Devoicing of Vowel in Korean

Hyun-Gi KIM,* Seiji Niimi and Hajime Hirose

Introduction

Linguists have generally accepted the devoicing of a vowel , in the phonological view,as an allophone of the voiced vowel and the recent studies of devoiced vowels have frequently treated it as an example which is characteristic of Japanese.

It is known that the high vowels /i/ and /u/ between voiceless consonants are often devoiced in many Japanese dialects (Bloch, 1950; Han,1962; Sawashima, 1971; Hirose,1971; Fromkin,1983). Han mentioned that the devoicing depends on whether the vowel is accented or not and which type of voiceless consonants are adjacent to it. In French, Carton(1974) reported that the high vowel /i/ can be devoiced in the final position following the voiceless consonant.

According to Mackawa (1989), the high vowel preceded by a voiceless consonant is influenced not only by following a voiceless consonant but also by a voiced vowel occurring at the normal speaking rate and the faster speaking rate.

Concerning the interrelation between glottal width and acoustic characteristics on the spectogram of a devoiced vowel, Sawashima (1971) finds, in his fiberopic observations, a wide open glottis without any gesture of adduction throughout the period of a devoiced vowel and this time segment shows turbulent noise with some characteristic formant patterns on the spectogram.

Hirose's(1971) electromyographic study proves that the difference in the laryngeal condition in the presence or absence of vowel devoicing depends on the inherent difference in the motor command.

The vowel devoicing in Korean is partly mentioned by Hirose (1974). His electromyographic and fiberopic studies show that the interarytenoid muscle(INT) activity is markedly suppressed for the voiceless segments of [si] after an initial increase for the voiced segment. In the phonetic environment, the glottal gesture of a voiceless segment [si] seems to be wide open.

The primary purpose of the this study is to investigate the acoustic and fiberopic properties of some Korean devoiced vowel related to speech events by observing glottal gestures.

Method and Procedure.

The subject was one male native Korean speaker of the Chonla dialect. The test words selected were five meaningful words on the basis of spectrographic phenomena among the verbal forms containing the possible devoicing of high vowel /i/, /u/ and /ɯ/ between voiceless consonants in the frames "___ta " (_____ is) . Two different morphonological forms were added in the present study. These two words were also meaningful words containing a geminated consonant between high vowel /i/.

The seven test words were uttered successively in a normal speed. These words were repeated ten times separately for the fiberopic studies. Table 1. shows the list of the test words.

* Department of French Language and Literature, Chonbuk Nat.Univ.,Korea

Table 1. The test words for the devoiced vowels

1. /c^hic^hita /	" drew a line upwards "
2. /sip^hita/	" be chewed "
3. /sik^hita/	" let do "
4. /sicita/	" be soured "
5. /sit^heta/	" is timed "
6. /sic^hikk n/	" a little sour "
7. /sicikk n/	" strong sourish "

The glottal gesture was observed by use of a flexible laryngeal fiberscope inserted through the nostril. The glottal views were video-recorded at a rate of 30 frames(60 fields) per second. The speech signal was simultaneously recorded on a DAT cassette tape recorder with a camera-synchronized pulse train which corresponds to each video-field.

The glottal views appeared on a TV monitor and then transferred to a personal computer. The distance between the two vocal processes was measured on the computer monitor.

Separately from the fiberopic observation, 10 males and 10 females subjects between the age of 20 and 30 years uttered the above test words. The sound spectrographic analysis was obtained by means of a High-Speed Speech Analysis System using a NEC PC-9801 series computer and by the MacAdios Spectrographic Analysis system (GW Instruments) implented on a Macintosh II Ci computer.

Results

The present studies clarify if the high vowel between the voiceless consonants in Korean can be devoiced or not by methods of acoustic, Fiberscope, PGG and EGG. In the sound spectogram, the vowel formants represent an primary acoustic cue to verify the voiced/devoiced vowels. By repeating the test words in normal speech , we find that, among high vowel /i/,/u/ and /ɯ/, only vowel /i/ is devoiced between the voiceless consonants. Moreover, some cases show a voiced vowel in this phonetic environment. Fig.1 shows a sample of /sik^hita/ with voicing/devoicing of high vowel/i/ between fricative /s/ and aspirated stop/k^h/. The wave forms of a voiced/devoiced vowel segment are not distinguishable: the amplitudes of aperiodic segments are similar to each other, but the spectrogram wide bands show the differences. The devoiced vowel segment [s̥i] in the case of /sik^hita/(fig. 1-B) maintains the continued turbulant noise level without the formant, while the voiced vowel segment [si] presents an acoustic cue in the formant area with very short duration (fig. 1-A)just before the beginning of the oral closure for the following voiceless consonant.

Discussion

The LPC curve (fig. 2) indicates some differences in formant areas. A high amplitude of the wave form is the line-up point for the voiced/devoiced vowel segment /si/. The devoiced vowel [i] segment
(LPC curve with dashed line) shows high F2, F3 and F4 peaks without an F1 formant area, while the voiced vowel [i] segment (LPC curve with a dotted line) clearly presents an F1 peak with low F2, F3 and F4 peaks.

Concerning the influence for the devoiced vowel adjacent to the voiceless consonant, table 2 shows the average rate of the devoiced vowel on the basis of spectrographic data when the 20 subjects uttered the test words. The devoiced vowel [i̥] occurs only after the fricative /s/or /c^{h}/. The devoiced [i̥] is influenced by the following consonants: strong aspirated stops or lenis affricated.

T.2. The average rate of devoiced vowel cases when the 20 subjects uttered the test words.

p t.w	Occurtrences males	of devoiced females	vowel cases total	Percentage of devoiced
/sic^{h}ikk n/	10	10	20	100%
/sit^{h}eta/	7	10	17	85%
/sik^{h}ita/	8	7	15	75%
/sicita/	5	6	11	55%
/sip^{h}ita/	3	6	9	45%
/sicikk n/	3	4	7	35%
/c^{h}ic^{h}ita/	3	1	4	20%

By fiberopic observations, we find some devoiced vowel cases relative to the sound spectographic results. Fig. 3 shows the difference of the voiced and devoiced vowel case. Fig.3 (A) illustrates the successive glottal images containing the voiced vowel [i] (on the left). These glottal images show that the glottis is closed in the voiced segment [i], but the glottis of devoiced vowel segment [i] (on the right) maintains the open glottal gesture.

Fig. 3 (B) presents the variation of glottal width at the two measure points of glottis during the time course of /sip^{h}ita/. In the varying glottal gestures, we measured the distance between the vocal process of the arytenoid cartilage, images by images, in relation to the time course. The abscissa represents the frame number counted minus 14 frames before the voice onset for second vowel /i/. One frame corresponds to 1/30ms. The ordinate gives the variations of arbitrary glottal width. The filled circles with dotted lines present the voiced vowel case and the open circles with dashed lines indicate the devoiced vowel cases. In each figure, the /sip^{h}ita/ containing the voiced vowel shows that a degree of narrowing of the glottis starts slowly for the voiced onset period of first vowel /i/ and begins the glottal opening immediately toward the glottal maximum opening, near the respiratory position. The glottis closes again rapidly for the second vowel /i/. On the other hand, the glottal images of /sip^{h}ita/ containing the devoiced vowel segment shows some differences. The glottis is open throughout the period from the initial [s] to the beginning of the second vowel [i] without complete contact of vocal processes. Fig 4 shows also the variationss of glottal gesture for devoiced vowels cases selected from among the ten repeated utterances in the test words. We mention that the glottal opening of long duration is observed for this kind of sound sequence involving a devoiced vowel.

It is not yet conclusive whether the devoicing of vowel /i/ originates from a dialectal variant or the rate of speech . It can be mentioned that the present study by means of experimental methods, shows some characteristics of the devoiced vowel in Korean.

The devoicing of vowel /i/ usually occurs with the high vowel /i/ when it is adjacent to the fricative noise level consonants : the fricative /s/ or aspirated affricated consonant preceded by the vowel /i/ ,and strong aspirated stop or affricated consonant followed by the

vowel /i/. The wave forms do not show any distinction between the voiced/ devoiced vowel segment. But we can suppose that the vowel-like wave forms with turbulant noise level are a particular phenomena in the case of devoiced vowel segments. We think that the phenomena should be studied further especially the aerodynamic effect in this phonetic environment. The slight presence of formant may be an important cue to differenciate between the voiced and devoiced vowel segments. Interestingly in this study, the devoiced vowel segment does not show any low formant on the spectrogram.

The LPC curve shows the properties of the devoiced vowel segment. The F1 in the devoiced vowel cases does not show the first formant peak in comparison with the F1 peak of the voiced vowel, while the F2, F3 and F4 of devoiced vowel segments are higher than those of voiced vowel segment. The intensified high formant regions occur in the case of the devoiced vowel in contrast to the vowel [i] preceded by the voiceless consonant.

The fiberopic observation shows clearly the physiological cues for the devoiced vowel segment. The glottal width remains wide open in a sequence of the devoiced vowel [i] and decreases slowly from the respiratoy position to the voice onset of the second vowel /i/. But a sequence of the glottal gesture for the voiced vowel[si] begins in a closed position, opening toward the maximun position, and then decreasing to the voice onset of the second vowel /i/.

References

Carton, F.:Introduction á la phonétique française, Bordas, Paris, 1974.

Han, M. S.: Unvoicing of vowels in Japanese, The study of Sounds, No. 10, 1962, pp.81-100.

Hirose, H.: The Activity of the Adductor Laryngeal Muscles in Respect to Vowel Devoiceing in Japanese, Phonetica 23, 1971, pp.156-170.

Hirose, H., C. Y. Lee, T. Ushijima: Laryngeal control in Korean stop production, Journal of phonetics 2, 1974, pp.145-152.

Kagaya, R.: A fiberscopic and acoustic study of the Korean Stops, Affricates and Fricatives, Journal of phonetics 2, 1974, pp.161-180.

Kuriyagawa, F., M. Sawashima: Word accent, devoicing and duration vowels in Japanese, Ann. Bull. RILP 23, 1989, pp.85-108.

Maekawa, K.: Effects of speaking rate on the voicing variation in Japanese, SP 89-148, 1989, pp. 47-53.

Sawashima, M.: Devoicing of vowels, Ann. Bull. RILP 5, 1971, pp.7-13.

Vance, T. J.: An introduction to Japanese phonology, State Univ. of New York Press Albany, 1987.

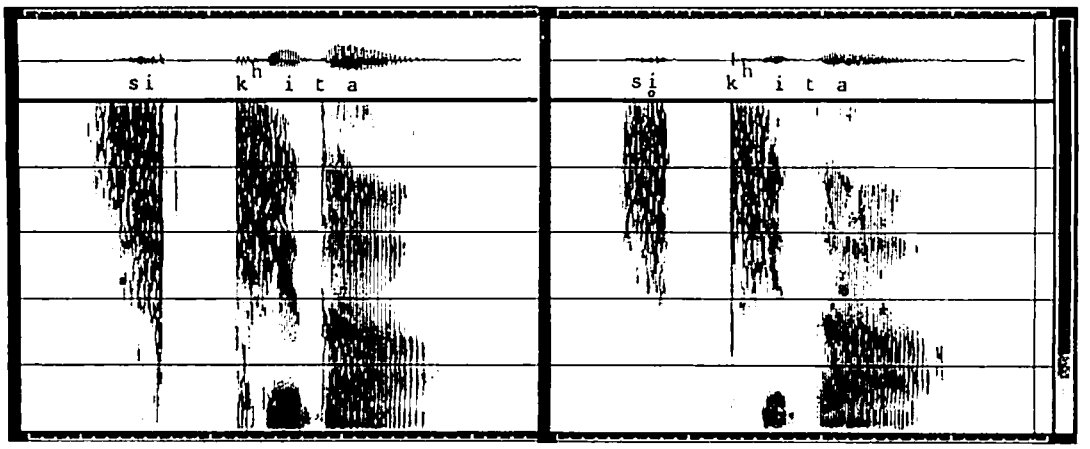


Fig.1. A spectrographic realization for the representative sample word /sik^{h}ita/ uttered with voiced (A) and devoiced (B)vowel

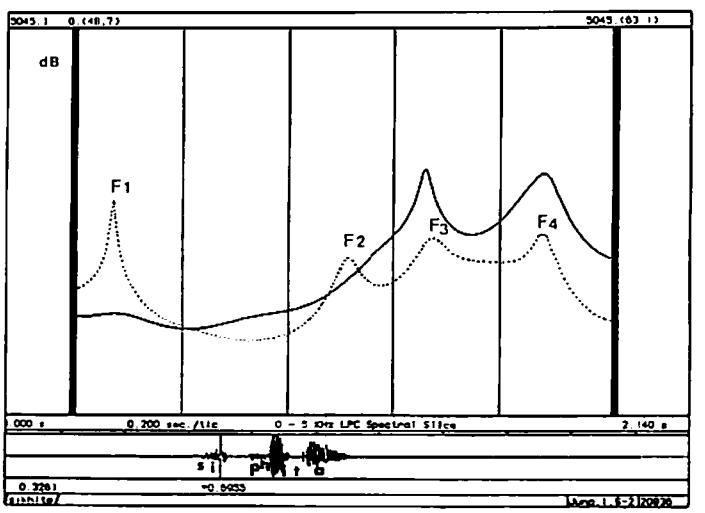
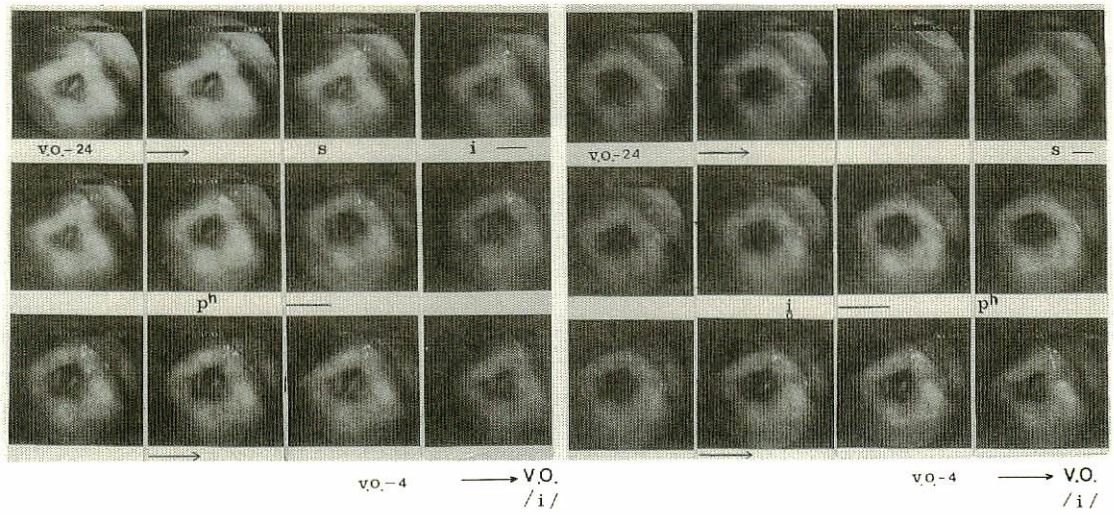


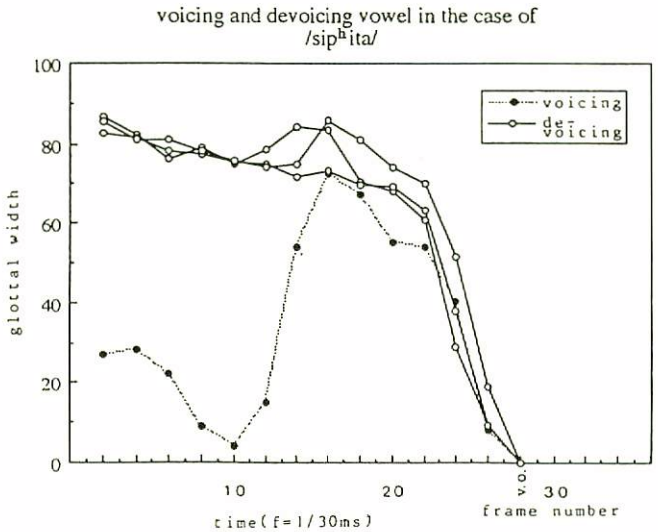
Fig.2. The LPC curve containing the voiced (dotted line)and devoiced vowel (dashed line)segment [si] in the sample word /sik^{h}ita/. A high amplitude of the wave form is the line-up point for the /si/ by means of MSLII system.

Fig.3 The difference of the glottal view for the voiced and devoiced vowel case. (A) The succeeding glottal images for the test word/sip^{h}ita/ containing the voiced vowel [i] (on the left) and the devoiced vowel [i̥] (on the right). (B) The variation of the arbitrary glottal width containing the voiced/devoiced vowel in the same test word. The filled circles with dotted lines represent the voiced vowel segment and the open circles with dashed line indicate the devoiced vowel segment. V.O. means the voice onset of the second vowel /i/ following the voiceless consonant /p^{h}/.

(A)



(B)



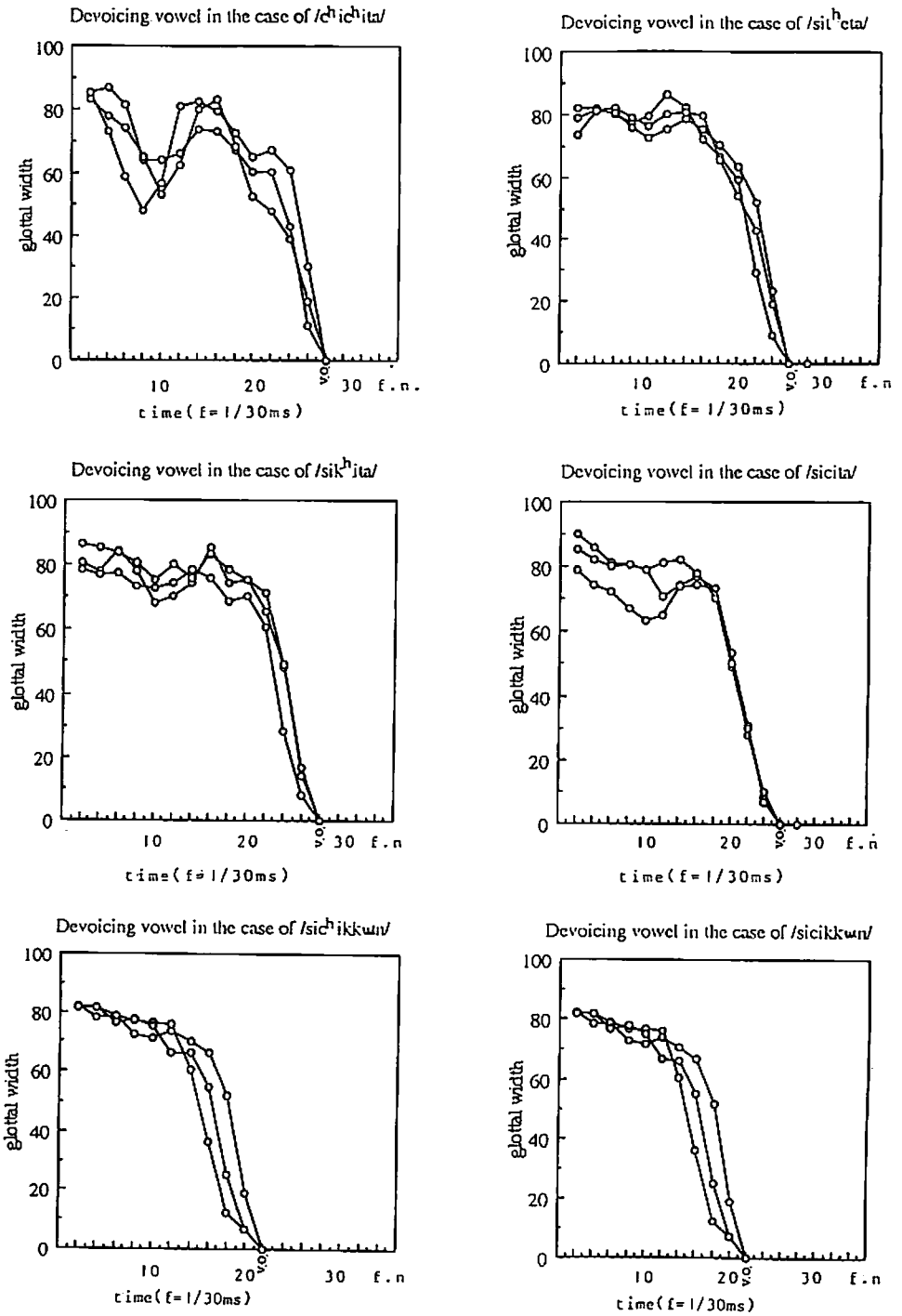


Fig.4. The different variations of glottal gesture for devoiced vowels cases from among the ten repeated utterances in the test words.