

On Svarabhakti Vowel Duration: phonetic and phonological considerations

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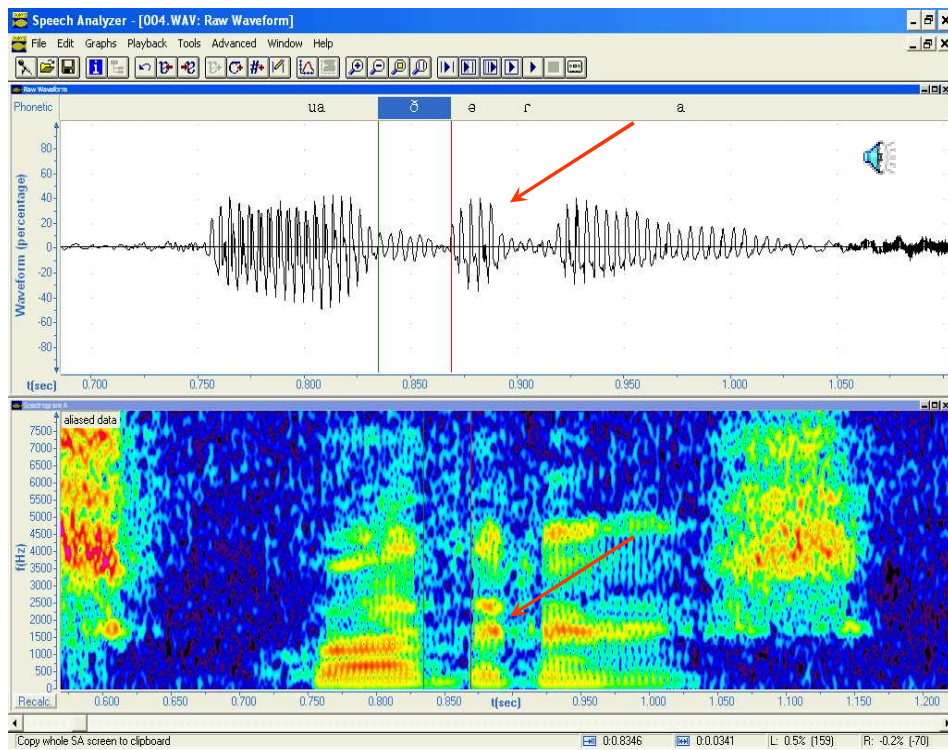
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Introduction

- Lenz (1892), Navarro Tomás (1918), Gili y Gaya (1921) – Svarabhakti vowels (henceforth, SVs)
- The term means ‘vowel-fragment’ in Sanskrit and originates from Sanskrit grammarians about 2500 years ago
- Environment: /Cr/ complex onsets
- a Spanish tap: əɾə
- The first consonant:
 - Voiceless fricative: [f]
 - Voiceless stop: [p], [t], [k]
 - Voiced stop: [b], [d], [g]
 - Voiced approximants: [β], [ð], [ɣ]

The problem: Durational variability of SVs

- *pronto* [pəɾ] 'soon'
 - *fresco* [fəɾ] 'fresh'
 - *otro* [təɾ] 'other'
 - *negro* [ɲəɾ] 'black'
- Below is an example of a canonical SV *cuadras* [ðəɾ] 'stables'



Data Collection

- Source
 - Recordings are part of a larger database of field recordings from different Spanish dialect zones
 - Speakers read a short passage
- All /Cɾ/ clusters were analyzed spectrographically and aurally
- Number of participants: 5 speakers of Peninsular Spanish
- Number of tokens: 159

Gili y Gaya (1921)

- First to conduct a phonetic study on SV duration for Peninsular Spanish
- performed duration measurements on a corpus containing 73 /Cɾ/ tokens that were systematically varied with respect to prosodic position within the word and segmental makeup of the cluster
- Noted SVs' high variability and its longer duration as compared to the ɾ

Bradley and Schmeiser (2003)

- Categorized GG's data into prosodic and segmental influences

Variable	Mean duration of SV (in cs) by cluster type			
Position within the word	Word initial	5.3	word internal	3.7
Stress	Stressed syllable	6.5	unstressed syllable	5.2
Order of constriction location	Back-to-front /kr/ vs. /pr/	6.3	Front-to-back /pr/ vs. /kr/	5.5

Five hypotheses on SV durational variability

- Based on Bradley and Schmeiser (2003) analysis of GG's data, three hypotheses regarding perceptability factors were put forth:
 - 1) word-initial /CrV/ demisyllables will evidence longer SVs than non-initial ones
 - 2) stressed /CrV/ demisyllables will evidence longer SVs than unstressed ones
 - 3) /CrV/ demisyllables with a back-to-front order of constriction location will evidence longer SVs than ones with a front-to-back order

Hypotheses continued

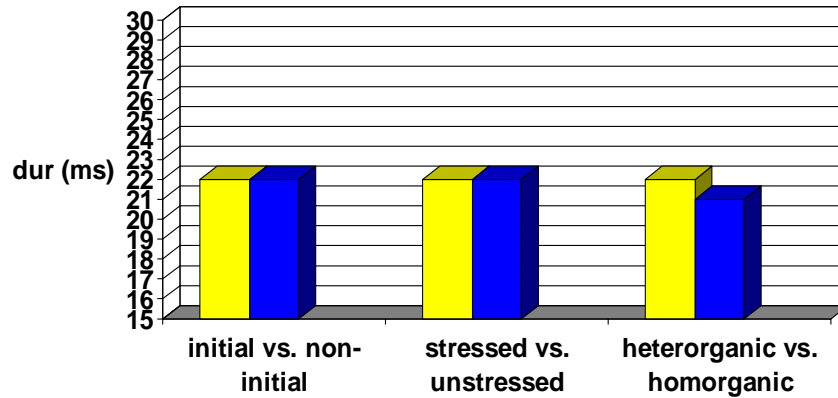
- Two more hypotheses were added, focusing on articulatory factors:
 - 4) Heterorganic /C_r/ clusters will evidence longer SVs than homorganic ones
 - 5) /C_r/ clusters in which C1 is voiced will evidence longer SVs than ones in which C1 is voiceless

Data Analysis

- Of the five hypotheses, two environments showed statistically relevant results: 1) voicing and 2) order of constriction
- Only one of the three environments from GG's study was statistically relevant: order of constriction
- SV duration was found to be more variable than rhotic duration, as shown by the coefficient of variation: SV (41%) and rhotic duration (29%)

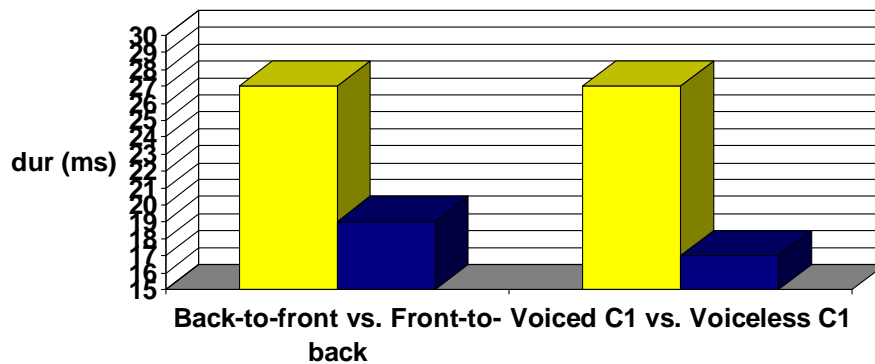
Hypotheses 1,2 and 4

No significant differences between means

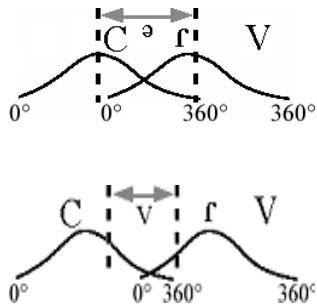


Hypotheses 3 and 5

Significant differences between means -- at the $p < .0001$ level according to a single-factor ANOVA



Theoretical Implications



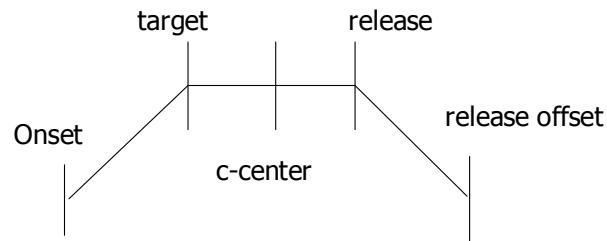
- In Browman and Goldstein's (1989, 1990, 1991, 1992) Articulatory Phonology (AP), gestures are dynamically defined articulatory movements that produce a constriction in the vocal tract.

3 relevant aspects of AP for this discussion

- 1) articulatory gestures have internal duration, a property represented abstractly in terms of a 360° cycle. Phonetic timing is thus intrinsic to the phonological representation
- 2) adjacent gestures are temporally coordinated with respect to each other and may exhibit varying degrees of overlap
- 3) Finally, consonantal articulations are *superimposed on vocalic gestures*, which are themselves articulatorily adjacent (Gafos 1999).

What is a gesture?

- A gesture is a spatio-temporal unit, consisting of the attainment of some constriction at some location in the vocal tract (Gafos, 2002:270, 271)
- Gestures, in Gafos' terms, are characterized by 'landmarks'



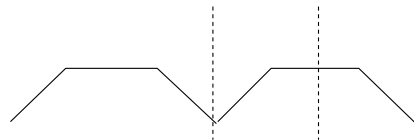
Byrd's notion of a phase window

- lexical representation specifies the requisite gestures and specifies which gestures are to be coordinated relatively
- Coordination between associated gestures is assumed to be variable but constrained to particular ranges specific to the types of gestures involved (e.g. C to C)
- It acts to limit the temporal compressibility or disassociation of gestures
- Useful for capturing the timing variability observed in the coordination of these gestures

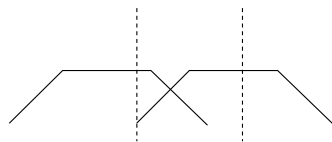
Spanish /Cr/ clusters -- My analysis in AP terms

- Gestures must intersect in the phase window
- The onset of the rhotic will be placed at the beginning of the phase window, given that the rhotic is less variable
- The gesture of C1 will be manipulated given that it is more variable (Blecua, 2001)
- For this reason, movement of the C1 gesture will control the perception of the SV

AP explanation of Spanish /Cr/ clusters



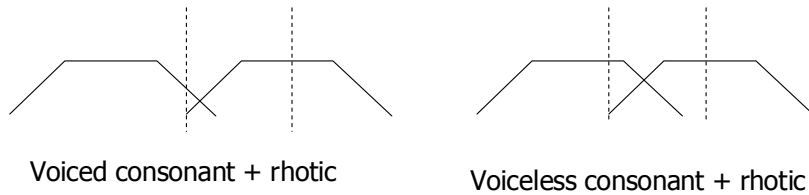
Full vowel confusion -- crónica → corónica
*note that the /o/ is a copy vowel



Svarabhakti vowel -- tres → [t̚əres]

Voicing

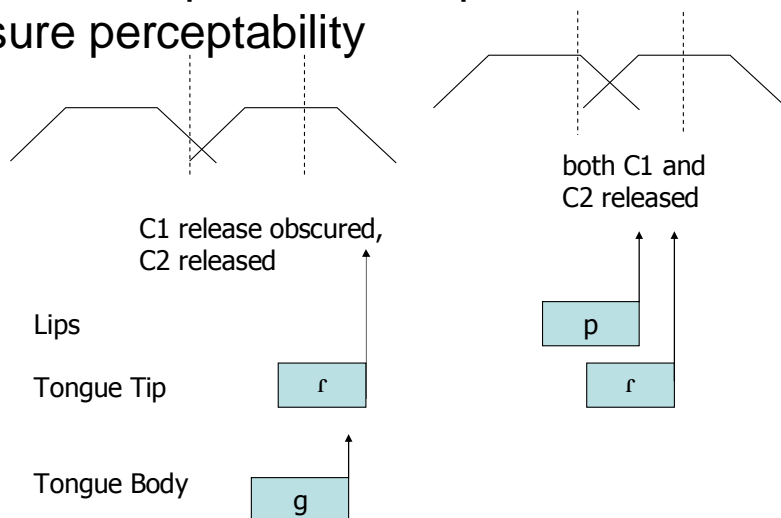
- The shorter the duration of the consonant, the less it extends into the phase window



- Thus, voiceless consonants consume more space in the phase window, creating a shorter SV duration

Order of constriction

Two gestures separate in the phase window to ensure perceptibility



Comparison to similar studies: Blecua's (2001) findings

- Analyzed rhotic duration in the speech patterns of two speakers of Peninsular Spanish
- Blecua considers SVs to be part of rhotic duration
- Only the duration of the SV varies with the duration of the C1
- The tap duration is not modified
- The SV is the principal factor in the differences in duration of the rhotic
- These observations corroborate my study's observations

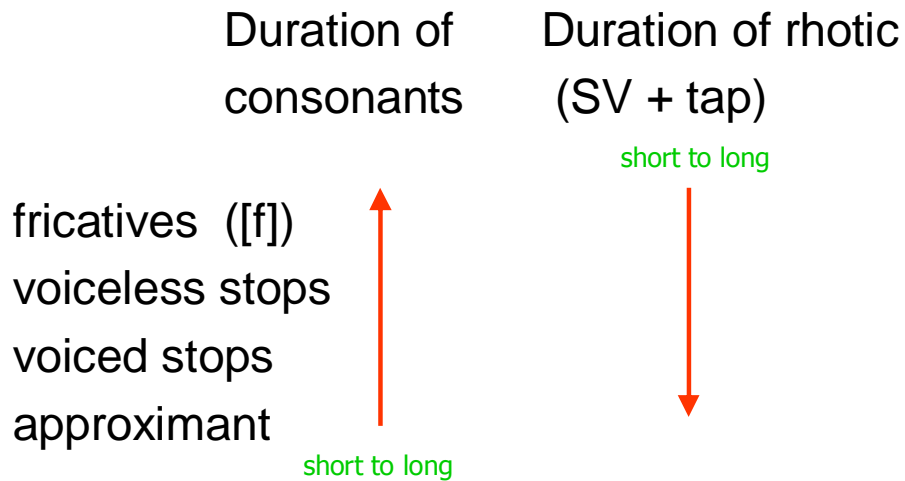
Blecua (2001) continued

- My findings corroborate Blecua's (2001) findings in terms of the following:
 Voicing: SVs were longer after voiced consonants
- My findings differ from Blecua's (2001) findings in terms of the following:

place of articulation was relevant in my study,
but not in hers

manner of articulation was relevant in her
study, but not tested in mine

Blecua's implicational relationship hypothesis



Manner of Articulation

- The following lists the average SV duration (in ms) with respect to manner of articulation:
- Fricatives [f] : 17.447
- Voiceless Stops [p], [t], [k] : 20.7
- Voiced Stops [b], [d], [g] : 25.4
- Approximants [β], [ð], [ɣ] : 28.593

Discussion

- Though the differences were *not* statistically significant, the previous slide does support Blecua's hypothesis that manner of articulation affects SV duration
- These data, coupled with the data in Schmeiser (to appear) seem to suggest that SV duration is not as varied as previously thought

Order of Constriction and Voicing: A closer look

- Voiced Consonants (longer SV)
 - [b], [d], [g], [β], [ð], [ɣ]
- Back to Front Order of constriction (longer SV)
 - *[k], [ð], [ɣ]
- Voiceless Consonants (shorter SV) -- [f], [p], [t], [k]
- Front-to-back Order of constriction (shorter SV) -
 - [f], [p], *[b], *[β]
- * = explained in the following slide

Problematic areas of the analysis

- For order of constriction and voicing, there are consonants in contradictory categories. For example: *[b], *[β] are voiced (longer SV) *and* front-to-back order of constriction (shorter SV).
- *[k] is voiceless (shorter SV) *and* back-to-front order of constriction (longer SV)

Voicing *within* Order of Constriction and vice versa

- 'statistically significant' = $p < 0.05$ in ANOVA single factor
- The following categories were found not to be statistically significant:
 - For voiced consonants: front to back ([b], [β] vs. back to front ([g], [ɣ])
 - For Back to Front consonants: voiced ([g], [ɣ]) vs. voiceless [k]
 - For Front to Back consonants: voiced ([b], [β]) vs. voiceless [f], [p] (p value of 0.055)
- The following category was found to be statistically significant:
 - For voiceless consonants: Front to back ([f], [p]) vs. back to front ([k]) (p value of 0.016)

Problematic areas, cont'd

- With regard to manner of articulation, [p] and [k] are both voiceless stops, yet they have an opposite order of constriction (front-to-back and back-to-front, respectively)
- Place of articulation?
- Another possibility is to organize the consonants by place of articulation:
 - (labiodental [f], bilabial [p],[b], [β] , alveodental [t], [d], velar [k], [g], [ɣ] interdental [ð],)
- Again, the problem arises of consonants in the same class with contradictory categories (e.g. bilabial: [p] is voiceless, [b] voiced)

Conclusion Part 1-- Where do we go from here?

- Analyze SV duration with regard to manner of articulation with more speakers, given that there is a trend.
- Find to what extent order of constriction plays a role, given that it was relevant in my study, but not in Blecua's
- Test Blecua's hypothesis on a possible 'onset window,' which could give insight into the notion of the syllable

Conclusions – Part 1 continued

- Use the five hypotheses set forth by Bradley and Schmeiser (2003), manner of articulation and place of articulation to analyze SV duration. However, also analyze SV duration variability following EACH phoneme (or allophone)
- Move on to the effects of the previous and following vowel (though Blecua found this to be statistically insignificant)
- Test more speakers of both Peninsular and Latin American Spanish

Conclusion – Part 2 Final Remarks

- **Schmeiser (to appear) found that order of constriction and voicing showed statistically significant results**
- **The present study focused on manner of articulation, finding a *trend*, which calls for further study**
- **However, given that the categories are quite broad and contain problematic and contradictory cases, do we analyze place of articulation or do we look at other qualities of the consonant? (Blecua found place of articulation to be statistically insignificant)**
- **Moreover, should we expect consistent findings from such a variable phenomenon? That is, should we be content with discovering *trends* in SV duration variability?**

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