listeners misinterpreting articulatory patterns that create the acoustic signal (Ohala 1981). Listeners try to faithfully recreate the sound patterns they hear, including productions that are reduced from their original targets (Chen 2003).

Variation in production of stops (shorter duration, incomplete closure)

Listeners imitate PRODUCED constriction, rather than intended constriction target

Reduced production becomes phonologized, leading to a new gestural target for stops

- No need for active speaker implementation of lenition (cf. Kingston 2008, Kirchner 1998)
- Avoids needing to posit that listeners try to maintain contrasts in the phonological system

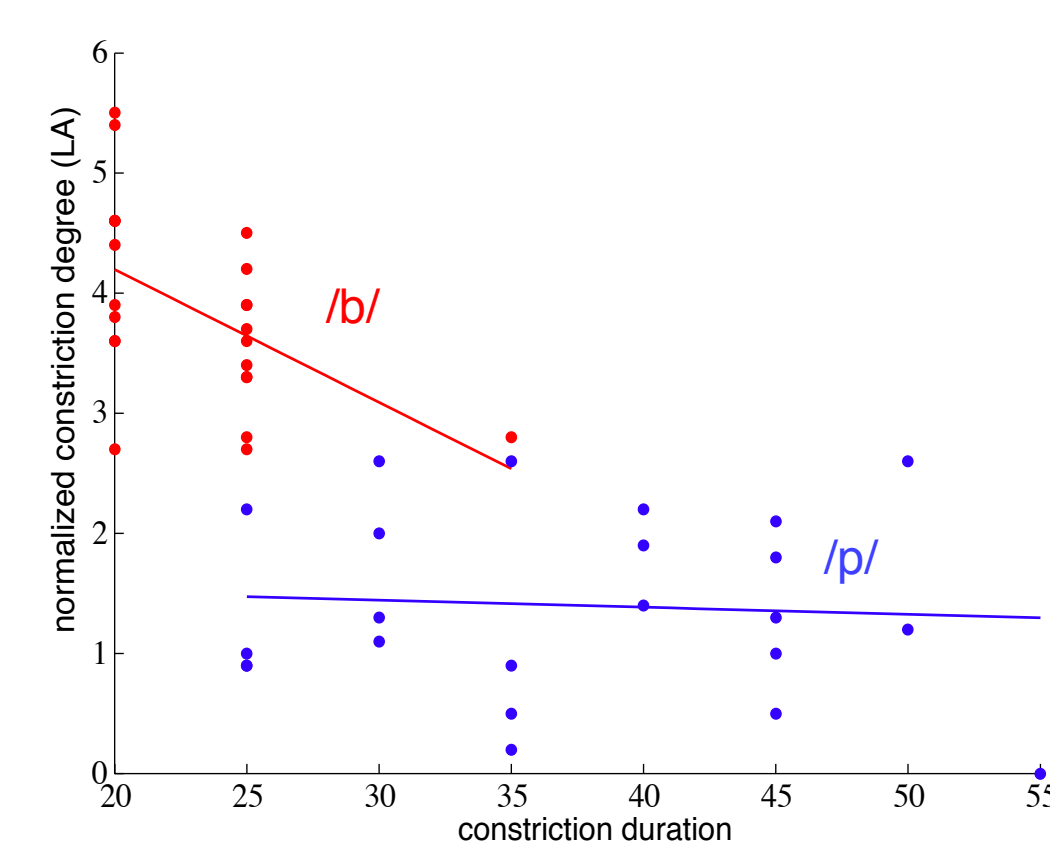
## Further questions

- Can this approach explain retention of /b, d, g/ after consonants/ different results of lenition based on vowel differences?
  - In principle, yes. Initial position closer to target after consonants or high vowels may result in full closure, which would not lead to gestural target reinterpretation. Further modelling will provide a more detailed account.
- Why does /b/ never delete? Why does /b/ merge with /v/?
  - Frication caused by undershoot may lead to merger with /v/. No existing coronal or velar voiced fricative.
  - Role of visual (multi-modal) input?
- What role, if any, do undershoot and reinterpretation play in processes of degemination (e.g. Latin /tt/ → Romance /t/) and voicing (e.g. Latin /d/ → Romance /t/)?

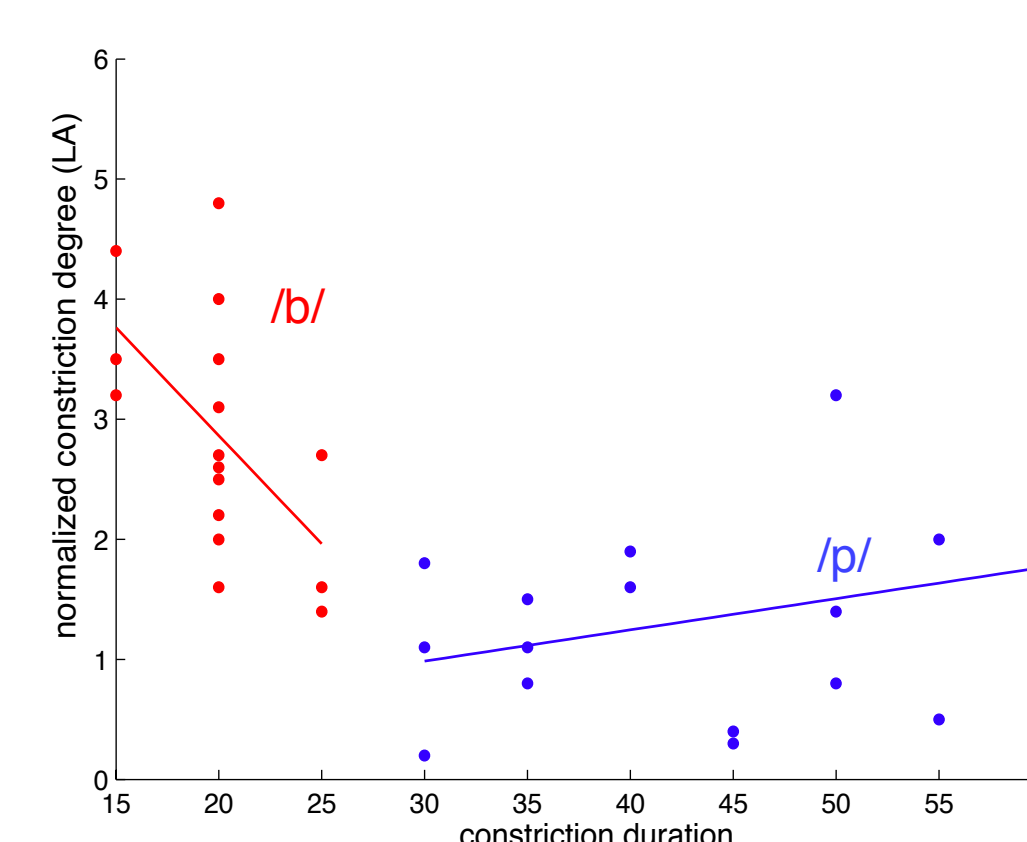
## Spirantization in Spanish: articulatory data on reduction

Question: Is lenition caused by duration alone, or does it also rely controlled constriction degree of reduced magnitude? (Parrell submitted)

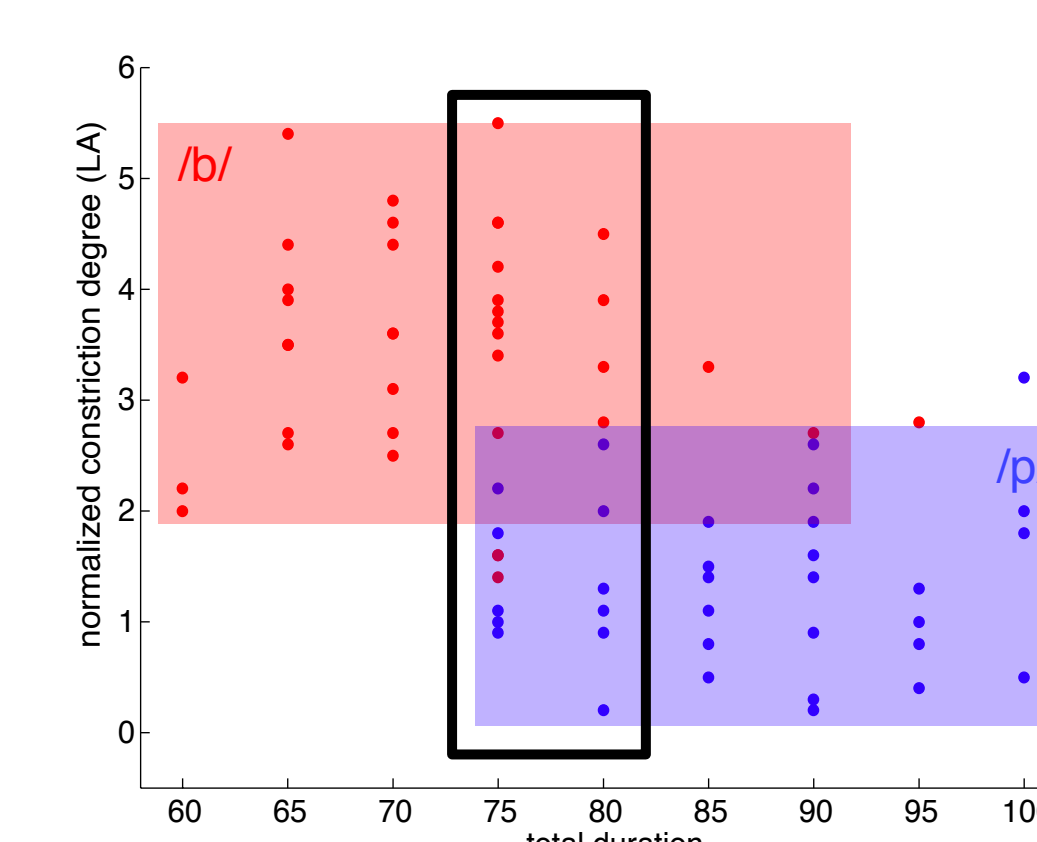
- EMA data from 2 speakers of peninsular Spanish
- /b/ and /p/ produced in phrase-internal position
- Lip Aperture measured at point of maximum closure



Subject A: correlation for /b/ between Lip Aperture and duration (R<sup>2</sup>: 0.26)



Subject B: correlation for /b/ between Lip Aperture and duration (R<sup>2</sup>: 0.32)



Both subjects: lots of overlap in duration, little overlap in Lip Aperture. Implies a less occluded target for /b/ than for /p/.

- Lenition is not just shorter duration (at least in peninsular Spanish)
- Duration does contribute to lenition of voiced stops, but their intended degree of lip aperture must also differ from that for voiceless stops

## Modeling interactions of duration and target

Hypothesis: Learners will interpret reduced constriction degree (caused by shortened duration) as the speaker's gestural goal

- Intervocalic /b/ modelled in TaDA (Nam et al. 2004), a computational model that generates both articulatory trajectories and corresponding acoustic signals (using HLSyn, Hanson & Stevens 2002)
  - Duration and intended constriction degree (CD) manipulated
    - Duration: 50-180 ms, 10 ms steps
    - Target CD: 0.5 to -2.0 mm, 0.1 mm steps
- Look for areas with similar acoustic and articulatory productions despite different articulatory control
  - differences due to normal duration fluctuations in running speech (e.g. speech rate)
  - possible sources of learner mishearing

Yellow box: target duration  
Red box: short duration in casual speech  
Green box: long duration at a word boundary  
solid line: reinterpretation to new target

### STAGE 1: Latin, Italian

- full closure at all durations
- burst at all durations
- slightly weaker intensity at 70 ms

### STAGE 2: Proto-Romance (?)

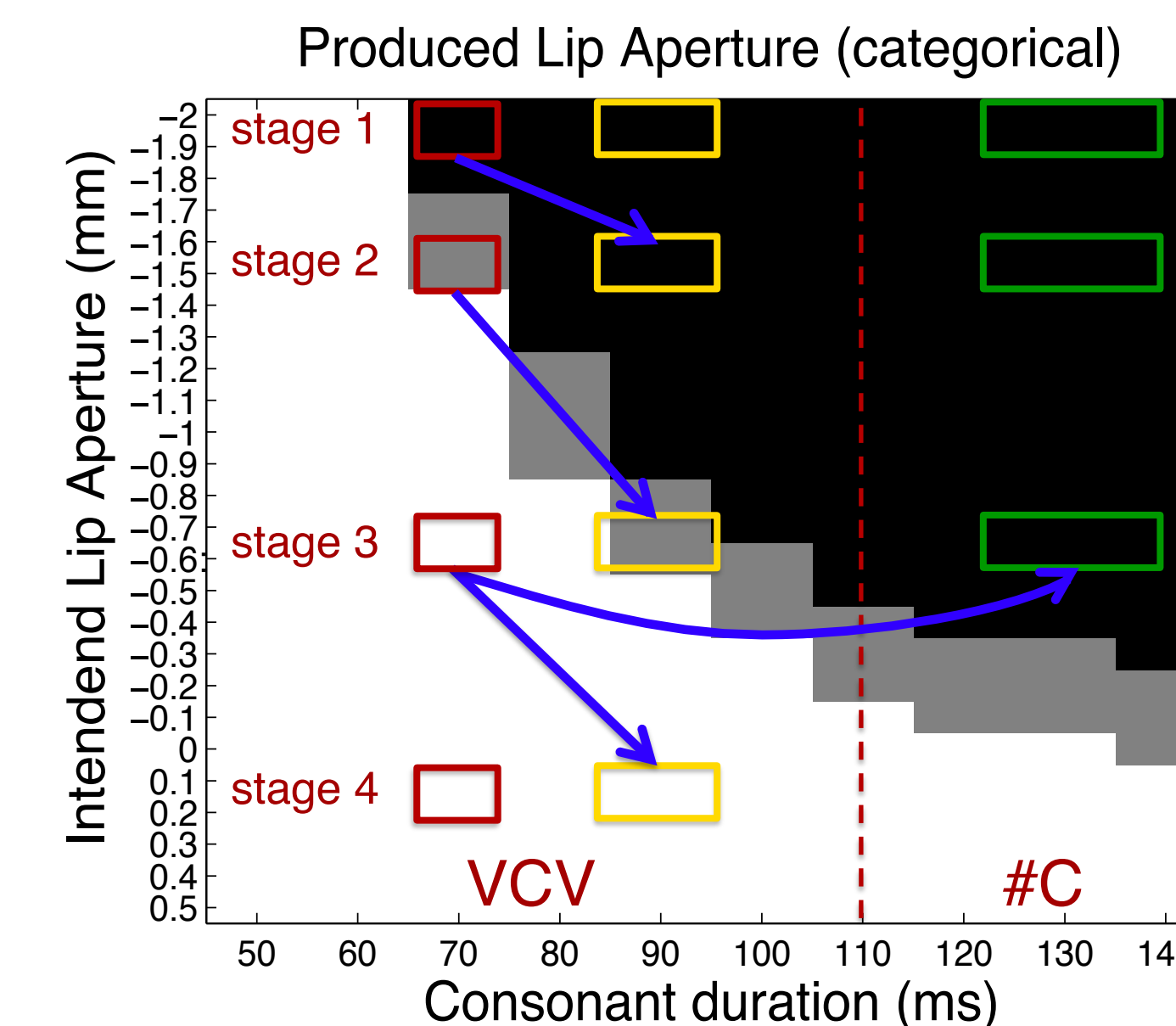
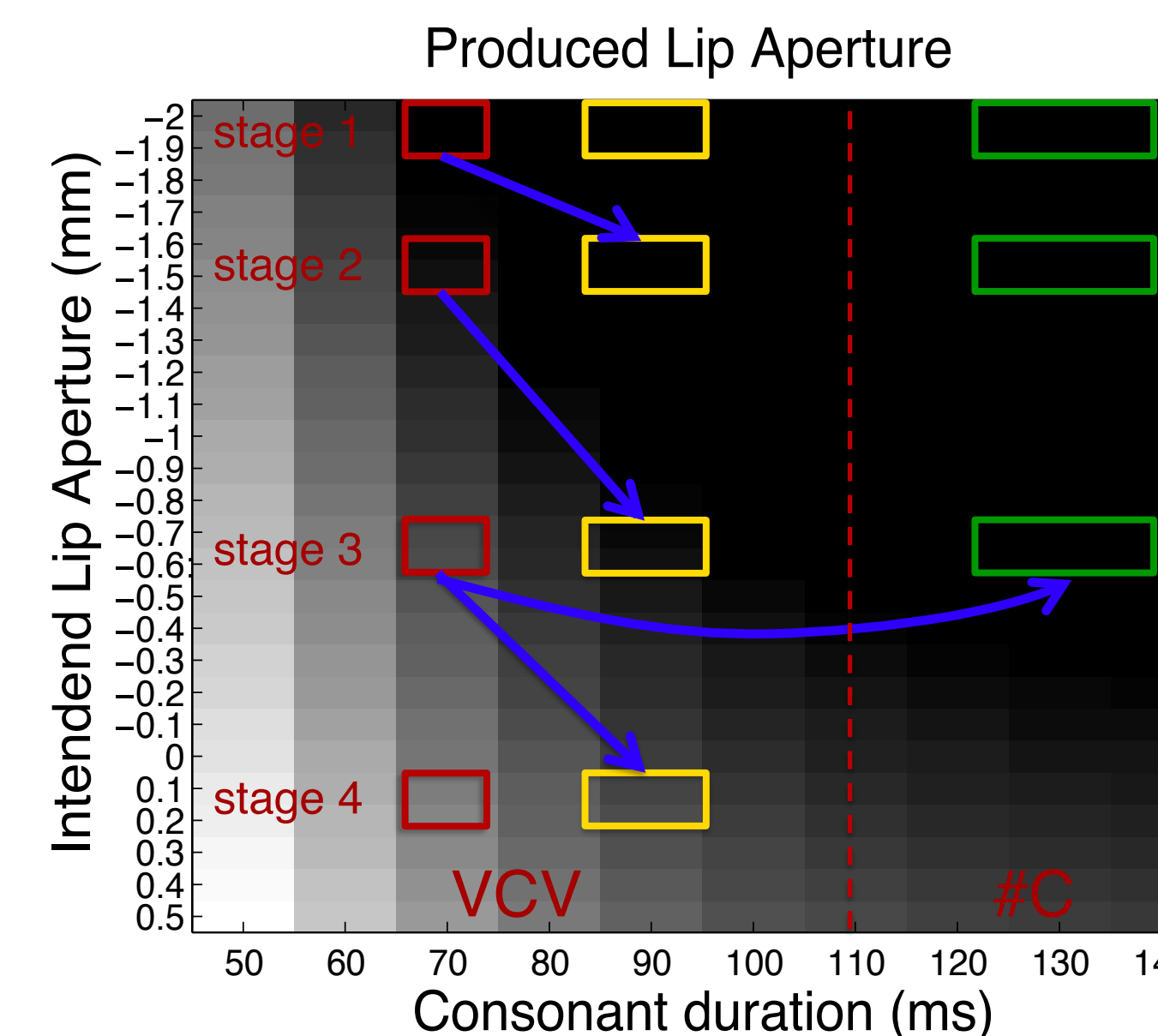
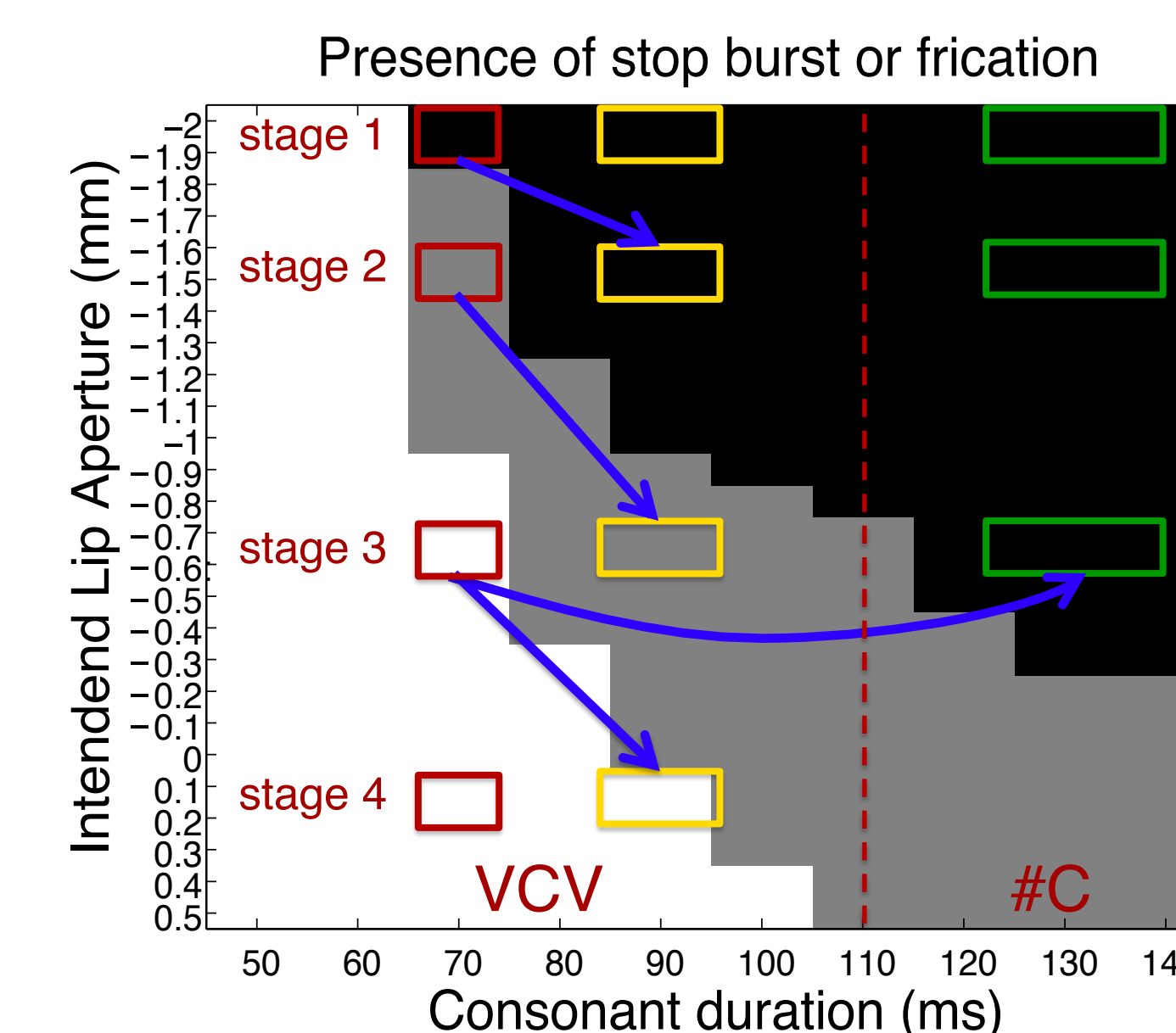
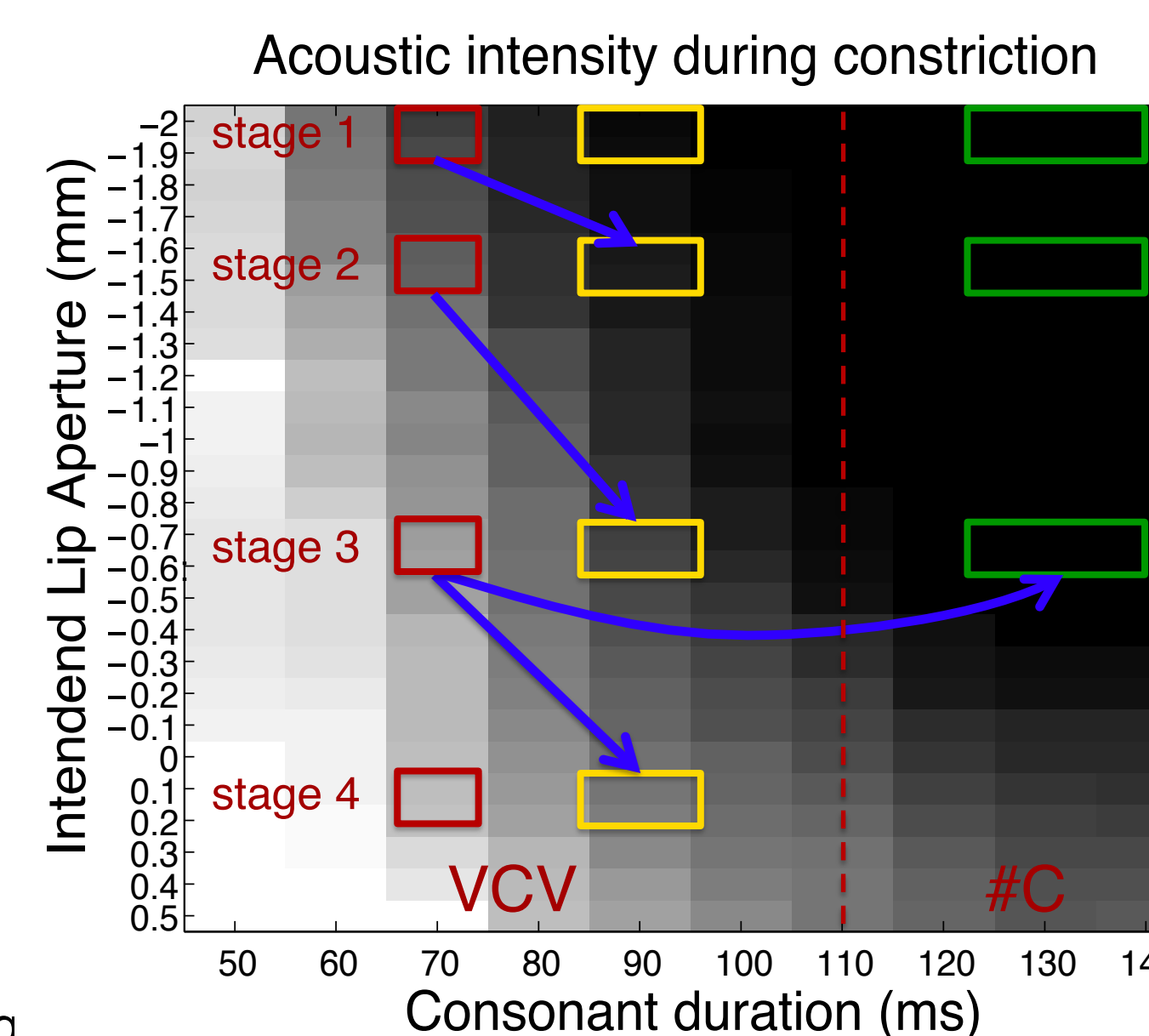
- closure at 120 & 90 ms, open at 70 ms
- burst at 120 & 90 ms, frication at 70 ms
- intensity: 70ms < 90 ms < 120ms

### STAGE 3: Spanish

- closure at 120ms, narrow at 90 ms, open at 70 ms
- burst at 120 ms, frication at 90 ms, nothing at 70 ms
- intensity: 70 ms < 90 ms < 120 ms

### STAGE 4: French

- different targets for word-medial & initial positions
- closure at 120 ms, open at 90 & 70 ms
- burst at 120 ms, nothing at 90 & 70 ms
- intensity: 70 ms = 90 ms < 120ms



## Conclusions

- Lenition of voiced stops to approximants (and subsequent deletion) starts with sporadic undershoot of full stop closure due to decreased duration
  - Can be seen in non-spirantizing languages such as English and French
  - Same variation in duration does not cause spirantization of voiceless stops due to their inherently longer duration
- Multiple combinations of intended consonant duration and constriction degree result in similar acoustic and articulatory consequences
  - Produced lip aperture, acoustic intensity, and the presence of a burst or frication
  - This many-to-one mapping could create confusion in perception of the intended speech gesture by language learners