

# An Electromyographic Study of Laryngeal Adjustments for the Korean Stops in Syllable-Initial and Final Positions

H. Hirose, H.S. Park and M. Sawashima  
*Tokyo, Japan*

## 1. Introduction

It is known that in Korean there is a three-member distinction in both manner and place of articulation that serves to differentiate nine stop consonant phonemes. For classification, the three types are generally referred to as 'forced' (Type I), 'lax' (Type II) and 'aspirated' (Type III). All stop types may occur in the syllable-initial position to be realized as voiceless, while in the medial position, the lax stops are usually manifested by voiced allophones. In syllable-final position, the three stop types are phonetically realized as voiceless 'applosives', being characterized by the absence of oral release.

The purpose of the present study is to investigate electromyographically the laryngeal adjustment for Korean stops both in the syllable-initial and syllable-final positions in various phonological conditions.

## 2. Procedures

Two native Korean speakers of the Seoul dialect served as the subjects. They read meaningful test words which were selected so as to place the stop consonants in different phonological environments, where (1) stop consonants are placed at the syllable-initial position and (2) they are placed at the syllable-final position and followed by an appropriate word starting with a syllable-initial stop. Electro-myographic (EMG) recordings were made using hooked-wire electrodes inserted percutaneously into the thyroarytenoid (VOC) muscle of the subjects. The recordings were made when the subjects read the utterance samples ten to twelve times each repeatedly. The recorded EMG signals were then reproduced and computer-processed after appropriate rectification and integration and average indication of the muscle activity of VOC was obtained over more than ten selected tokens of each test utterance type.

### 3. Results

#### 1. EMG findings on syllable-initial stops

For both subjects, it was revealed that VOC activity was suppressed for each type of the stop consonants examined, the degree of which was slightest for the forced type and most marked for the aspirated type, while it was moderate for the lax type. VOC activity increased (reactivated) again toward the voice onset of the postconsonantal vowel after the suppression. The timing of the reactivation was earliest for the forced type followed by the aspirated and the lax types in that order. The peak of the reactivation was higher for the forced and the aspirated than for the lax type.

#### 2. EMG findings on syllable-final stops

It was revealed that the pattern of VOC activity for those utterance types containing the syllable-final stop followed by the syllable-initial lax or forced stop was quite similar to that for the initial forced stop in terms of the degree and timing of VOC suppression for consonant segments, and of the degree and timing of VOC reactivation for postconsonantal vowels. EMG patterns were found to be similar even when the place of articulation of syllable-final applosives was different from that of the following syllable-initial stop. In contrast, when the syllable-final stop was followed by the aspirated stop, the pattern resembled that for the single syllable-initial aspirated stop, suggesting the occurrence of assimilation.

### 4. Discussion

The present study reveals that the three types of Korean stops in the syllable-initial position are characterized by different patterns of VOC activity. For the production of the aspirated type, VOC is markedly suppressed and then reactivated for the following vowel. Such activity patterns seem to correspond to a marked abduction gesture of the glottis for the aspirated type, which has been confirmed by fiberoptic observation (Kagaya, 1974).

EMG patterns for the lax type can also be considered to correspond to the glottal abduction gesture for this type of stop, in which a moderate degree of glottal opening is always observed by fiberoptic observation.

It has been observed by fiberoptic study that the glottal opening is smallest for the forced type among the three stop types of Korean, and the glottis tends to close earlier relative to the voice onset of the following vowel (Kagaya, 1974). Minimum suppression and early reactivation of VOC activity found in the present study for the syllable-initial forced stop seem to correspond at least to the temporal feature of the glottal dynamics for the forced type. However, the increase in VOC activity before the voice onset of the vowel following the forced type, the degree of which is relatively higher

than that for the lax type and comparable to that for the aspirated type, cannot be explained by a simple dimension of glottal abduction-adduction. Rather, as already suggested by Hirose, Lee and Ushijima (1974), the relatively steep increase in VOC activity for the forced type must be taken as a characteristic feature of this type of Korean stop. This activity pattern may correspond to the acoustic feature of 'laryngealization' described by Abramson and Lisker (1972) and Ladefoged (1973), and can be a physiological correlate of the rapid intensity build-up after stop release which was found to be characteristic for the forced type by Han and Weitzman (1970).

Results of the present study also indicate that the patterns of VOC activity for the consonant clusters consisting of a syllable-final applosive and a syllable-initial forced or lax stop is quite similar to that of the syllable-initial forced type, regardless of the type of the syllable-final stop. It is claimed that when the syllable-final applosive is followed by an initial lax stop, the initial lax stop first changes into the forced type and then assimilates the preceding stop (Sawashima and Park, 1979). It is also shown that the pattern of VOC activity for the cluster type consisting of a syllable-final applosive followed by a syllable-initial aspirated stop resembles that of the syllable-initial spirated type. These EMG results are comparable to those of fiberoptic observations reported by Sawashima, Park, Honda and Hirose (1980), who claimed that for consonant clusters with an intervening word boundary the laryngeal feature of the final stop is assimilated to the following syllable-initial stop, regardless of the difference in the place of articulation.

It is reasonable to consider that the dynamics of glottal configuration observed by a fiberscope is under the muscle control of the larynx. The present study suggests that the pattern of VOC activity is an important physiological correlate for differentiating the three stop types of Korean as well as for phonetic realization of consonant clusters across an intervening word boundary in Korean with reference to the dynamic control of glottal configuration.

### 5. Summary

An EMG study was conducted to investigate the laryngeal control in Korean stop production. The results are summarized as follows:

1. The pattern of VOC activity appeared to characterize the three different types of Korean stops.
2. Specifically, for the production of the forced stop, VOC showed marked increase of activity with relatively earlier timing before the onset of the following vowel.
3. When the final stop was followed by the syllable-initial lax or forced stop, the EMG pattern of VOC for the cluster resembled that for the initial forced stop. In contrast, when it was followed by the aspirated stop, the pattern resembled that for the single syllable-initial aspirated stop.

**References**

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