

LARYNGEAL ADJUSTMENTS FOR SYLLABLE FINAL STOPS IN KOREAN:
SOME PRELIMINARY RESULTS OF FIBEROPTIC OBSERVATION

M. Sawashima and H. S. Park

1. Introduction.

It is well known that Korean stop consonants in syllable-initial position are of three types; lax, aspirated and forced (or inaspirated). Phonetic characteristics of these three types have been reported by acoustic and physiological observations (Umeda and Umeda 1965, Kim 1970, Hirose et al. 1974, Kagaya 1974). In the syllable final position, however, these three different types are neutralized to a single type of stop consonant with the same place of articulation, although the underlying three-way distinction is preserved in the Korean orthographic (Hangul) system. Thus the syllable-final stops are phonetically realized as voiceless "applosives" which are characterized by the absence of oral release.

The aim of our present study is to investigate the laryngeal adjustments for these syllable final stops in various phonological conditions. The study is now under way. In this paper, we will present some of our preliminary results.

2. Experimental Procedures.

2-1. Test materials

We selected the velar stops /k, k^h, k^ʰ/ as the representatives of the stop consonants. Meaningful words containing these sounds were prepared according to the different phonological environments described below where the test words are presented in both orthography "____" and phonetic transcription.

Case i: Syllable-final stop at the end of sentence.

Test words were:

- "kɛ k" [kɛk'] (guest),
- "puək^h" [puək'] (kitchen),
- "pakk" [pak'] (outside).

Here "k" is the lax stop which corresponds to /k/ and [k], "k^h" the aspirated stop corresponding to /k^h/ and [k^h], and "k^ʰ" the forced stop corresponding to /k^ʰ/ and [k^ʰ]. The phonetic symbol [k'] indicates the velar applosive sound. The test words were pronounced in a sentence "ike ____". (This is ____).

Case ii: Syllable-final stop followed by syllable-initial stops.

In this case, the following lax stop is pronounced as a forced stop. The test words were:

- "pɛ kkač'i" [pɛ k'adʒi] (to the boat),
- "pɛ k kač'i" [pɛ k'k'adʒi] or [pɛ k'adʒi] (a hundred kinds),
- "pɛ k kkač'i" [pɛ k'k'adʒi] or [pɛ k'adʒi] (up to one hundred),
- "č'e k^h i" [tɕ ek^h i] (my key),
- "tɛ k k^h i" [tɛ k' k^h i] or [tɛ k^h i] (your key).

"puək^hk^hi" [puək'k^hi] or [puək^hi] (key of the kitchen)

The test words were embedded in the frame sentence "ike ___ ta".
(This is _____).

Case iii: Syllable-final stop followed by a particle, word ending, suffix or copula, with the vowel in the initial position.

In this case, the syllable final stop shifts to the initial position of the following syllable and consequently its underlying feature as a syllable-initial stop becomes manifest. The test words here were the same as those in case i. They were embedded in a frame sentence "ike ___ ita" (This is ___), "ita" being the copula of the test words. The pronunciations were to be:

"ike kɛk ita" [igekɛgida]

"ike puək^h ita" [igepuək^hida]

"ike pakk ita" [igepak^hida]

2-2 Subjects.

Two female Korean adults, Min and Park, served as subjects. One was a native speaker of the Seoul dialect and the other was a native speaker of the Kyounggido dialect. The subjects were students of the University of Tokyo and fluent speakers of Japanese. In order to facilitate natural utterance of the words, the subjects were asked to pronounce the Korean test words in response to the corresponding words written in Japanese. The speaking rate was kept as constant as possible within the natural ranges of the subjects.

2-3 Data collection.

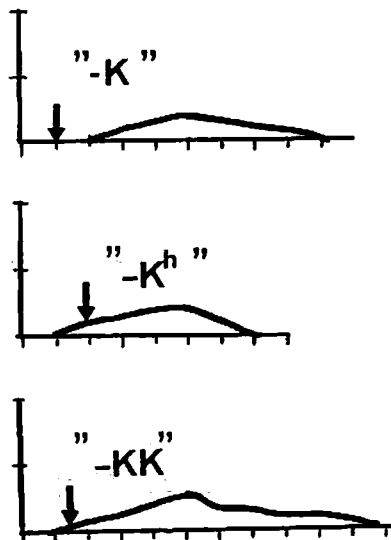
A flexible fiberscope was inserted through the nose of the subject and the laryngeal view was filmed at a rate of 50 frames per second simultaneously with the speech recording. The instrumentation has been reported elsewhere (Sawashima 1977). A magnified image of the laryngeal films were examined, frame by frame, for the pertinent consonant segments. The distance between the tips of the vocal processes of the arytenoid cartilages was measured when the glottis was open. For each subject, the number of utterance samples obtained for each of the test items was 6.

3. Results and Comments.

3-1 Case i: Syllable-final stop at the end of sentence.

Figure 1 shows the time courses of the glottal width for typical utterance samples of the two subjects. In each graph the abscissa is the time axis demarcated by the interval of each film frame (20 msec), and the ordinate corresponds to the apparent glottal width measured on an arbitrary scale. The downward arrow indicates the time point of the articulatory closure. For both subjects, the glottis begins to open at or immediately after the oral closure for all the test words, the extent of the opening remaining small for a time period of 4 to 5 frames after closure. There is no difference in the contour of the time curve for the three different test words.

SUBJ.P.



SUBJ.M.

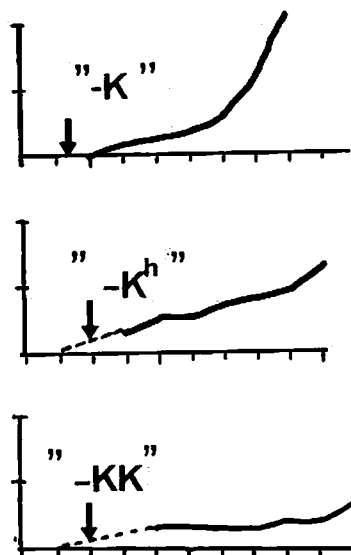


Fig. 1: Typical examples of the time course of the glottal width for the syllable-final stop consonants; "-k" of "kek", "-k^h" of "puək^h" and "-kk" of "pakk". In the figure, ↓ indicates the time point of the oral closure.

The results reveal that the basic feature of the laryngeal adjustments for the syllable-final stops is characterized by a small extent of the glottal abduction irrespectively of the underlying types of the consonant as indicated in the orthographic description. It should be noted also, that the laryngeal adjustment is clearly different from that for the glottalization which is typically observed for the syllable-final stops in Fukinese, one of the southern dialects in China (Iwata and Sawashima 1979).

3-2 Case ii: Syllable-final stop followed by stop consonants.

Here we first compare the glottal conditions for the sequence of "- k k -" in "pɛk kaçi" and "- k kk -" in "pɛk kkaçi" with that for the syllable initial "kk-" in "pɛ kkaçi". Some typical examples are shown in

Fig. 2. In the figure, the vertical line and the upward arrow indicate the time point of the oral release and the voice onset of the following vowel respectively. There is a small extent of the glottal opening for the syllable initial forced stop, the glottis being completely closed or nearly closed at the oral release. The finding here is consistent with that in the previous report by Kagaya (1974). The glottal conditions for the sequence of the final stop and the following forced or lax stop is quite the same as that of the syllable initial forced stop, except for a longer duration of the oral closure especially for 'the "-k kk-" sequence in both subjects.

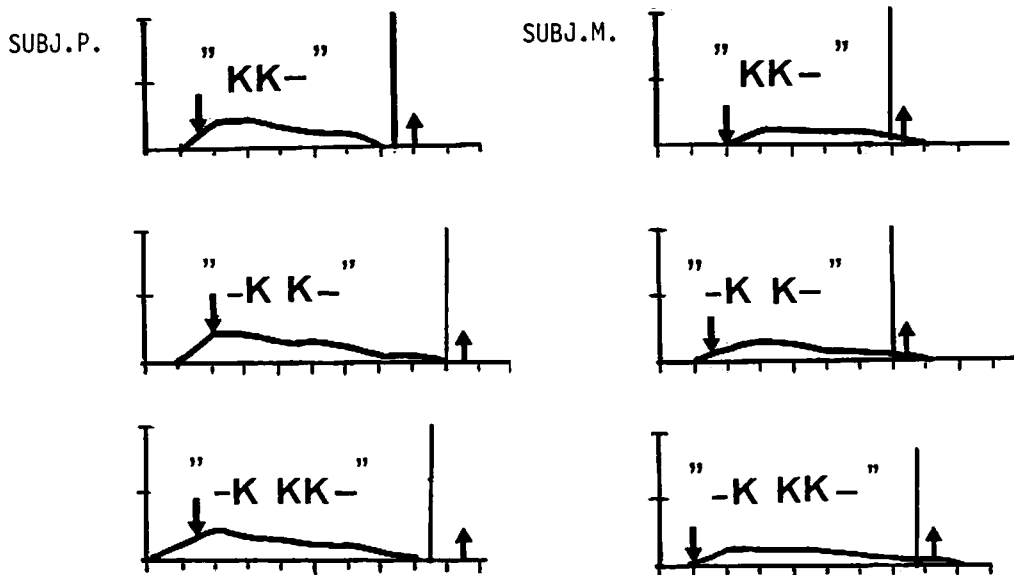
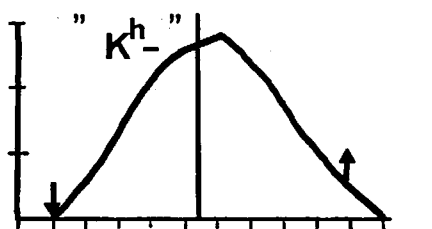


Fig. 2: Typical examples of the time course of the glottal width for the syllable-final stop consonants with the following syllable-initial stops; "-k k-" in "pɛk kaci" and "-k kk-" in "pɛk kkaci". The example for the initial "kk-" in "pɛ kkaci" is displayed as the reference. In the figure, ↓ indicates the time point of the oral closure, ↑ indicates the voice onset of the following vowel. The time point of the oral release is indicated by the vertical line.

Typical examples of the glottal conditions for "k^h-" in "ce k^hi", "-k k^h-" in "tɛk k^hi" and "-k^h k^h-" in "puə k^h k^hi" are shown in Fig. 3. For the syllable initial aspirated stop, there was a great extent of the glottal opening, the peak glottal width being reached after the oral release. This finding is also consistent with that of a previous report (Kagaya 1974). When the syllable-final stop is followed by the aspirated stop, there is also an opening of the glottis, with the peak value and the time curve of the glottal width being quite similar to those of the syllable initial aspirated stop. It should also be noted that the closure duration for "-k k^h-" was longer than "k^h-" in both subjects. The oscillograms of speech waves of subject M indicate that the vowel /i/ following /k^h/ was unvoiced for most of the samples.

SUBJ.P.



SUBJ.M.

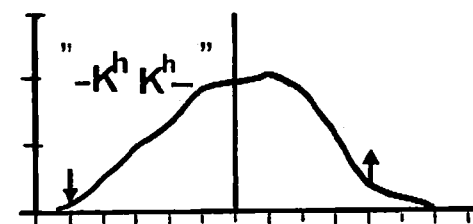
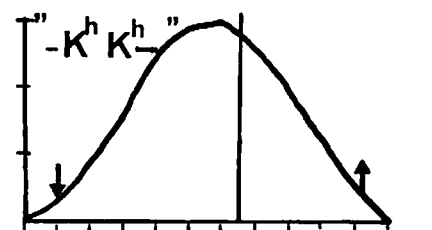
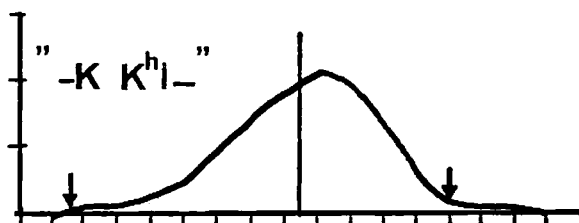
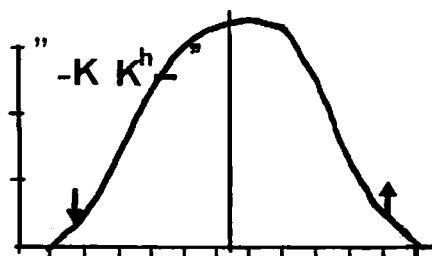
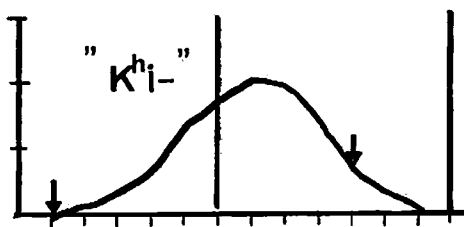


Fig. 3: Same display as Fig. 2 for the syllable-final stops with the following syllable-initial aspirated stop; "k k^h-" in "tɛk k^hi" and "-k^h k^h-" in puək^h k^hi". An example of the syllable-initial "k^h" in "ce k^hi" is also displayed as the reference. In subj. M., the vowel /i/ of "k^hi-" and "-k k^hi-" was unvoiced.

The results reveal that the laryngeal feature of the syllable-final stop was assimilated to the following stop in the consonant sequences examined. Thus the claim of Huh (1978) in his text book that the laryngeal feature of the syllable-final stop is not influenced by that of the following stop may not be supported by the present data, at least for the stop sequences with the same place of articulation. The glottal conditions for the stop sequences with different places of articulation will be dealt with in the future.

A longer duration for the oral closure can be noted for some of the stop sequences as compared with those of the original syllable-initial stop. This phenomenon is considered to be an indication that those stop sequences are pronounced as a geminate stop. A systematic acoustic study is to be made on this aspect.

3-3 Case iii: Syllable-final stop followed by the copula "ita".

In this case, the syllable-final stop is said to be pronounced as the stop consonant at the initial position of the following syllable containing the vowel [i], the underlying three-way distinction of the stop being manifested.

Figure 4 shows the time curves of the glottal width for typical utterance samples for "-kk" of "pakk" and "-k^h" of "puək^h". The glottis for "-k" of "kεk" was consistently closed with the vocal fold vibration because the sound was pronounced as the voiced stop as was normally observed for the word-medial lax stop in the inter-vocalic position.

For "-kk", the glottis began to open immediately after the oral closure and was nearly closed at the oral release in subj. P.. The time pattern was quite similar to the initial "kk-" of "kkači" (Fig. 2) except for a slightly larger peak glottal width in the "-kk" of "pakk". For subj. M., the glottis for "-kk" was observed to be open, though not to a great extent, before the oral closure. This open glottis before the oral closure may be due to the unvoicing of the preceding vowel /a/ of "pakk" which is shown in the oscillograms of the speech waves of the speech vowel /a/ of "pakk" pronounced by this subject. The glottal condition at the oral release can be observed to be quite the same as that in the syllable initial forced stop, "kk-" of "kkači" which is shown in Fig. 2.

For the syllable-final "-k^h" of "puək^h", there is a greater extent of the glottal opening, the timing of the oral release being around the peak point of the time curve of the glottal width. The pattern appears to represent the basic features of the glottal condition for the syllable-initial aspirated stop as shown in Fig. 2.

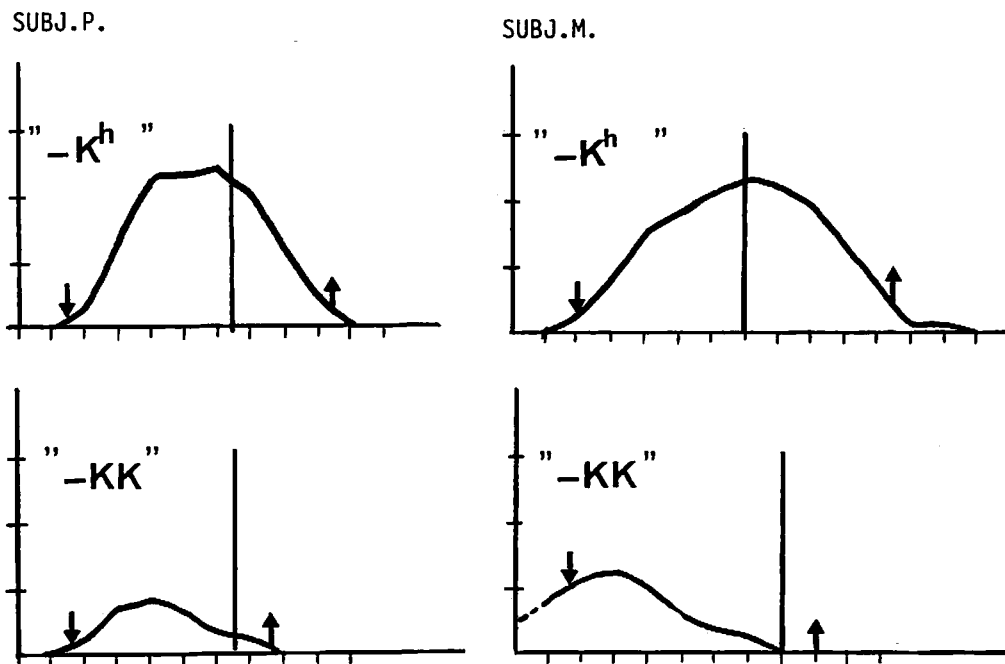


Fig. 4: Typical examples of the syllable-final stops followed by the vowel /i/ of the copula "ita"; "-k^h" in "puək^h ita" and "-kk" in "pakk ita".

A detailed discussion and conclusive comments will be presented in a future paper with more systematic data collection and analysis. The results obtained so far are summarized as follows:

1. The basic laryngeal feature of the Korean syllable-final stop is characterized by a slight extent of the glottal opening which begins almost synchronously with the oral closure.
2. In the case of the final stop followed by the syllable-initial stop, the laryngeal feature of the final stop appears to be assimilated to the following stop, as far as the glottal opening is concerned. A sequence of the stop consonants of the same place of articulation may be pronounced as a geminate stop sound.
3. The basic laryngeal features for the three-way distinction of the syllable-initial stops appear to apply to the final stop, when the stop recovers its underlying characteristic, as indicated by the Korean orthography, by the following vowel under certain linguistic conditions.

References

- Hirose, H., C. Y. Lee and T. Ushijima (1974): "Laryngeal Control in Korean Stop Production". *J. Phonetics* 2, 145-152.
- Huh, W. (1978): "Phonemics of Korean" Choung Woom Co., 159.
- Iwata, R., M. Sawashima, H. Hirose and S. Niimi (1979): "Laryngeal Adjustments of Fukienese Stops - Initial Plosives and Final Approximants-". *Ann. Bull. RILP* No. 13.
- Kagaya, R. (1974). "A Fiberscopic and Acoustic Study of the Korean Stops, Affricates and Fricatives." *J. Phonetics* 2, 161-180.
- Kim, C-W. (1970): "A Theory of Aspiration" *Phonetica* 21, 107-116.
- Sawashima, M. (1977): "Fiberoptic Observation of the Larynx and other Speech Organs" in *Dynamic Aspects of Speech Production*, M. Sawashima and F. S. Cooper (eds.), 31-46, Univ. Tokyo Press.
- Umeda, H. and N. Umeda (1965): "Acoustical Features of Korean 'Forced' Consonants". *Gengo Kenkyu*, 48, 23-33.

Acknowledgments

Many thanks are due to Prof. H. Umeda (Tokyo University of Foreign Studies, Institute for the Study of Languages and Cultures of Asia and Africa) for his advice in preparing the test words.

The work was in part supported by Grant in Aid for Scientific Research, Ministry of Education (No. 349008).