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# Growth Curve Modeling of Nucleus F0 on the Korean Accentual Phrase

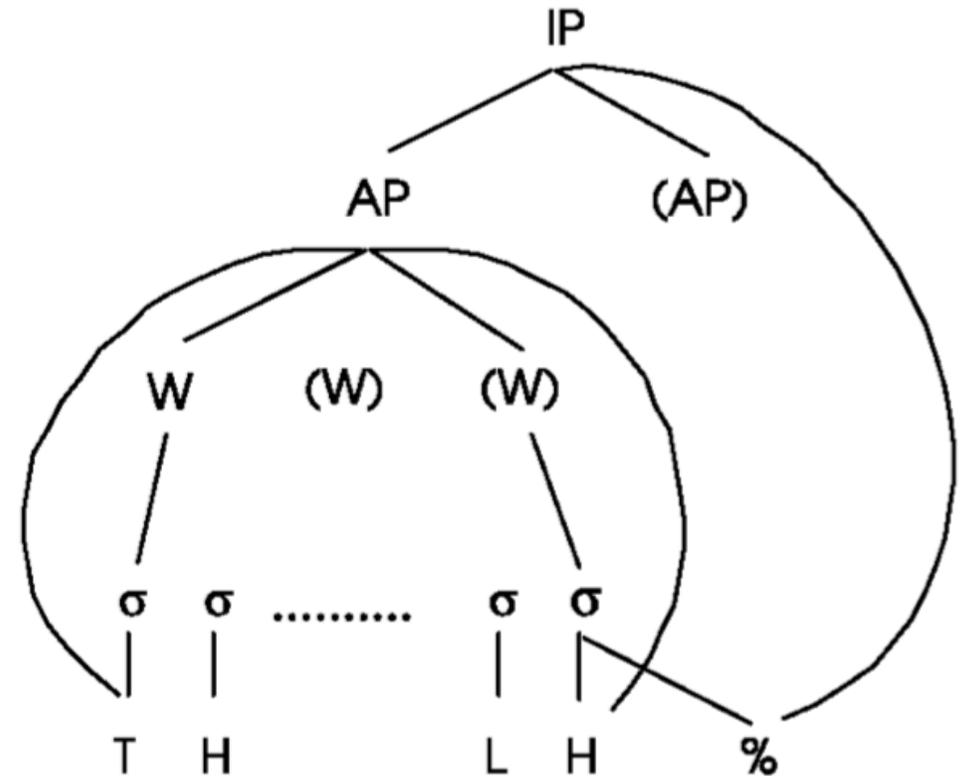
윤태진

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# The Accentual Phrase (AP)

- The smallest unit demarcated by the pitch contour.
- Approximately word-sized (Jun & Kim, 2004)
- has 3-4 syllables
- 1.14-1.2 content words on average (Jun & Fugeron, 2000; Kim, 2004; 2009; Kim et al. 2007).



Jun (2005)

# Tonal patterns of the AP

- The AP has the underlying tonal pattern of THLH.
- The realization of the initial tone (T) tends to depend on the laryngeal feature of the phrase initial segment.
  - The initial tone is H when the initial segment is a tense or aspirated consonant, or a fricative (/s, s\*, h/),
  - It is L when the initial segment is a plain consonant, a sonorants, or a vowel.

# Two research questions

- What is the effect of initial segment on the F0 of the AP initial syllable nucleus?
- What governs the phonetic realization of a medial L in the canonical AP?

# Effect of initial segment on the AP initial F0

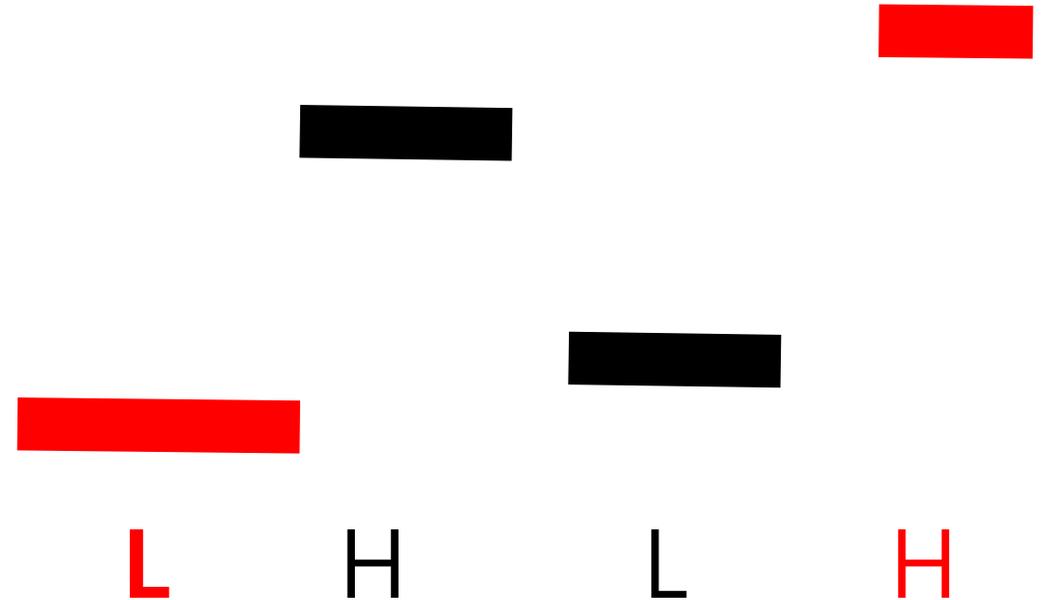
- Assume that both the initial L and the ultimate H are realized on a vowel

(1) The longer the vowel, the lower the F0

(2) The higher the vowel, the shorter the F0.

→ AP-initial lengthening

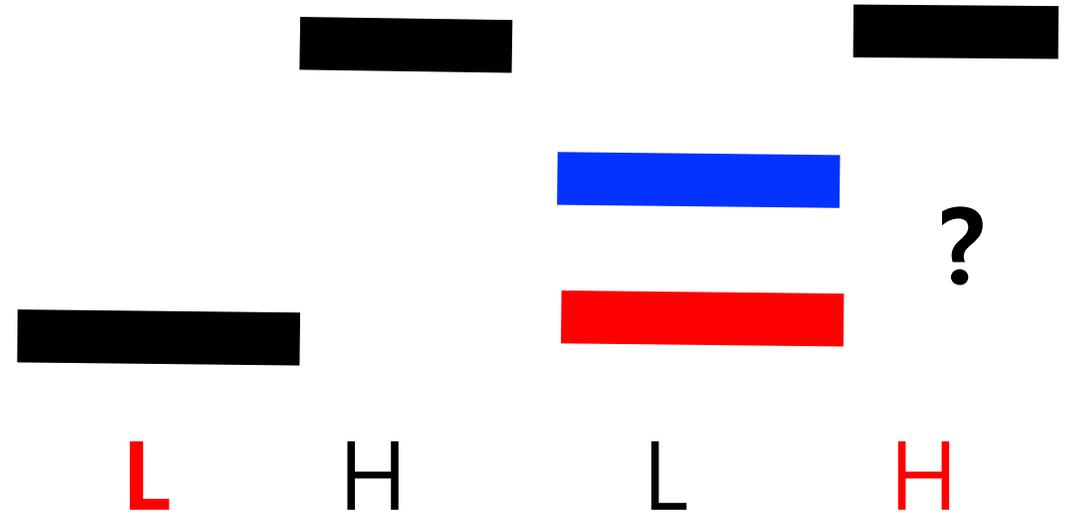
→ No AP-induced final lengthening



Vowel  
**Lenis obstruent**  
sonorant

# Governing principles of medial L

- How low will the level of F0 for the Medial L 1 be?
- Different Prediction
  - **Ease of articulation**
  - **Principle of maximal contrast**



# Goal

- The present study investigates the effect of Accentual Phrase on F0 (in semitone) using a subset of large-scale reading-style corpus of Seoul Korean.
- Four syllable words which were not preceded nor followed by silent pauses were presumed be canonical exemplars of Accentual Phrases in Korean.
- These four syllable words were extracted from female speakers' speech samples.

# Data

- The data come from a subset of The Reading-Style Speech Corpus of Standard Korean (The National Institute of the Korean Language 2005)
  - a corpus collected from speakers of Korean residing in the Seoul metropolitan area (over 2 generations).
- For the acoustic analysis, we chose a subset of the data which contains 17 female speakers whose age is in their 20's at the time of recording in 2003.

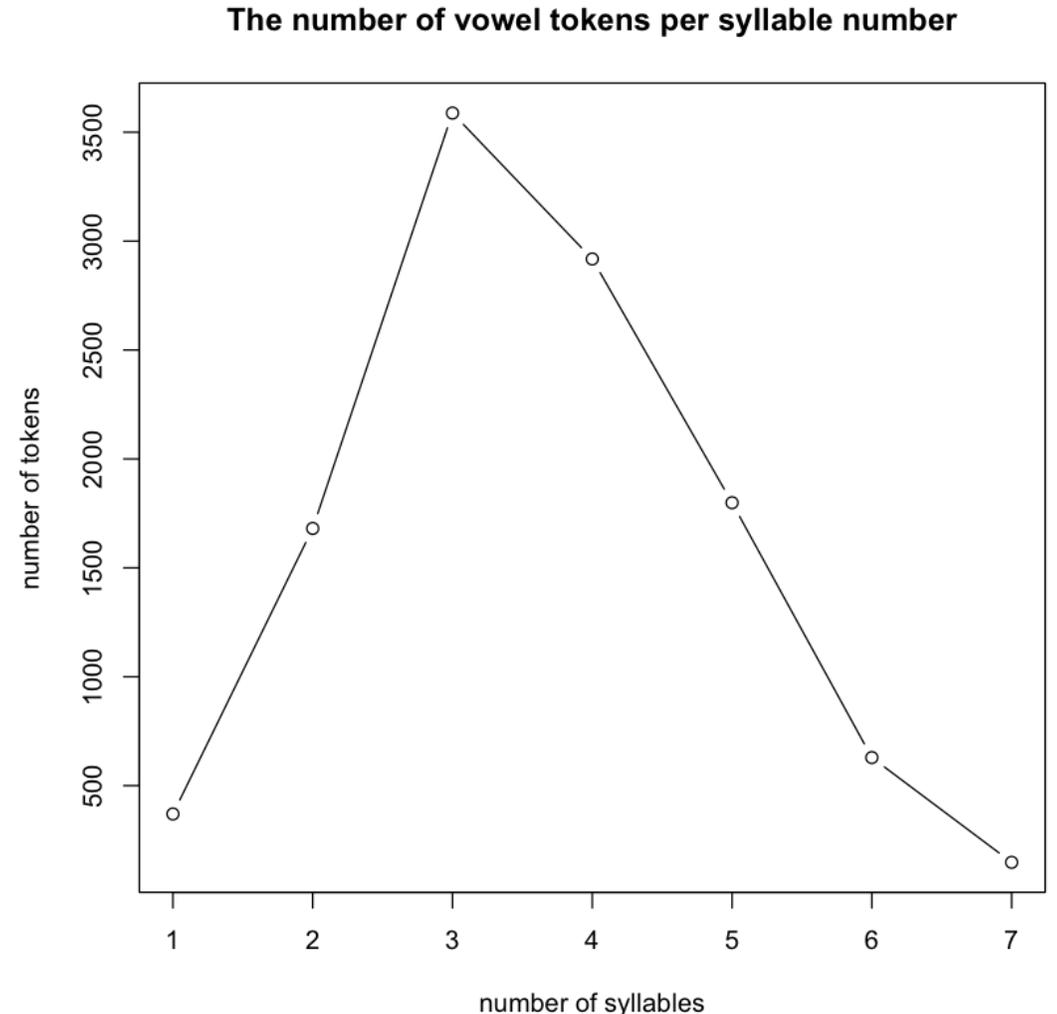
# Data

- Each of the speakers read 9 well-known fairy tales, short stories, or essays

	Reading materials	S. num	Duration
1.	호랑이와 곶감(The tiger and the dried persimmon)	42	3m7s
2.	해님 달님(The sun and the moon)	28	2m07s
3.	그리운 시내가(Longing for the stream bank)	36	5m1s
4.	광화문 지하도 아주머니(An elderly lady in the Kwanghwamun underground passage)	27	2m47s
5.	막 지은 밥(Rice just cooked)	17	2m17s
6.	눈 오던 날(The day when it snowed)	35	2m46s
7.	승냥의 지혜(The wisdom of sungnyung, scorched-rice water)	19	1m58s
8.	까만 눈동자들 앞에서(In front of dark eyes)	27	3m43s
9.	내 고향 개울 물에서(In the brook in my hometown)	40	3m12s
	합계	930	26m59s

# Distribution of number of syllables per word

- The tonal contour shapes over the Accentual Phrases in Korean show a wide range of variation.
- The majority of previous studies limited their scope to F0 contour shapes common at the level of the Accentual Phrase.



# Result 1: F0 (st) of the nucleus affected by the initial segment

- ANOVA:  $F(3, 752) = 294.9, p < .001$
- Post-hoc test with Bonferroni correction
  - Each pair of the initial categories was statistically different from each other (all  $p < .05$ )
- F0 (in semitone) is in fact affected by the type of initial categories, unlike the collapse of vowels, lenis obstruents, and sonorants to a single tonal category of L

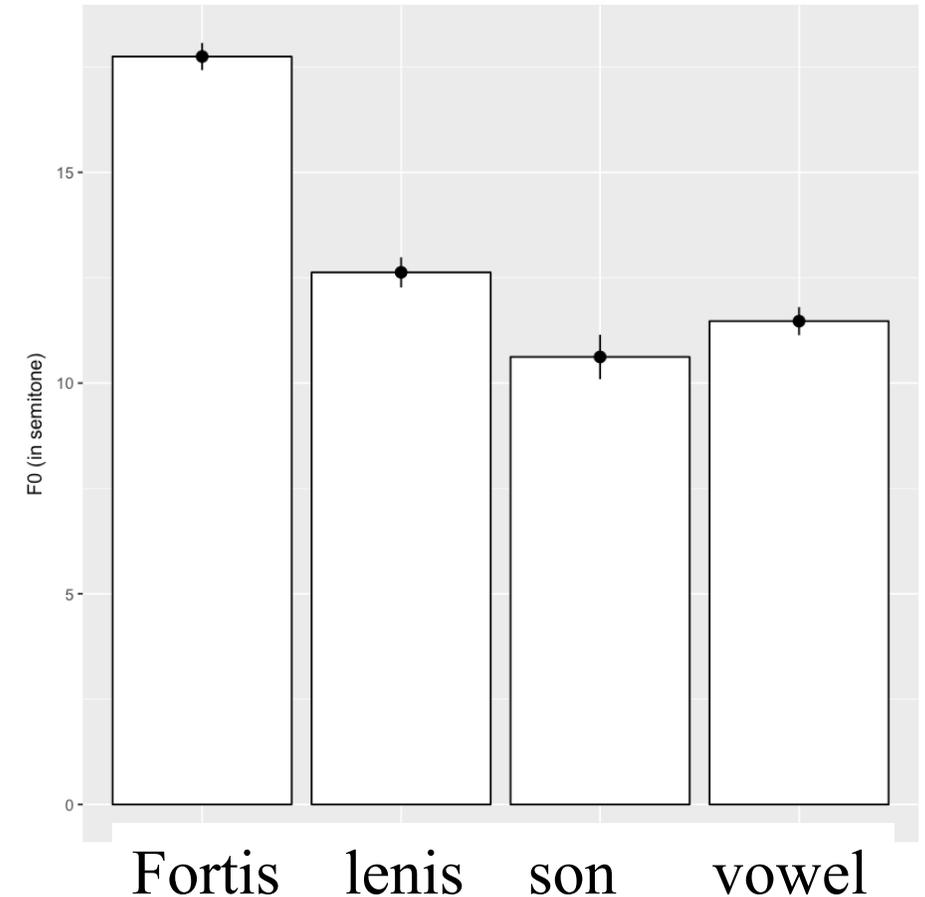


Table 4: Categorical Status of Initial Segments (Total: 2,828)

Initial segment	Vowel	lenis Obs.	fortis Obs.	Sonorant
# Tokens	996	627	785	420

# Growth Curve Analysis for underlying tonal patterns

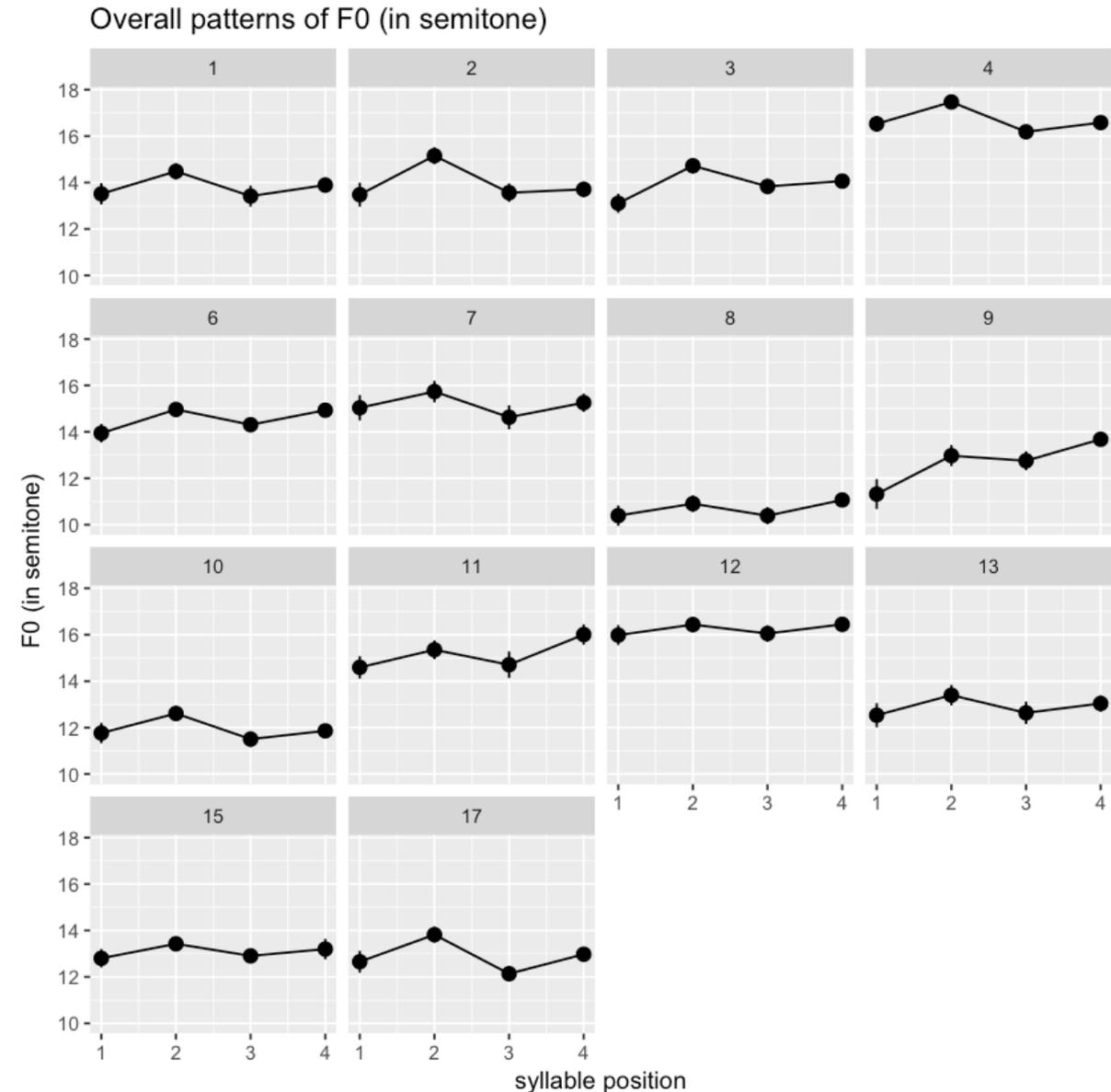
- “a way to analyze nested data that takes the grouping into account and provides a way to quantify and assess the shapes of time dependent curves (Mirman, 2014: 3).”

$$Y_{ij} = \beta_{0i} + \beta_{1i} \cdot Time_j + \varepsilon_{ij}$$

F0

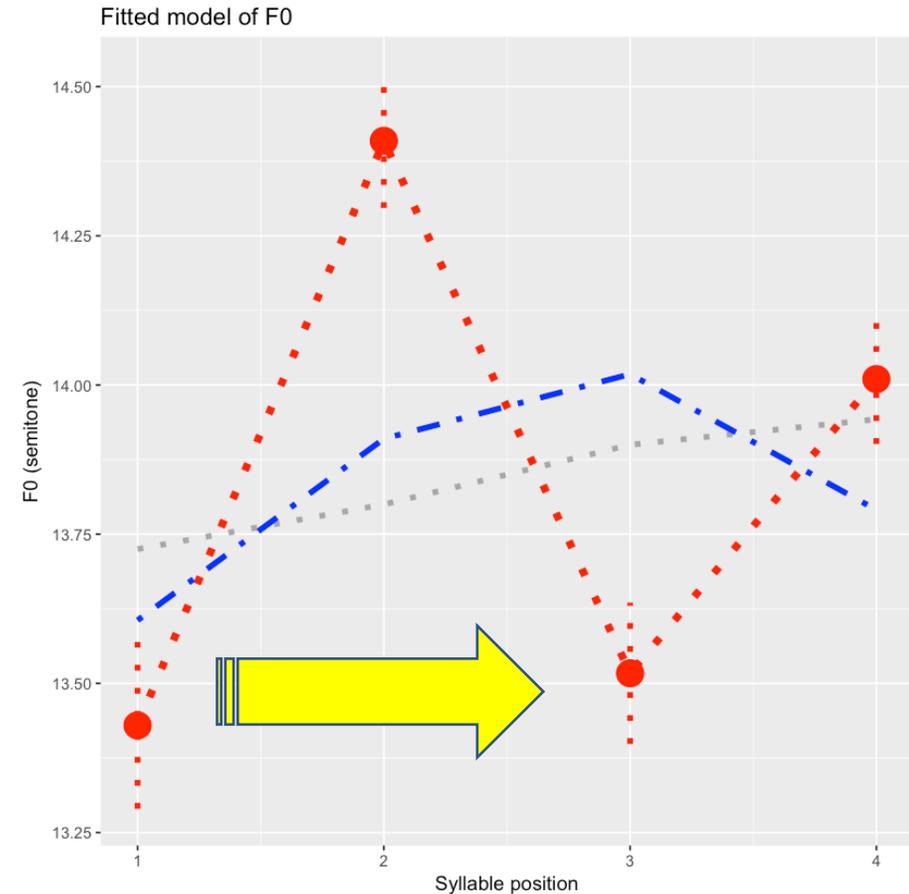
Speaker of  $i$

Time at  $j$



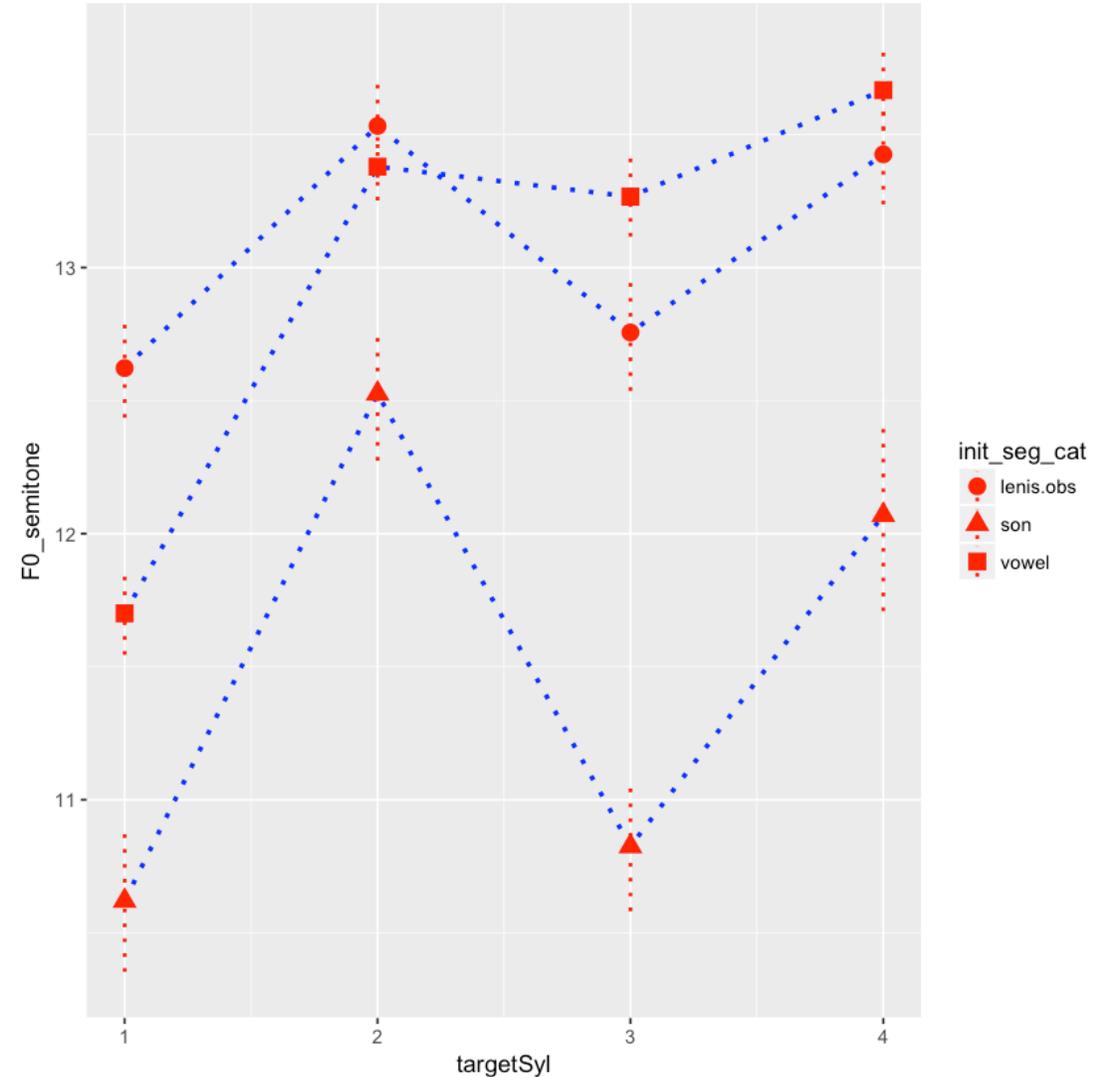
# Result 2: Overall tonal pattern and medial L

- Model fit with cubic polynomial terms
- Articulatory ease
  - The F0 of the medial tone may be higher than the initial L tone.
- Contrast maximization
  - The medial tone can be as low as or lower than the initial L tone.



# F0 of medial L in LHLH tonal patterns

- GCA with Polynomial cubic terms
- The best fitted model is made with the functional form cubic polynomial terms for syllable position terms on fixed effect of initial segment categories
- The model allowed individual subjects to vary randomly on any of the polynomial components.



# Conclusion

- The acoustic properties of APs, defined as word-like prosodic units neither preceded by nor followed by silent pauses, were extracted from a large-scaled corpus of speech samples.
- Two research questions were posed:
  - (i) whether the initial segment would have more than binary effects on the F0 of the syllable initial position, and
  - (ii) whether the medial L tone in LHLH is governed by the contrastive maximization principle.

# Conclusion

- In order to probe answers to these questions, the F0 values measured in semitone are fed into Growth Curve Analyses with the functional form of the cubic polynomial terms.
- The results showed
  - (1) that in general the initial segment had an effect on the F0 on the nucleus of the initial syllable, and
  - (2) that the medial F0 in the LHLH form seems to be governed by the contrast maximization when the initial segment is either a lenis obstruent or a sonorant, and by the ease of articulation when it is a vowel.