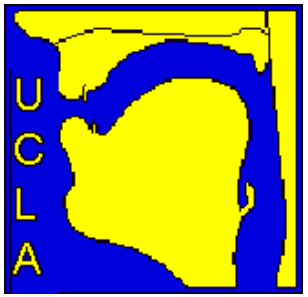
Prominence vs. phrase-initial strengthening of voice quality



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LSA 2013 Meeting, January 5, 2013

Introduction:
Word-initial glottalization

- **Word-initial vowels** in many languages are often preceded by a **glottal stop [ʔ].**[1,2,3,4]
  - Or by an incomplete glottal stop (laryngealization/creaky voice).
  - Glottal stops are often thought to be inserted segments.

- Glottal stops typically occur in prosodically **strong** environments (phrase-initial and/or prominent).[1,2,3]

- Thus, **glottal stops** may result from **prosodic strengthening**.

1. Pierrehumbert & Talkin (1992), 2. Dilley et al. (1996), 3. Fougeron (2001), 4. Borroff (2007)

Introduction:
Prosodic strengthening

- **Prosodic strengthening** is a more "forceful" articulation as a result of **phrasal position** and/or **prominence** (phrasal accent). [1,2]
  - *All the students have been studying **ALL** day long.*

- More "forceful" articulation →
  - Greater muscular activation[3,4]
    - E.g., greater activation of *levator palatini* for nasal and oral sounds alike → /n/ shows **decrease** in nasal flow.

1. Fougeron & Keating (1997); 2. Cho (2005); 3. Straka (1963); 4. Fougeron (2001)

Introduction:
Prosodic strengthening of voice quality

- **Word-initial glottalization** may result from **prosodic strengthening**.
  - Strengthening of what?
  - **Is word-initial glottalization a reflex of voice quality strengthening**?

- How could voice quality be strengthened?
  - Greater muscular activation
    - E.g., greater activation of intrinsic laryngeal muscles used in voicing

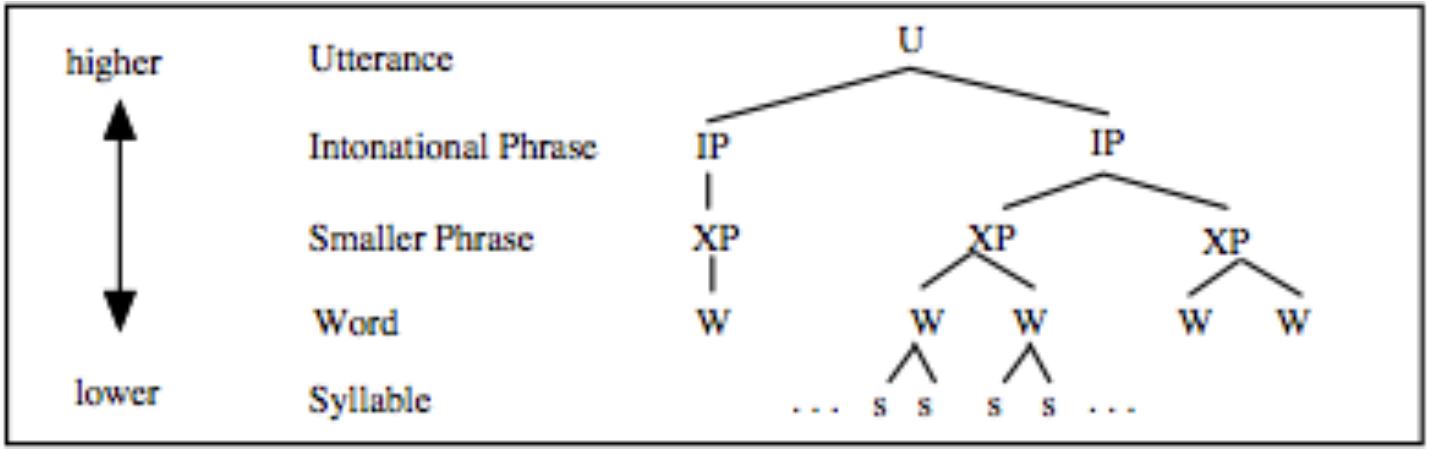
    → Greater vocal fold contact → **laryngealization**, or (at extreme) a **glottal stop [ʔ].**[1,2]
  - So, glottalization ≠ insertion of glottal stop?

- But if voice quality **in general** is strengthened, **other voiced sounds** should show glottalization like vowels.

1.Fougeron (2001); 2. Borroff (2007)

Introduction:
Prosodic strengthening of voice quality

- For vowels and sonorants, we should find **increased** vocal fold contact in **strong** positions, such as:
  - **Prominent** positions:
    - Lexical and phrasal stress
  - **Phrase-initial** positions:
    - Starts of prosodic phrases, esp. in the highest phrasal positions.



(Keating et al. 2003)

Introduction:
Prosodic strengthening of voice quality

- Preliminary predictions regarding voice quality strengthening:

1. Prosodic strengthening of voice quality should regularly involve increased vocal fold contact, for both prominent and phrase-initial positions.

- *If glottalization is a reflex of **voice quality** strengthening* →

2. Other voiced sounds (e.g. sonorant consonants) should show similar effects.

Introduction:
Utterance-initial voicing

- However, Utterance onsets pose a problem for these predictions.

- The onset of an Utterance is characterized by:
  - rapid increase in subglottal pressure and airflow
  - vocal fold abduction or **spreading**[1]

- Vocal fold spreading in Utterance-initial position can be due to **respiration**:
  - Utterances are preceded by intake of breath.
    - Vocal folds spread widely during inspiration.

1. Slifka (2000; 2006)

Introduction:
Utterance-initial voicing vs. strengthening

- Prosodic strengthening of voice quality should involve increased vocal fold **contact**.

- Paradoxically, Utterance-initial voicing should involve increased vocal fold **spreading**.
  - Even though Utterance onsets are the strongest phrasal position.

- **Do Utterance-initial constraints on voicing initiation inhibit prosodic strengthening of voice quality?**

Introduction:
Prosodic strengthening of voice quality

- Revised predictions regarding voice quality strengthening:

1. Prosodic strengthening of voice quality should involve increased vocal fold contact, for both prominence and phrase-initial strengthening, **except Utterance-initially**.

- *If glottalization is a reflex of **voice quality** strengthening* →

2. Other voiced sounds (e.g. sonorant consonants) should show similar effects.

Introduction:
Cross-language differences

- Glottalization rates vary across languages.[1,2]
  - Voice quality strengthening might vary in degree cross-linguistically.

- For example, glottalization is thought to be rare in Spanish.[1,3]
  - Only the strongest positions (prominent + IP-initial) should show voice quality strengthening in Spanish.

1. Bissiri et al. (2011); 2. Pompino-Marschall & Żygis (2011); 3. Valentín-Márquez (2006)

Introduction:
Research questions

- Do **both** prominence and phrase-initial strengthening yield increase in vocal fold contact?
- Does voice quality strengthening affect **both** vowels and sonorants?
- Does Utterance-initial vocal fold spreading **inhibit** voice quality strengthening?
- In Spanish, which has "rare" glottalization, does voice quality strengthening occur in **only the strongest prosodic positions**?

Method:
Task and stimuli

- English or Spanish read speech, with target words embedded in several sentential frames for differing prosodic positions.

- Vowel-initial or sonorant-initial proper nouns (e.g. *Anna* in English or *Ana* in Spanish).

- Target sound was either stressed (e.g. *Anna/Ana*) or unstressed (e.g. *Annette/Anita*).
  - Stressed syllable can attract phrasal prominence.

- Sonorants: [m, n, l, ɹ, w, j] in English; [m, n, l, j] in Spanish.

Method:
Phrasal positions in English

- Utterance-initial:
  - ***Anna*** *was sitting on the sofa for the entire day.*
- IP-initial:
  - *Was that Alexander?* ***Anna*** *was talking to him today.*
- ip-initial:
  - *Teddy, Alexander,* ***Anna****'s older sister, and Jim slept.*
- ip-medial (word-initial):
  - *Alex liked to bother* ***Anna****'s older sister on the trip.*

Method:
Participants & recording

- 12 (6F, 6M) native speakers of English, 12 (7F, 5M) native speakers of Mexican Spanish read the target sentences.

- English: 60 sentences (read twice per speaker) = 1440
  Spanish: 56 sentences (read twice per speaker) = 1344

- Simultaneous electroglottography (EGG) and audio were recorded.

Method:
Labeling and segmentation

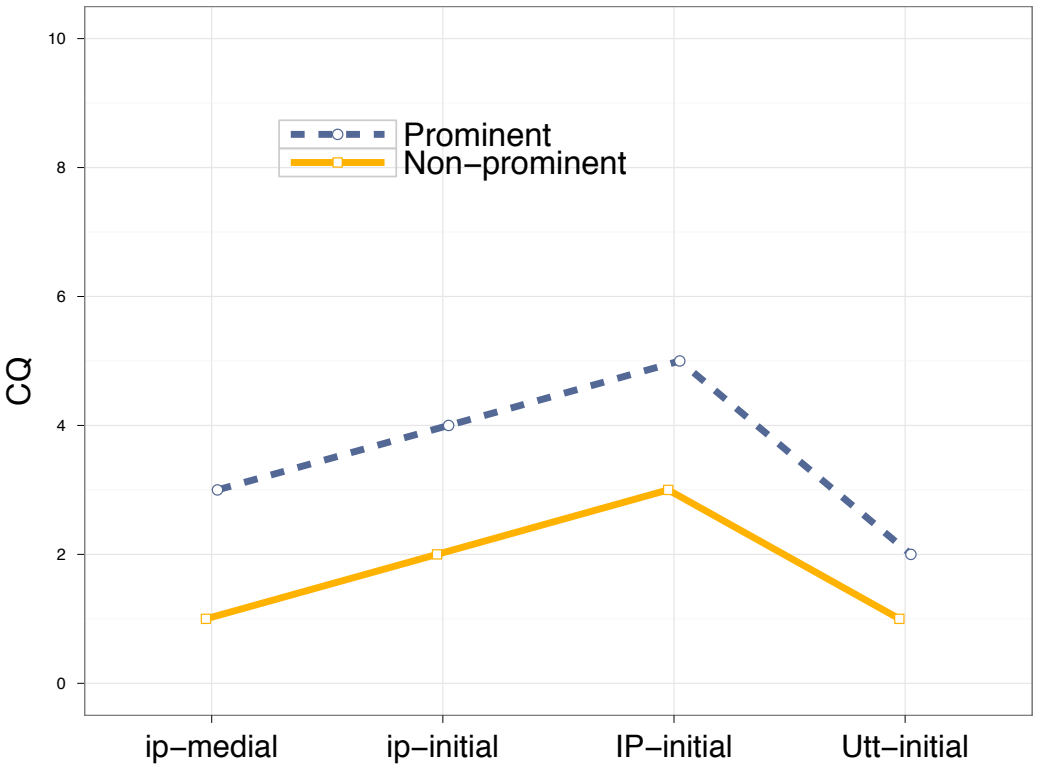
- Native English/Spanish speaker labeled and segmented the target sounds.
  - For sonorant-initial words, also segmented the post-sonorant vowel.

- Recordings were not labeled for prosody, but were checked during segmentation:
  - Presence of pitch accents on target syllable
  - Presence of boundary tones/phrase accents before target word
  - Suitable percept of juncture between target and preceding word

- For each token, obtained voice measures:
  - Mean contact quotient (from EGG), using EggWorks[1]
  - [H1*-H2*/H1-H2 (from audio), using VoiceSauce[2]]

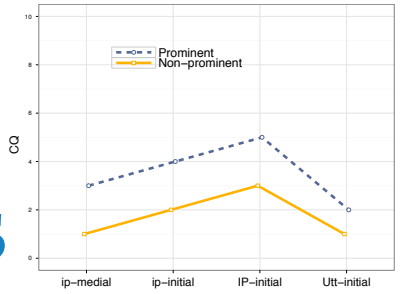
1. Tehrani (2010); 2. Shue et al. (2011).

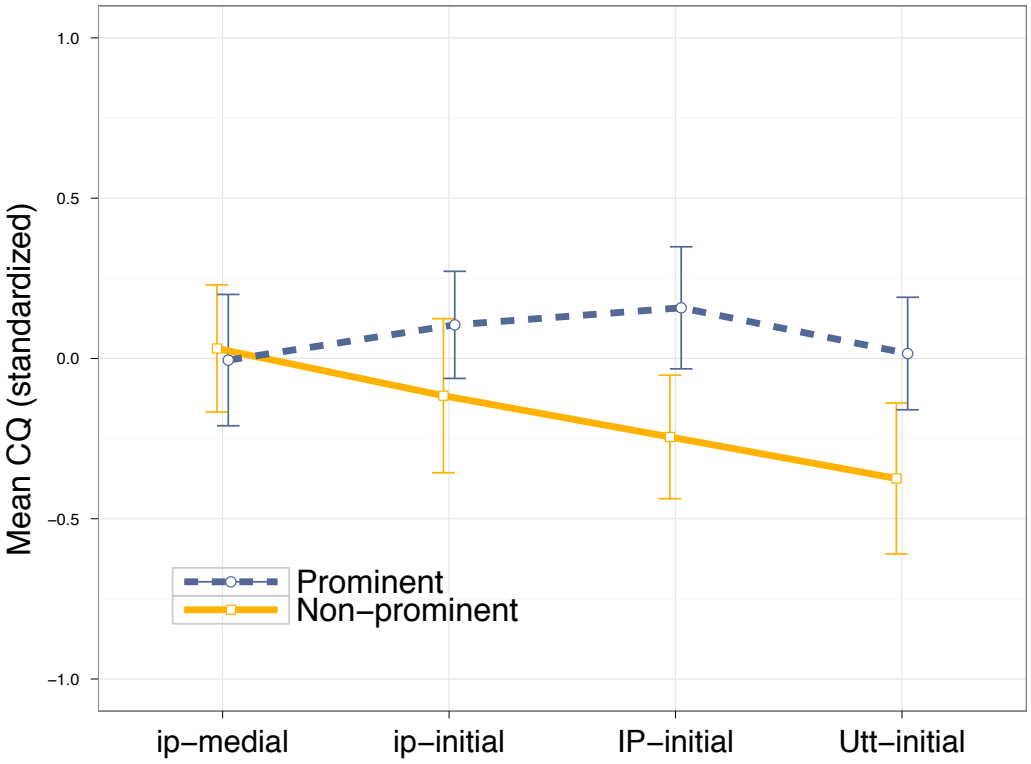
Results:
Predicted results for English



- More contact under prominence
- More contact phrase-initially (if Utterance-medial)
- Less contact Utterance-initially

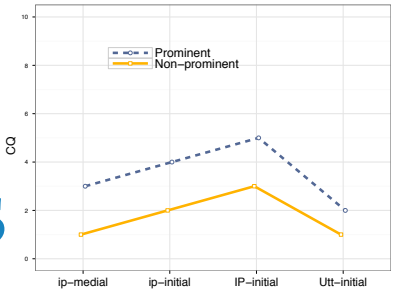
Results:
English – Word-initial vowels

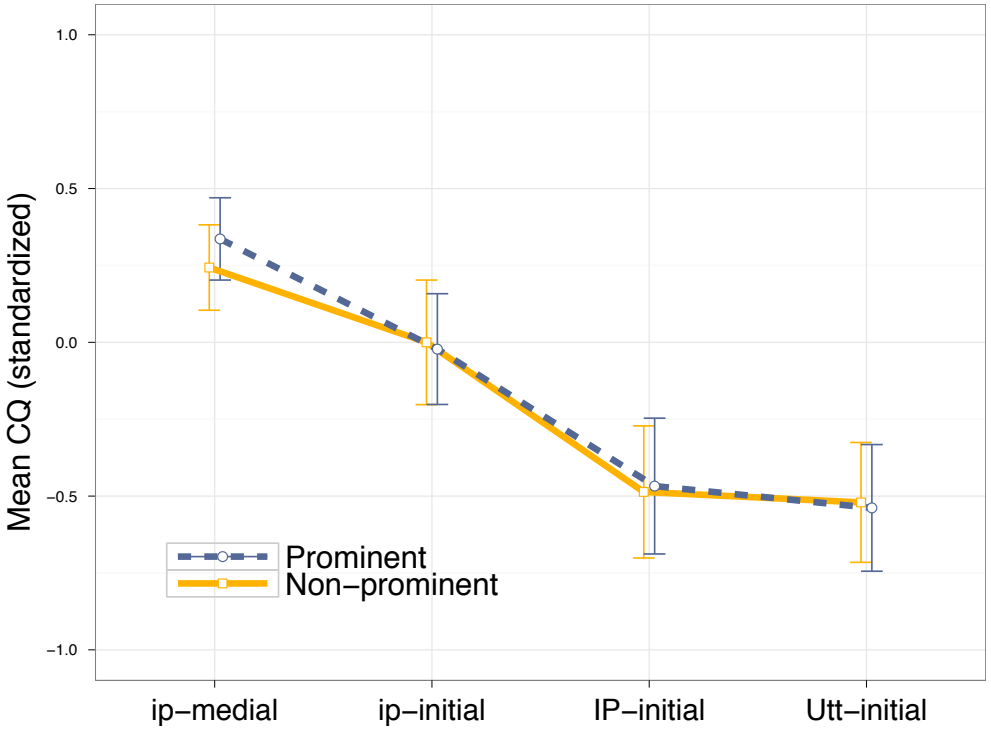




- **Less** contact with higher phrasal position
  - but only for non-prominent vowels.
- More contact for prominent vowels that are IP- or Utterance-initial.

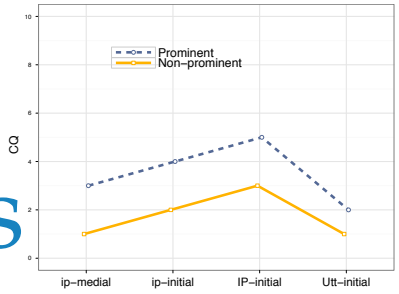
Results:
English – Word-initial sonorants

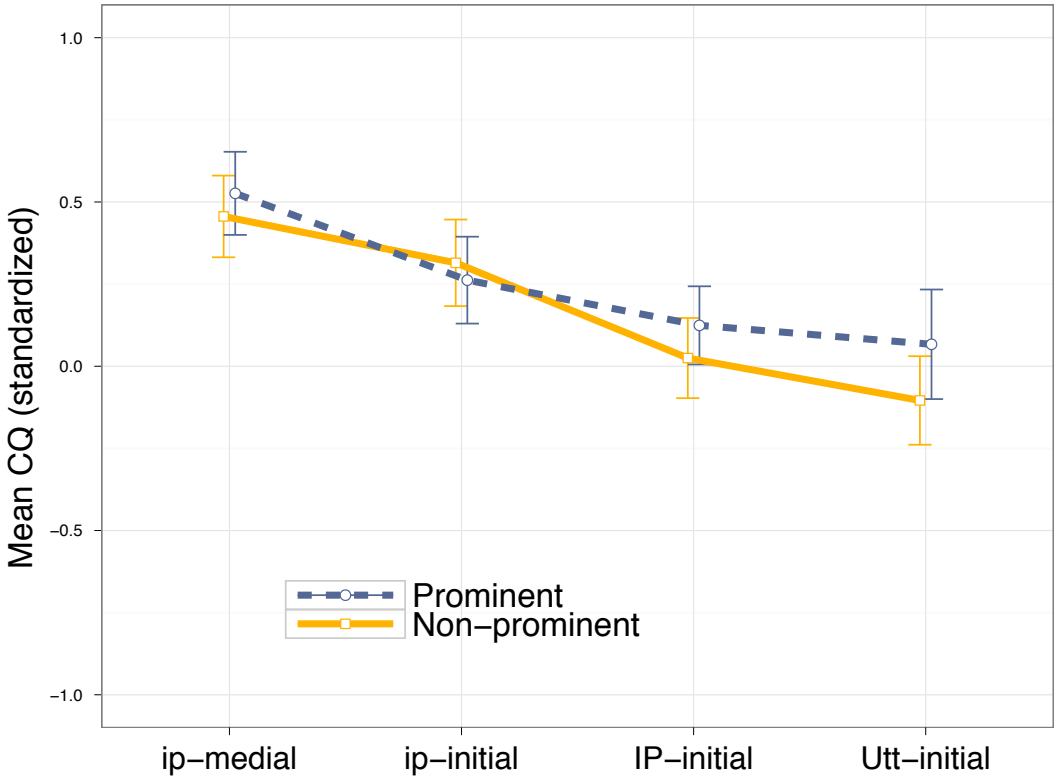




- Less contact with higher phrasal position.
  - Like non-prominent initial vowels
- No effect of prominence on contact.
  - Unlike initial vowels

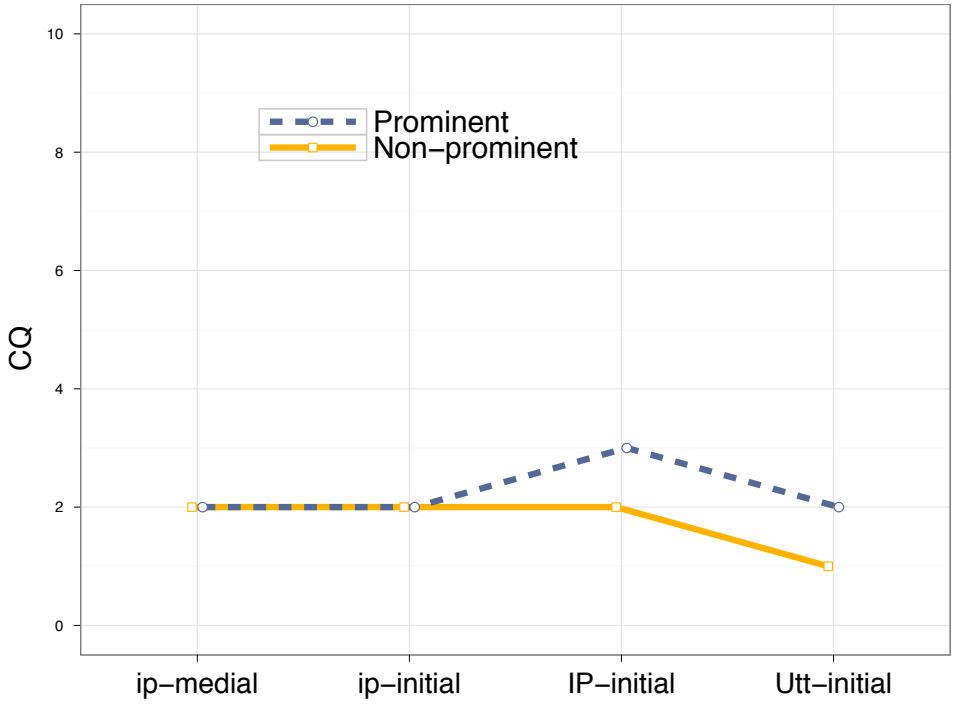
Results:
English – Post-sonorant vowels





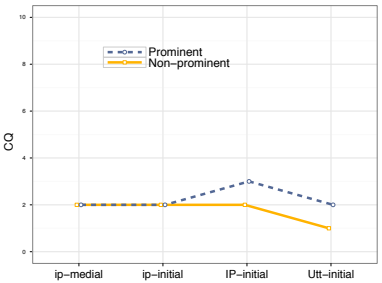
- Less contact with higher phrasal position.
  - Like initial (non-prominent) vowels and sonorants
- No effect of prominence on contact.
  - Unlike initial vowels

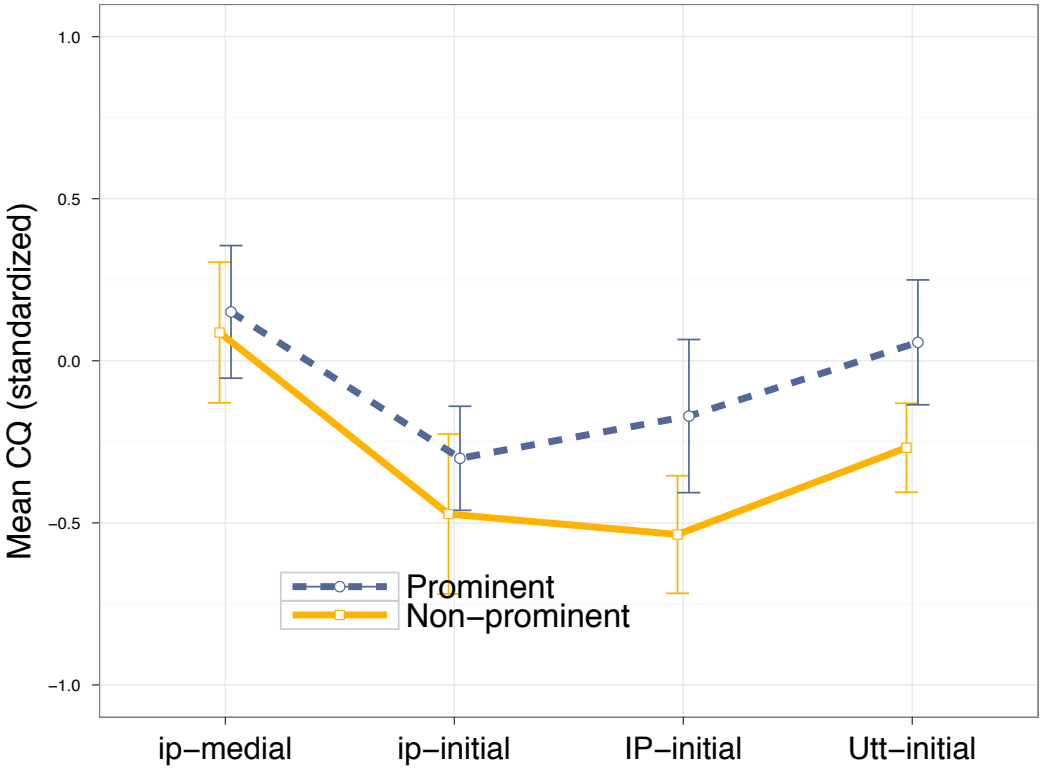
Results:
Predicted results for Spanish



- Prominence strengthening only at highest domains
- No phrase-initial strengthening of voice quality
- Less contact Utterance-initially

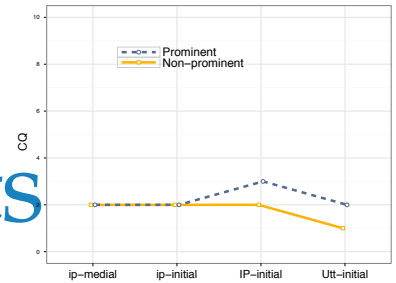
Results:
Spanish – Word-initial vowels

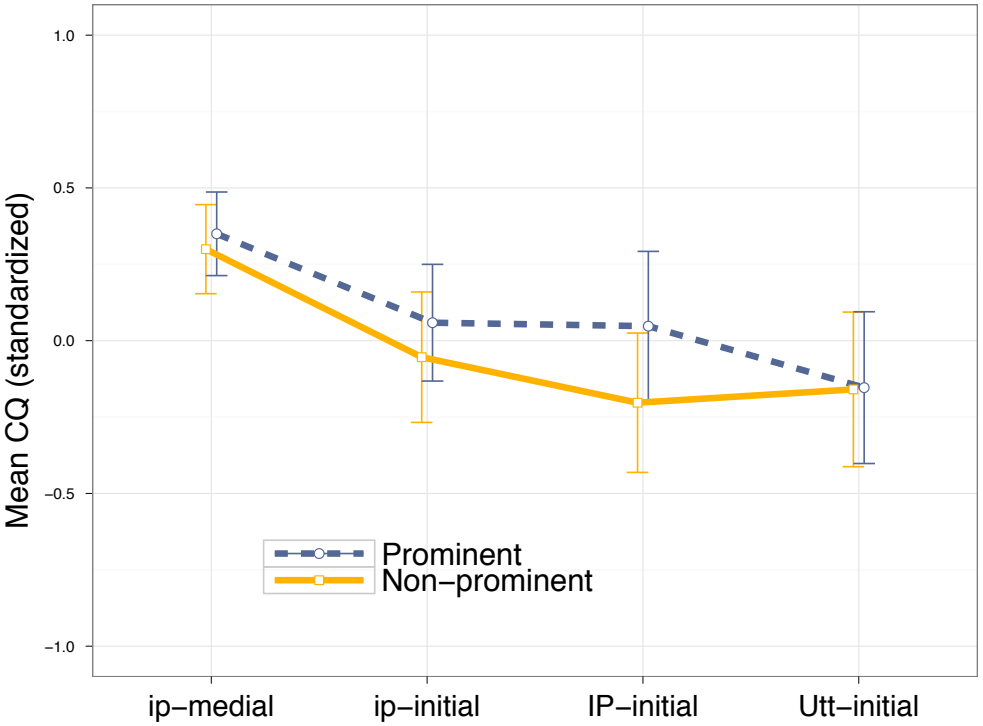




- Less contact phrase-initially, **except** Utterance-initially.
- More contact for prominent vowels that are IP-initial and Utterance-initial.

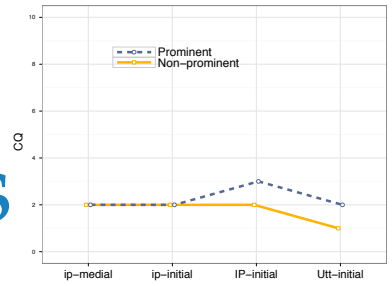
Results:
Spanish – Word-initial sonorants

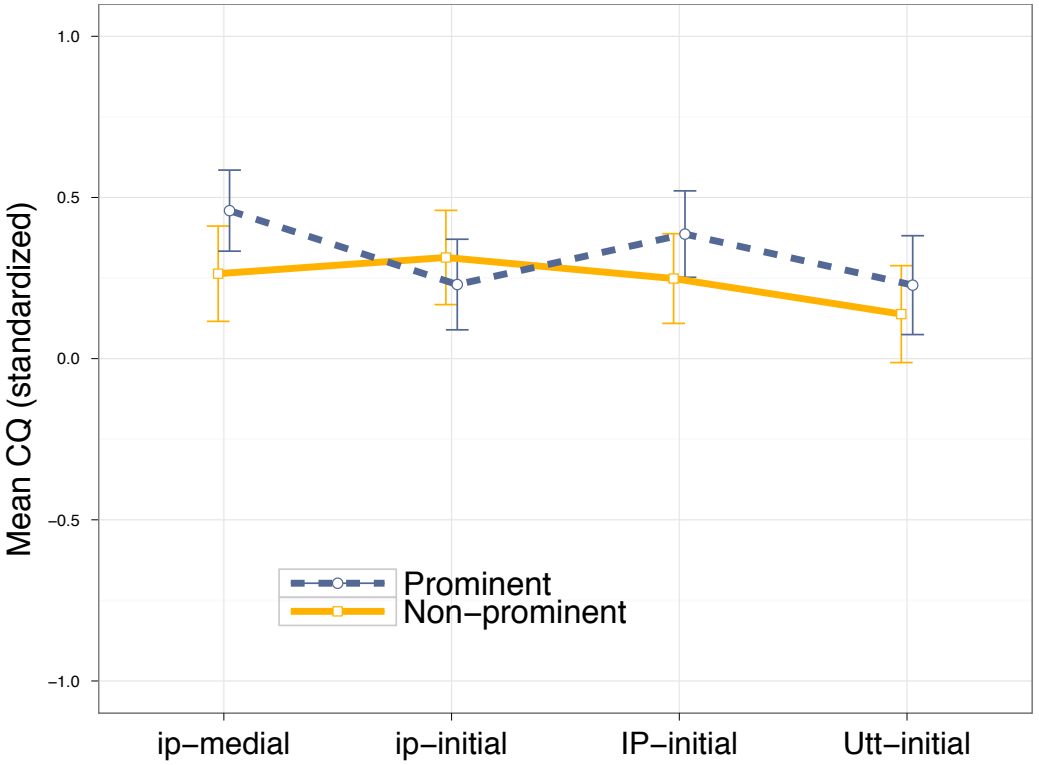




- Less contact with higher phrasal position.
- No effect of prominence on contact.

Results:
Spanish – Post-sonorant vowels





- No effect of phrasing on contact.
- Higher contact for prominent vowels when ip-medial and IP-initial.

Results:
Summary

Effect of phrasing:

- Surprisingly, higher prosodic domains that are Utterance-medial show a **decrease** in EGG contact quotient.

Effect of prominence:

- Prominence shows an **increase** in contact, but mostly for word-initial vowels.

Effect of language:

- **Both** languages show similar effect of prominence on word-initial vowels, and similar effect of phrasing →
  - **No major differences**!

Results:
Answers to research questions

- Do **both** prominence and phrase-initial strengthening yield increase in vocal fold contact?
  - Only prominence strengthening, and mostly word-initial vowels.

- Does voice quality strengthening affect **both** vowels and sonorants?
  - Prominence strengthening via increased contact only affects word-initial vowels.

- Does Utterance-initial vocal fold spreading **inhibit** voice quality strengthening?
  - All phrasal onsets show less contact; no specific Utterance-initial effect!

- In Spanish, which has "rare" glottalization, does voice quality strengthening occur in only the strongest prosodic positions?
  - Yes, but the same is true for English.

Discussion:
Why phrase-initial vocal fold spreading?

- If there's no phrase-initial strengthening, why then do Utterance-medial phrasal onsets show decrease in contact?

- All phrasal onsets (in English and Spanish) are accompanied by **pitch reset** (change in slope of f0 declination).[1]

- Rapid changes in f0 (both rises and falls) are associated with **relaxation** of thyroarytenoid (TA) and cricothyroid (CT) muscles of the larynx.[2]

- TA and CT relaxation results in vocal fold spreading.[3]

1. Ladd (1984, 2008); 2. Hirano, Ohala, & Vennard (1969); 3. Zhang (2011)

Discussion: Prominence strengthening of voice quality

- Voice quality is not uniformly strengthened under prominence.
  - Only word-initial vowels show increased contact.

- This is not consistent with strengthening due to increased muscular activation.
  - If so, **all** voiced sounds would be strengthened under prominence.

- Why are only **word-initial** vowels strengthened when prominent?
  - Most likely due to presence of glottalization gesture.

Discussion:
Implications for theories of glottalization

- Glottalization is not a form of prosodic strengthening of **voice quality**.[1,2]

- Glottalization is not a form of **prosodic** (phrase-initial and prominence) strengthening.[1,2,3,4]

➢ Glottalization is best viewed as a form of **prominence** strengthening, unique to word-initial vowels!

  ➢ Phrase-initially, it is strengthened to [ʔ].

1. Fougeron (2001), 2. Borroff (2007); 3. Pierrehumbert & Talkin (1992); 4. Dilley et al. (1996).

Discussion: Glottalization as prominence strengthening

- Why glottalize word-initial vowels that are prominent, especially in phrase-initial position?

- Prominence = **salience**
  - usually conveyed through loudness, duration, and pitch excursions.[1]

- Phrase-initially though, voicing is **weak** and **breathy**.
  - → Noisy, not conducive for conveying prominence on an initial vowel

- Glottalization → rapid buildup of pressure and change of voice quality
  - Laryngealized voice quality → stronger high-frequency energy, **more salient cues**.[2]

1. Ladd (2008), 2. Garellek (2011)

Conclusions:

- Voice quality strengthening =
  - Increased vocal fold contact under prominence.
  - No consistent phrase-initial strengthening.

- Only **word-initial** vowels consistently show strengthening of voice quality under prominence!

- Glottal stops before vowel-initial words are likely due to **prominence** strengthening (in English and Spanish), not prosodic strengthening more generally.

Thank you!

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