

VOT AND F0 IN KOREAN INFANT-DIRECTED SPEECH

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1. INTRODUCTION

Korean oral stops are unique in their three-way laryngeal contrast for oral stops, called plain, fortis, and aspirated (/p,t,k/, /p*,t*,k*/, /p^h,t^h,k^h/). The primary acoustic correlates of the contrast have been shown to be voice onset time (VOT) (Lisker and Abramson 1964, Hirose et al. 1974, Cho et al. 2002), fundamental frequency (f0) of vowel onset (Kim & Duanmu 2004), and voice quality of vowel onset (Ahn & Iverson 2004).

Early research into the implementation of the acoustic correlates of the laryngeal contrasts suggest that aspirated stops have the longest VOT, followed by plain stops with an intermediate VOT, and tense stops with the shortest VOT. Plain stops have been shown to have the lowest f0, followed by similar, higher f0 measures in tense and aspirated stops. More recent research, however, suggests that in the speech of younger adult Korean speakers, the acoustic correlates are undergoing a shift, whereby VOT no longer reliably separates plain from aspirated stops, with the weight of distinction being shifted to the f0 of the following vowel, resulting in a high tone following aspirated stops (Wright 2007).

Our current research asks how the covariation between VOT and f0 is implemented during the earliest stages of the infant-directed register in Korean? As there is increasing evidence that laryngeal timing gestures like VOT are inaccurately produced in IDS (Sundberg & Lacerda 1991, Narayan 2011), do mothers exaggerate the f0 differences?

The current research has implications for phonological development in Korean infants in light of recent findings suggesting a change in the Korean laryngeal contrast. Silva (2006) shows that contemporary Korean is developing a tonal system reflecting a change in speakers' implementation of VOT and f0 cues to the three-way laryngeal contrast. Silva shows that the phonological difference between plain and aspirated stops, which is usually signaled by a VOT difference, is now manifested in f0 patterns. The plain/aspirated distinction in Silva's study showed insignificant VOT differences, with categorization occurring according to tone. Plain stops are associated with low tone and aspirated stops with high tone.

2. METHOD

Three native Korean-speaking mothers were recorded at their homes for one hour as they interacted with their 5-month-old infants. Mothers were told to interact with their young infants in an *everyday* manner, while the researcher was in an adjacent room. The same mothers were then recorded for 10 minutes speaking with an adult, Korean-speaking researcher. All recordings were made using a high-quality lapel microphone directly to a digital recording device. The resulting .wav files were transcribed by a native Korean speaker. CVs were tagged at consonant and vowel onset and offset. Measurements were collected automatically using specially written Praat (Boersma 2011) script, which logged VOT and f0 characteristics. VOT was taken as the difference (in ms) between the aspiration offset time and onset. Vowel onset was indicated by the first zero-crossing of periodicity after the aperiodic noise of aspiration. In order to account for overall speech rate differences between IDS and ADS registers, raw VOTs were divided by the following vowel duration. Maximum f0s (Hz) were first converted to the perceptually relevant Mel scale and normalized using the standard z-transformation. Data from approximately 2000 CVs were extracted from the audio. Analyses focused on only word-initial CVs, resulting in a total of 950 tokens.

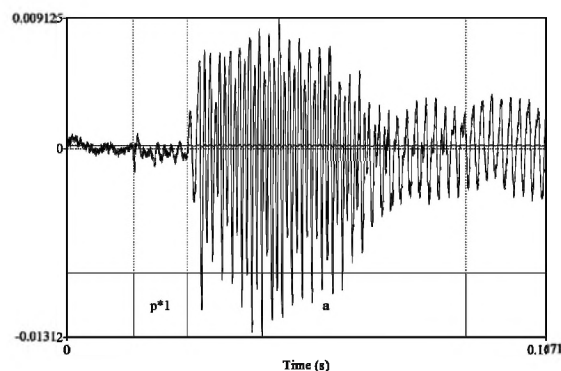


Figure 1. Sample CV with aspiration and vowel onset/offset.

3. RESULTS

Results suggest that plain and tense stops are not reliably different along the VOT dimension in IDS (figs.2,3), with aspirated stops having the longest VOTs ($p < 0.05$). VOT in tense stops was shortest in the ADS sample, with more similar VOTs observed in plain and aspirated stops ($p < 0.01$).

Fundamental frequency is significantly higher in tense and aspirated stops when compared to plain stops in IDS ($p < 0.05$). Fundamental frequency was low in plain stops relative to tense and aspirated stops ($p < 0.05$) in ADS.

VOT and f_0 were used as predictors in a multinomial regression model of laryngeal state in both registers. The pattern of VOT according to consonant type was similar in both registers. While both VOT and f_0 were predictive of laryngeal state, the interaction between the two was more significant in the IDS model, suggesting that the lack of distinction along VOT renders f_0 more useful in the IDS model.

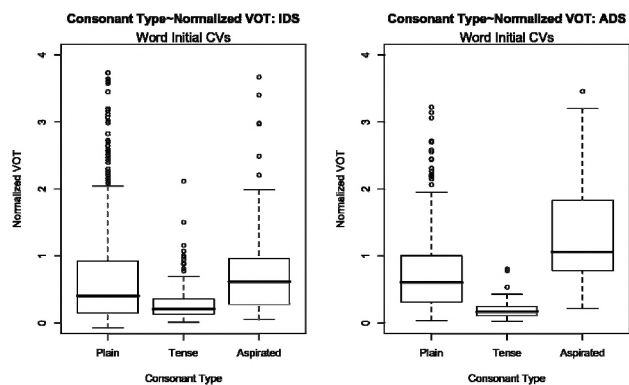


Figure 2: VOT ratio according to laryngeal type in IDS and ADS registers

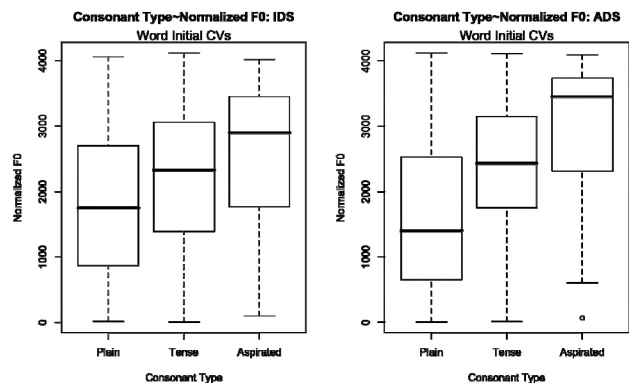


Figure 3: Normalized f_0 (mels) according to laryngeal type in IDS and ADS registers

4. DISCUSSION

While fundamental frequency operates similarly in both registers, it is more predictive of laryngeal state in the IDS model than in ADS because VOT shows more ambiguity in speech to infants. These results are generally consistent with the tonogenesis results of Silva (2006).

The three-way laryngeal contrast of Korean is rendered binary along the very salient VOT dimension. For the 5 month olds in the current study to accurately segregate three

consonant types, they must factor in to their perceptual categorization the f_0 cue.

We must consider the possibility that the current results, showing ambiguous VOT cues to laryngeal state, arise as a result of the demands of IDS rather than an overall change in the implementation of the contrast in adult Korean speakers, as VOT remains predictive of the three consonant types in ADS. The current research is part of a larger, longitudinal study assessing the acoustics of laryngeals in Korean. If the VOT/ f_0 acoustic dynamics remain consistent in the speech to older infants, we might conclude that the seeds the qualitative change in the nature of the Korean laryngeal contrast (Silva 2006) are indeed to be found in the earliest input to infants.

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