

The Effects of f_0 and Position-in-Utterance on Phonation in Santa Ana Del Valle Zapotec

Christina M. Esposito

esposito@humnet.ucla.edu

University of California, Los Angeles

Introduction

- Santa Ana del Valle Zapotec (SADVZ) is an Otomanguean language spoken in Santa Ana del Valle, Oaxaca, Mexico.



- The Ethnologue classifies SADVZ into the San Juan Guelavía subgroup. This subgroup includes several other Zapotec languages, such as San Lucas Quiaviní, San Juan Guelavía, and Tlacolula.
 - Approximately 28,000 speakers (1990 census) for the entire San Juan Guelavía subgroup. It is not known what portion of this is composed of SADVZ speakers.
 - Language has no written form.

Consonants and Vowels

	labial	dental	palatal-alv.	retroflex	palatal	velar	glottal
stop	(p) b	t d				k g	ʔ
fricative	(f)	s z	ʃ ʒ	ʂ ʐ			
affricate			tʃ dʒ				
nasals	m : m	n : n				ŋ : ŋ	
laterals		l : l					
approximants					j	(w)	
trill		r : r					
tap		ɾ : ɾ					

- Consonants in parentheses are only found in loan words.

	front	central	back
high	i	ɨ	u
mid	e		o
low			ɑ

Phonation and Tones

- SADVZ has a three-way contrast in phonation on vowels: modal, breathy and creaky (Esposito, 2003).

Modal: ex. **lat** “tin can”

Breathy: ex. **la̤t** “place”

Creaky: ex. **laꞰts** “field”

- Each phonation is associated with one or two tonal patterns (Esposito, 2003) :

Modal = high, or high-rising tone (in contrast)

Breathy = slightly falling tone

Creaky = falling tone

Effect of f0 and Position on Phonation

- Phonation can be sensitive to changes in f0 and position-in-utterance.
- **Position can effect phonation**, independent of changes in f0, in languages such as English (Epstein, 2002).
- **Changes in f0 can also create changes in phonation.**
There is a correlation between phonation, vocal fold vibration and f0.
 - We expect breathy voice to be correlated with a lower f0 and tenser voice qualities to have a higher f0.
 - In Hindi, breathy voice is associated with lowered f0 (Ohala, 1973).
 - In Jingpho, Lahu and Yi, there is a higher f0 for tenser vowels (Maddieson and Hess, 1987).

Why Study the Effects of f₀ and Position-in-Utterance in SADVZ?

- SADVZ provides an opportunity to study the effects of both f₀ and position-in-utterance on phonation, independently.
- SADVZ has:
 - **Relatively free word order.** Thus, it is possible to change the position of a word in an utterance and see if there are any effects on phonation.
 - **No phrase-final fall in f₀.** It is possible to study the effects of position without a strong influence of f₀.
 - **A variety of intonational contours.** It is possible to examine the potential influence of f₀ on phonation, independently of position, through the examination of a variety of intonational contours.

Experiment I: Effects of f0 vs. Position-in-Utterance on Phonation

- To determine if f0, position-in-utterance, or both, could be affecting phonation in SADVZ.

Method

- **Speakers**
 - Three native speakers of SADVZ (two male, one female), from 40 to 50 years of age, were recorded for this study.
- **Speech Materials**
 - The wordlist, which illustrated the three-way contrast in phonation, was composed of 44 monosyllabic words all with the vowel [a] and a range of consonants.

Procedure

- Speakers were asked to produce sentences that exhibited various intonational contours a total of 5 times.
- Each sentence included target words from each of the three phonations. The sentences comprised two sets.

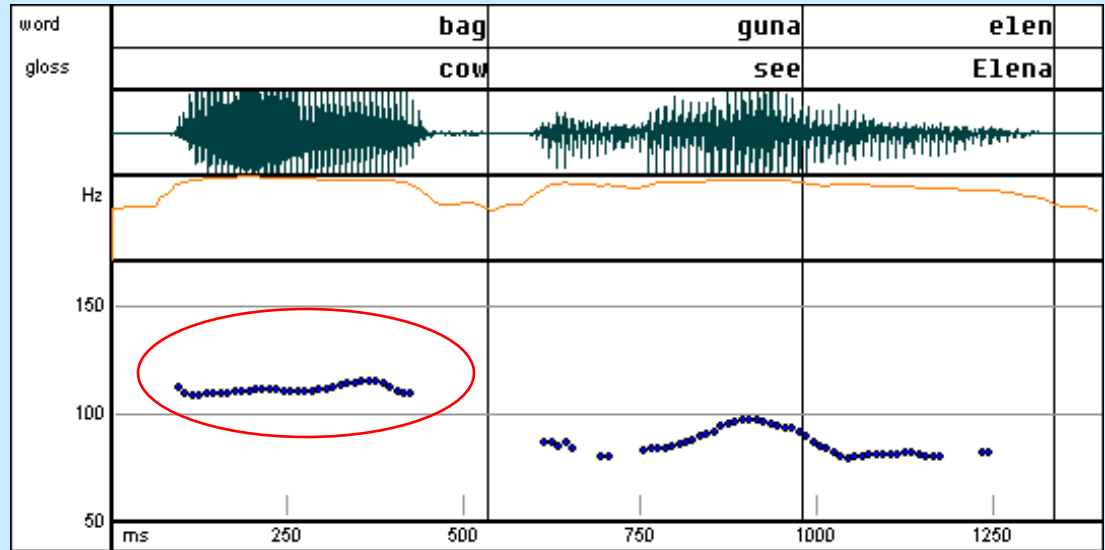
→ **Set I:** target words had different positions across the sentences but had the same f0.

When the position is ...	Compared to medial position the f0 is	Sentence	Gloss
sentence-initial (focused)	high	_ guna Len	“Elena saw _”
sentence-final (negative question)	high	Teka guna Len _	“Didn’t Elena see _?”

Procedure

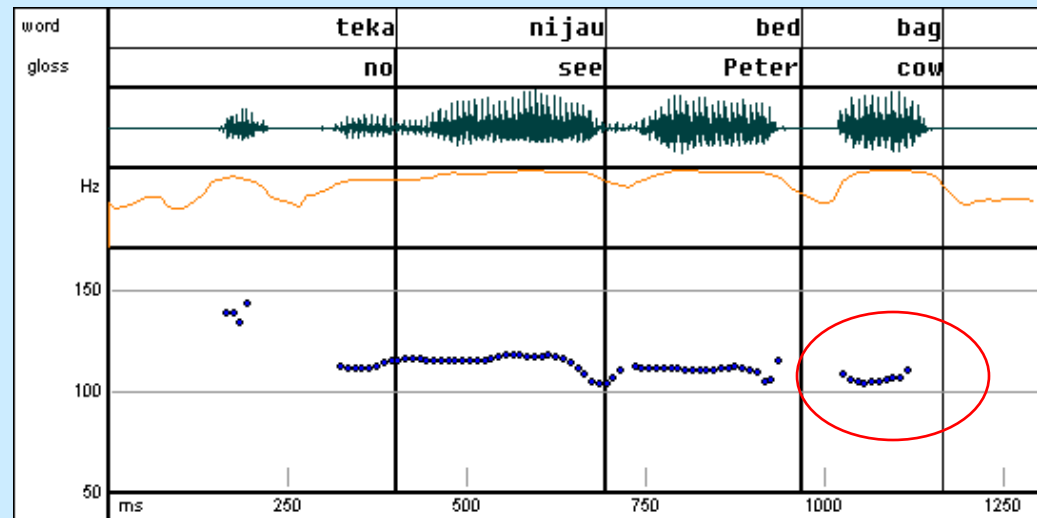
Set I : Different positions, but same f0.

- Sentence initial (focused) = High f0



[bág guna elen] "Elena saw a COW."

- Sentence final (negative question) = High f0



[teka nijau bed bág] "Didn't Peter see a cow?"

Procedure

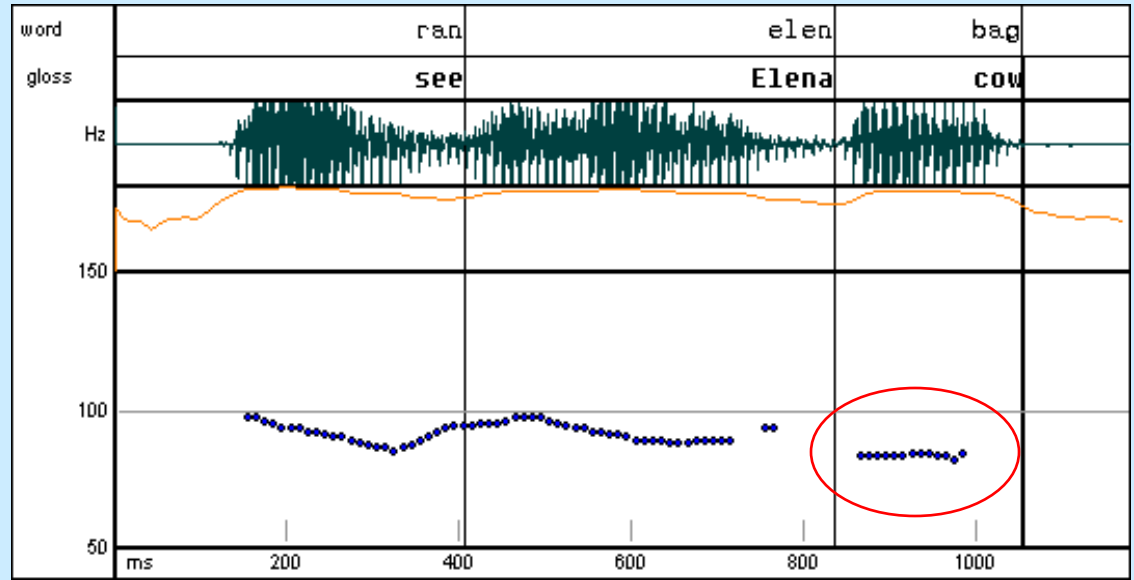
→ **Set II:** target words had the same position within the utterances, but different f0's.

When the position is ...	Compared to medial position the f0 is	Sentence	Gloss
sentence-final (non-focused, declarative)	low	guna Len _	“Elena saw _”
sentence-final (negative question)	high	Teka guna Len _	“Didn't Elena see _?”

Procedure

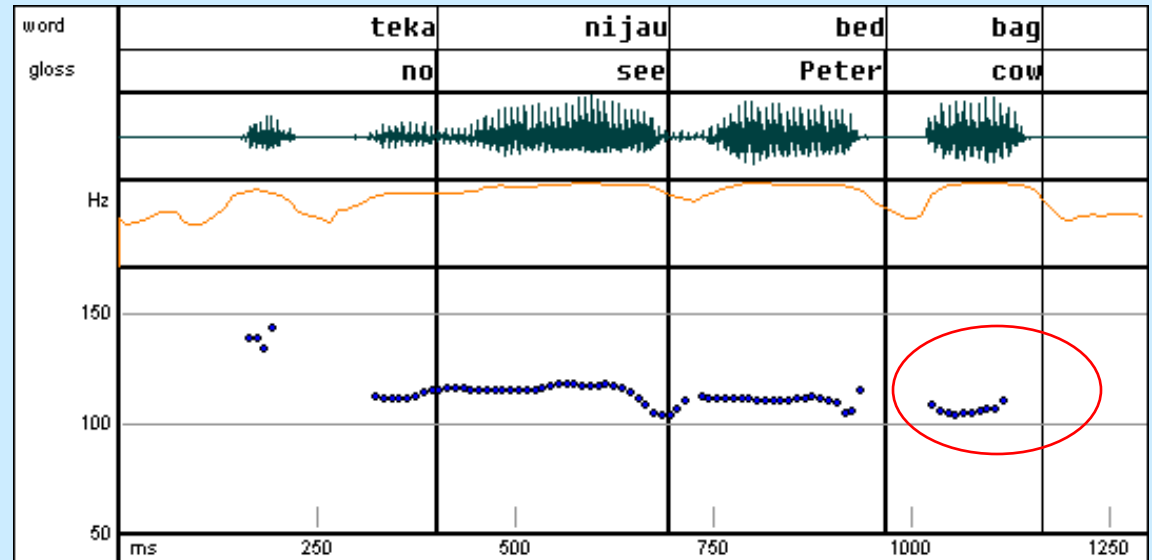
Set II: Same position, but different f0's.

- Sentence final (non-focused) = Low f0



[ran elen bág] "Elena sees a cow."

- Sentence final (in a negative question) = High f0

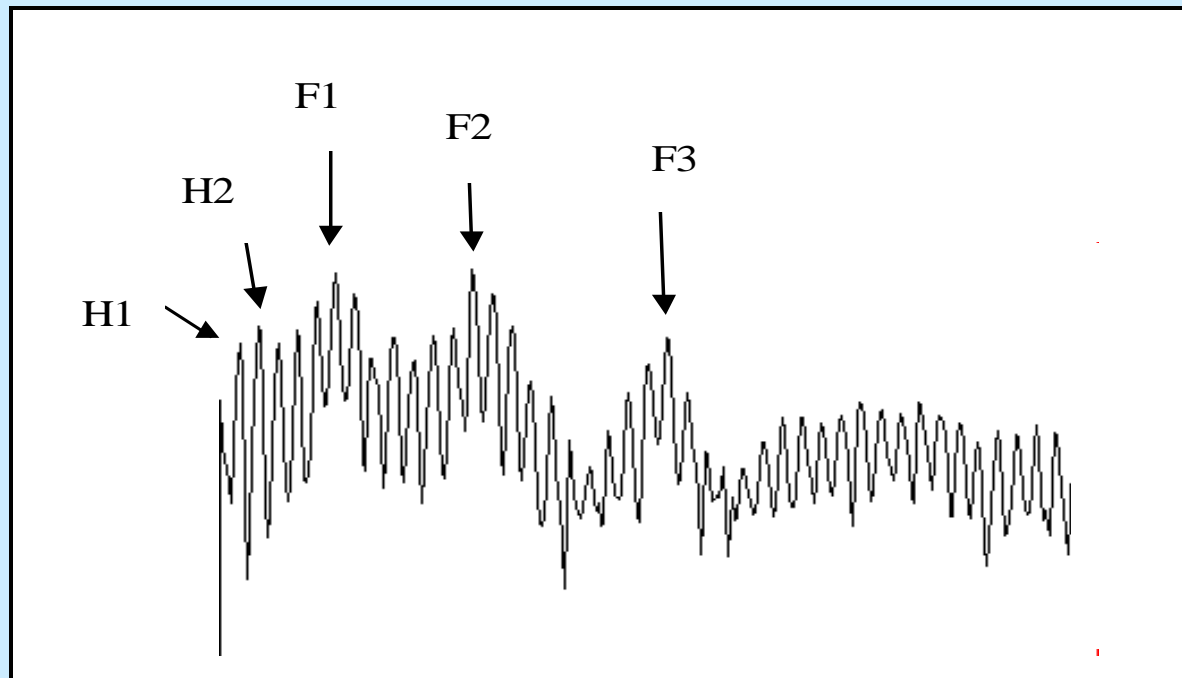


[teka nijau bed bág] "Didn't Peter see a cow?" 11

Procedure

- Tokens were digitized and analyzed in PCQuirer at a sampling rate of 22050 Hz.
- A Fast Fourier Transform was calculated over a 30 ms window starting 50 ms before the end of the vowel. (Spectrograms were used to position the 30 ms window.)
- To calculate the phonation the following measurements were taken manually from the FFT.:
 - for male speakers the amplitude of H1 (the height of f0 in the FFT) and F3 (the amplitude of the highest harmonic near the third formant) was taken from the FFT.
 - for the female speaker the amplitude of H1 and H2 (the height of the second harmonic) was taken.

(In a previous study, H1-F3 and H1-H2 were determined to be the best measure of phonation for the male and female speakers, respectively (Esposito, 2003).)

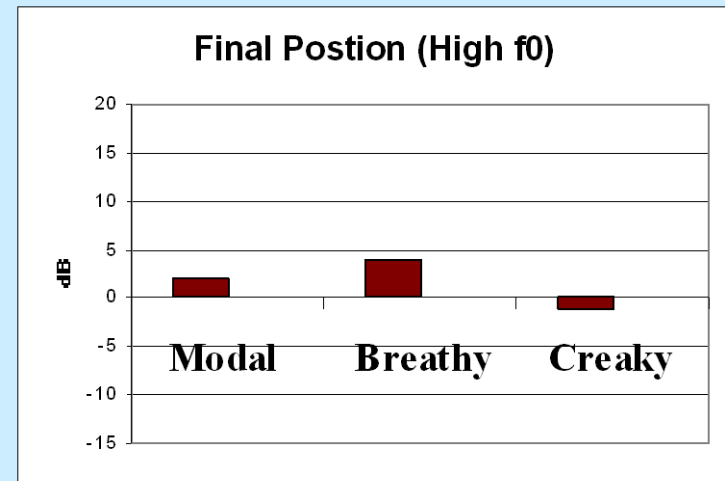
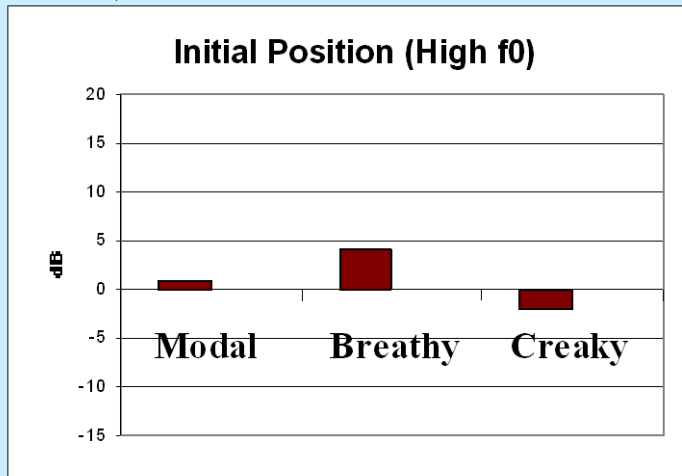


FFT of a modal vowel

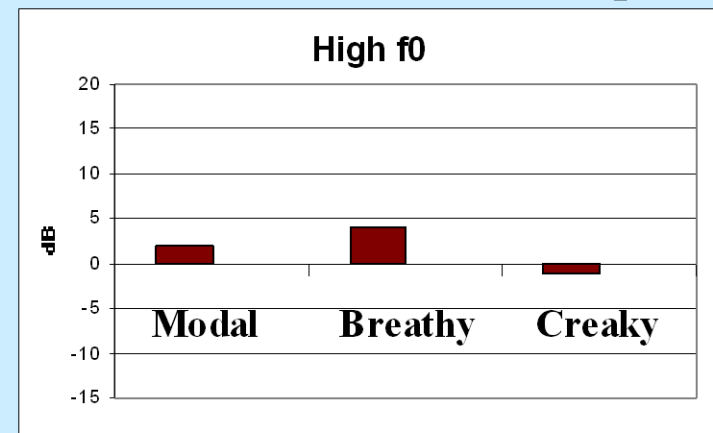
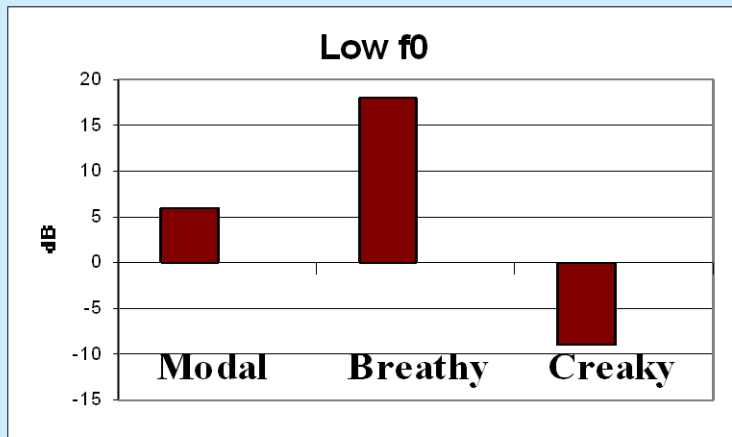
- The measure of phonation is the difference between the two measures (H1-F3, H1-H2) in dB.
- F0 was also measured from the FFT at three time points (the beginning, middle and end) of the vowel. F0 corresponded to the frequency of H1.

Results - Phonation

- Results for the three speakers are similar. The difference between the amplitudes of H1 and F3/H2 is given on the y-axis
- **Results of Set I: Same (high) f_0 , different position in utterance (Speaker 1)**



- **Results of Set II: Different f_0 , final position in utterance (Speaker 1)**



Results

- **There was an effect on phonation due to a change in f_0 , but not due to a change in position.**
- The three phonation categories are:
 - distinguished at low f_0 's, regardless of position.
 - not well distinguished at high f_0 's, regardless of position.

Experiment II: Effects of f0 on Phonation

- To examine the effects of f0 on phonation.

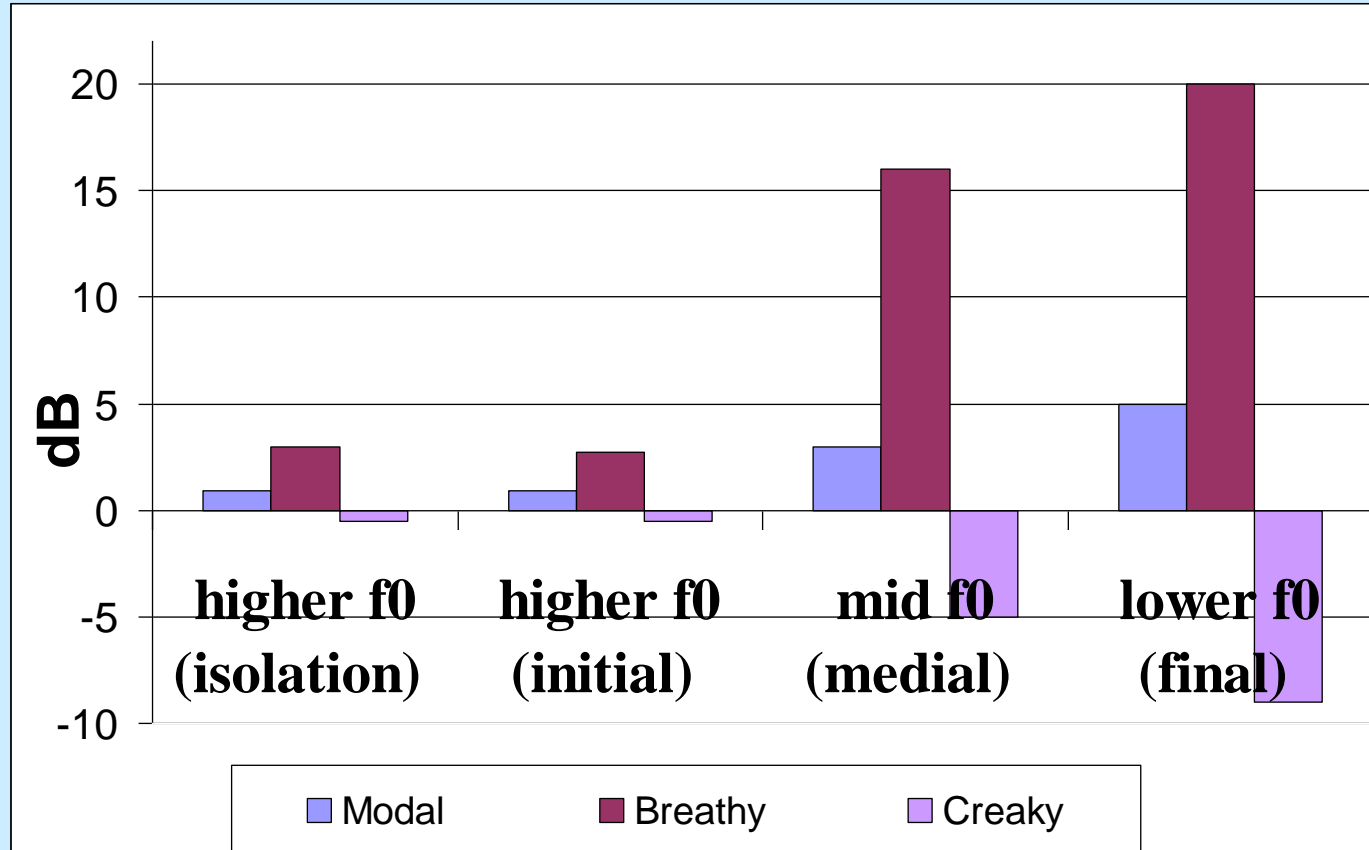
Methods and Procedure

- Speakers read tokens in four prosodic positions:
 - **Isolation** = higher f0 than sentence-medial position
 - **Initial (focused)** = higher f0 than sentence-medial position
 - **Medial**
 - **Final (end of declarative)** = lower f0 than sentence-medial position
- Phonation and f0 were measured following the procedure established in Experiment I.

- In the following graphs, the difference between the amplitudes of H1 and F3/H2 is given on the x-axis.
- When the results for the three speakers are similar, only one set of results will be shown.

Results

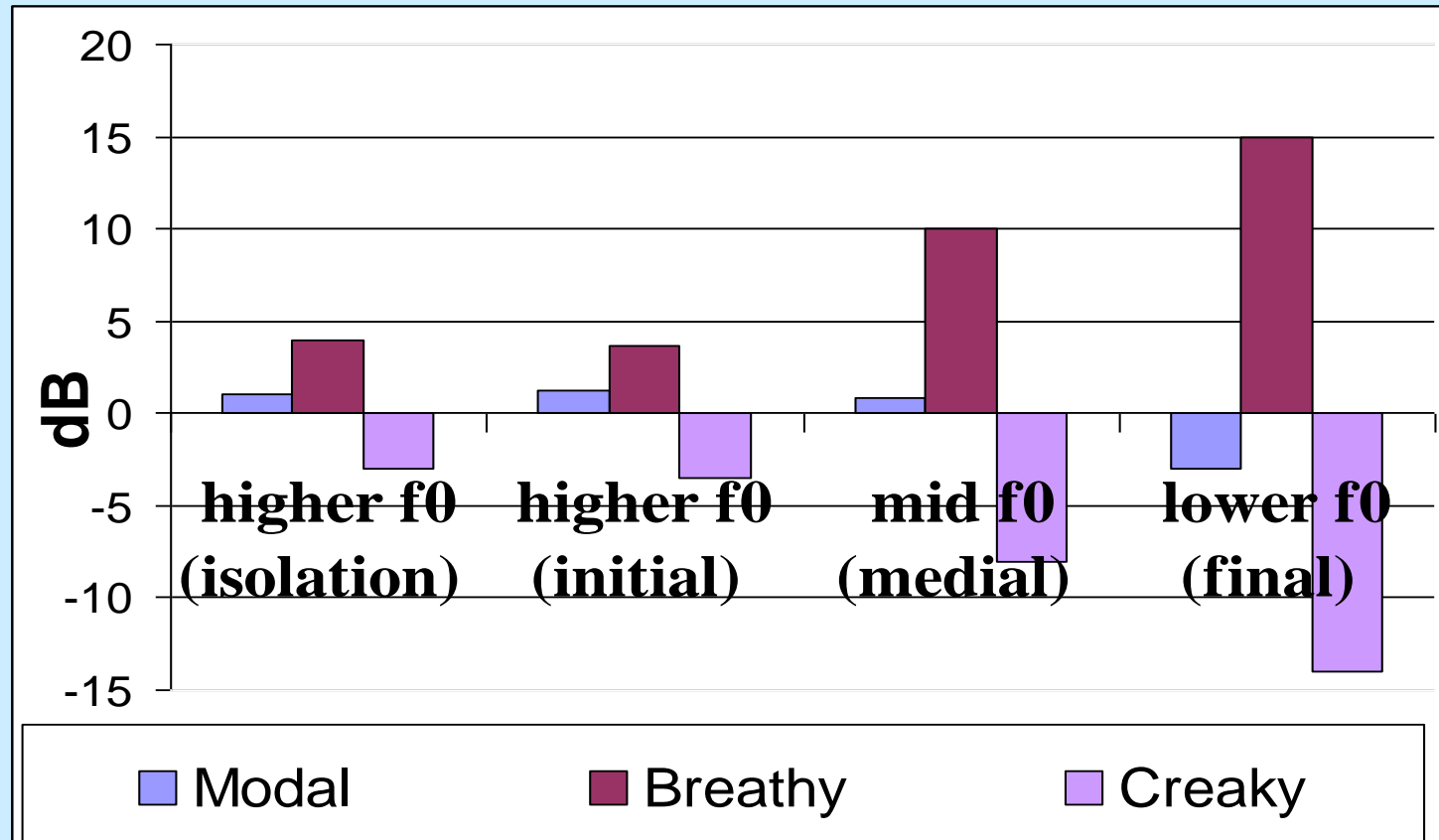
Effects of f0 on Phonation



Graph of H1-F3 in four prosodic positions. (male speaker)

Results

Effects of f₀ on Phonation



Graph of H1-H2 in four prosodic positions. (female speaker)

Summary of Results

Phonation

- **Higher f₀ (Isolation and initial position)** - The three-way contrast in phonation is minimized for all three speakers.
 - Breathy and creaky vowels have a much more modal phonation than when read in sentence-medial position.
- **Mid-range f₀ (medial position)** - There is a clear three-way contrast in phonation between modal, breathy and creaky.
- **Lower f₀ (final position)** - The three-way contrast was still preserved, but with some changes.
 - For the male speakers, modal and breathy vowels were breathier; for the female speaker, modal and creaky vowels were creakier and breathy vowels were breathier.

Results

F0

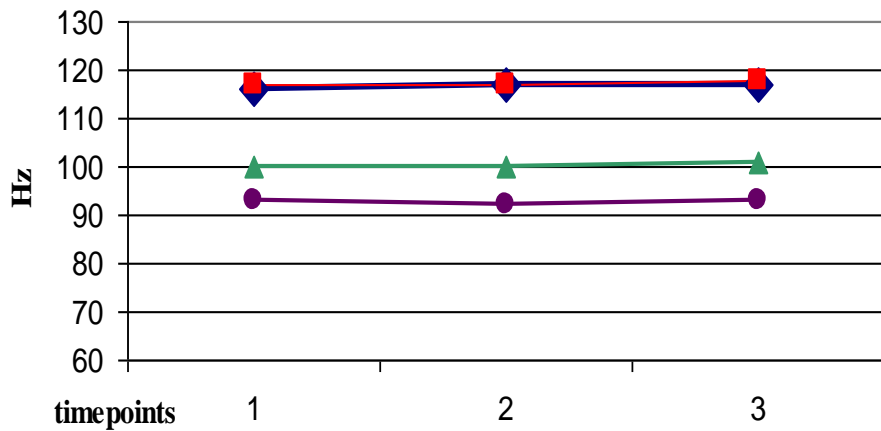
◆ Higher f0 (isolation)

▲ mid f0 (medial)

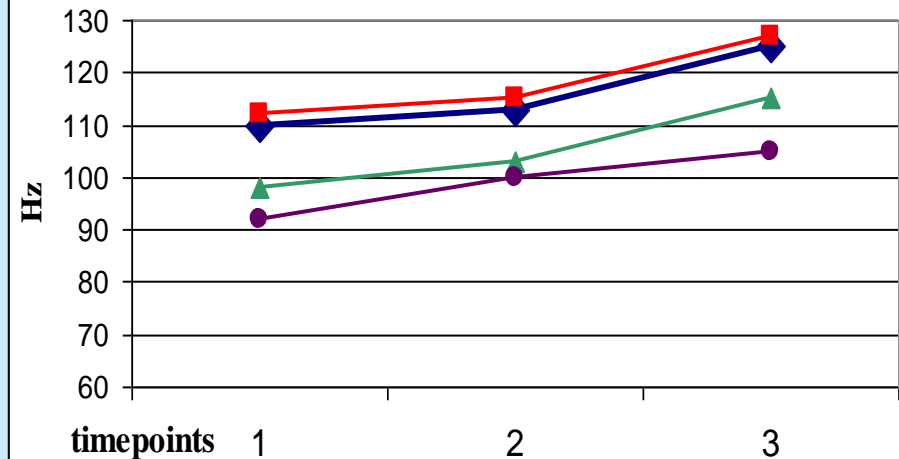
■ Higher f0 (initial)

● lower f0 (final)

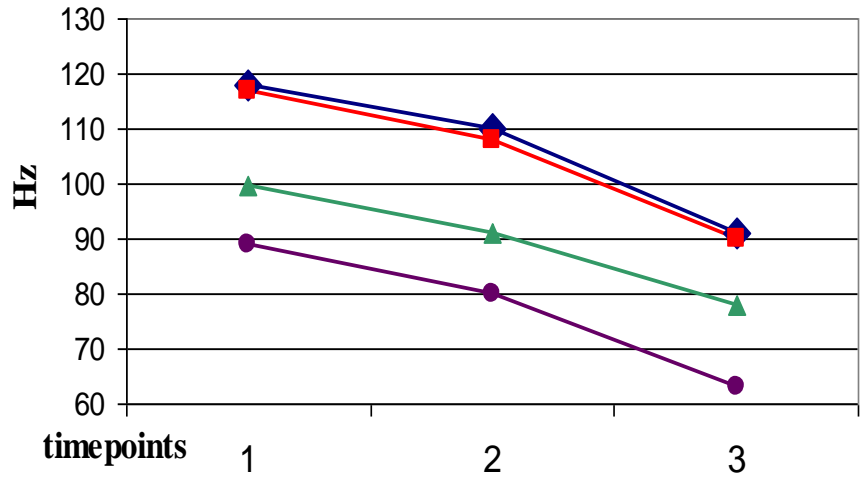
Modal (high-level)



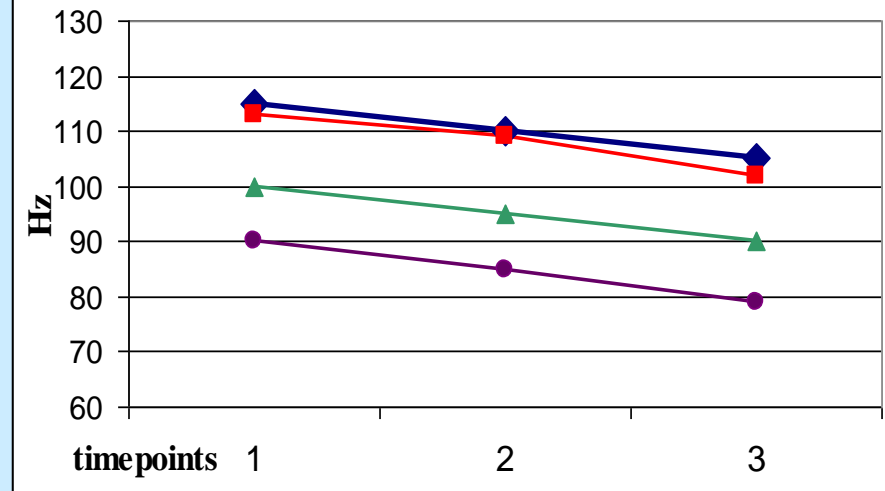
Modal (high-rising)



Creaky



Breathy



Summary of Results

F0

- In all four prosodic positions (isolation, initial, medial and final) the three-way contrast in tone (high, high-rising, falling) was always preserved.

Summary and Conclusion

- **F0 does have an effect on phonation, but changes in position-in-utterance (independent of f0) do not.**
- When the **f0 is mid-ranged** (sentence-medial position), there is a **three-way contrast in phonation**.
- When the **f0 is high** (isolation, sentence-initial position), the three way **contrast in phonation is minimized**.
 - Breathy and creaky vowels in the mid range f0, now had a more modal phonation.
- When the **f0 is low** (sentence-final position) **the three-way contrast in phonation is preserved**.
 - For the male speakers, modal and breathy vowels were breathier; for the female speaker, modal and creaky vowels were creakier and breathy words were breathier.

Summary and Conclusion

- **Is tone more basic?**
 - It seems that **when the phonation is weakened, the tonal pattern remains, preserving some level of distinction.** For example, in sentence-initial position, breathy phonation becomes modal, but the falling tone associated with breathy phonation remains.
 - No arguments have been found that phonation is more basic, as no cases have been found where phonation is preserved when the tone is compromised.
- Perhaps, tone is more basic and the phonation is only an enhancing feature, though more research will have to be conducted before a conclusion can be drawn.

References

- Epstein, Melissa. 2002. *Voice Quality and Prosody in English*. Ph.D. Dissertation. UCLA.
- Esposito, Christina 2003. Santa Ana del Valle Zapotec Phonation. M.A. thesis. UCLA.
- Grimes, Barbara F., ed 1990. *Ethnologue*. Consulting editors: Richard S. Pittman and Joseph E. Grimes. Dallas, TX: Summer Institute of Linguistics, Inc.
<http://www.sil.org/ethnologue>.
- Madiesson, I. and S. Hess. 1987. The effect of F0 on linguistics use of phonation types. *UCLA Working Papers in Phonetics*. 67, 112-118.
- Ohala, John. 1973. The physiology of tone. *Southern California Occasional Papers in Linguistics*. 1,1-14.