Prominence vs. phrase-initial strengthening of voice quality

Marc Garellek
University of California, Los Angeles
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.

Introduction:
Prosodic strengthening

• **Prosodic strengthening** is a more “forceful” articulation as a result of **phrasal position** and/or **prominence** (phrasal accent).¹²
  - *All the students have been studying* **ALL** *day long.*

• More “forceful” articulation ➔
  - Greater muscular activation³⁴
    - E.g., greater activation of *levator palatini* for nasal and oral sounds alike ➔ */n/* shows **decrease** in nasal flow.

---

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].¹²
    - So, glottalization ≠ insertion of glottal stop?

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

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 spreading¹

• 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.

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.\textsuperscript{1,2}
  • Voice quality strengthening might vary in degree cross-linguistically.

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

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, r, 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 EggWorks¹
  • \([H1^*-H2^*/H1-H2]\) (from audio), using VoiceSauce²

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.

![Graph showing mean CQ (standardized) for prominent and non-prominent conditions across different positions.](image-url)
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

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].

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

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.


Slifka, J. (2000). Respiratory constraints on speech production at prosodic boundaries. Ph.D., MIT.


