

LARYNGEAL CONDITIONS IN ARTICULATIONS
OF JAPANESE VOICELESS CONSONANTS*

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By use of a fiberoptic technique, we have observed glottal opening during articulations of Japanese voiceless consonants. Some of the results have already been reported in our previous papers¹⁾²⁾. Those observations, however, were limited to only one subject and more data collection on different subjects was necessary in order to reach general conclusions.

In this paper, results obtained on additional three subjects are presented in comparison with those that appeared in our previous reports. Data obtained for the voiceless affricate are also included in this report.

Experimental Procedures

Three adult males of the Tokyo dialect served as subjects. Twenty-four meaningful words were selected as speech material. These words are:

精製 /seHseH/	軽々 /keHkeH/	亭々 /teHteH/	生計 /seHkeH/
制定 /seHteH/	精通 /seHtsuH/	通性 /tsuHseh/	計数 /keHsuH/
趨勢 /suHseH/	ㄅ-ㄅ- /peHpeH/	節制 /seQseH/	設計 /seQkeH/
設定 /seQteH/	鉄槌 /teQtsui/	撤兵 /teQpeH/	隻影 /seki'eH/
赤誠 /sekiseH/	隻形 /sekikeH/	席亭 /sekiteH/	脊椎 /sekitsui/
気鋭 /ki'eH/	氣勢 /kiseH/	奇形 /kikeH/	規定 /kiteH/

In this word list, voiceless stops [p], [t], [k], the fricative [s], and the affricate [ts] are placed in the word-initial and medial positions. /Qc/'s are geminates of those consonants. The geminates occur only in word-medial position in Japanese. Devoicing of the vowel /i/ takes place regularly for /kiC/ sequences in these words when pronounced in the Tokyo dialect. No accent kernel is attached to these words in the Tokyo dialect.

The subjects repeated the word list four or five times, each word being inserted in a frame sentence "soreo--- to yuu." (We call that ---.). The speaking rate and the vocal intensity as well as the vocal pitch were kept as constant as possible for each subject, within his habitual range.

* A modified version of a paper to be presented at XVI International Congress of Logopedics and Phoniatrics, Interlaken, 1974, and one presented at the Spring Meeting of the Acoustic Society of Japan, 1974.

A fiberscope was inserted through the nose of the subject and the glottal view was photographed by a 16 mm cine camera at a frame rate of 50 per second simultaneously with speech signals. Frame-by-frame signals of the cine camera and timing marks were also recorded on one channel of a stereo-audio tape recorder, speech signals being recorded in the other channel. On the oscillographic trace of these signals, each of the film frames was allotted to the time course of the speech signals with a maximum error of 10 msec.

On the film image, the distance between the vocal processes of the arytenoid cartilages was measured frame-by-frame during the time period corresponding to the consonants examined.

Results and Remarks

The rate of speech showed individual variation among subjects. Durations of three-mora words and four-mora words were 390-430 msec and 450-520 msec respectively in Subj. 1, 520-580 msec and 670-750 msec in Subj. 2. The values for Subj. 3 were 370-430 msec and 460-530 msec. The values for the subject in the previous report were 400-500 msec for three-mora words and 550-650 msec for four-mora words.

As reported previously, the time course of the glottal opening and closing process for the voiceless segments during utterances showed a rather simple pattern with a single peak in the glottal width. Peak values of the glottal width for voiceless segments examined are summarized in Fig. 1.

In the leftmost column of the figure, (I) indicates the word-initial position, and (M) the medial position. Three columns from left to right show the data for Subj. 1 to Subj. 3 respectively. To provide a comparison with these results, data presented in the previous report are displayed in the rightmost column, as indicated by Subj. 0.

Horizontal bars in each item represent the entire ranges of the sample variations and filled circles indicate the mean values. At the bottom of each column is an arbitrary scale representing the measure of the glottal aperture, the left end of the scale indicating zero, i. e. apparently closed glottis. Numbers of utterance samples differed with different consonants and subjects, ranging from 65 of the initial [s] for Subj. 1 to 4 of geminate consonants, [p], [ts], and /kiC/'s for Subj. 2 and Subj. 3.

When we compare the peak values for different items, a pattern common to all the subjects emerges. In general, there is a fairly large opening of the glottis for [s] in both word-initial and medial positions. In stops, the opening is definitely larger for the initial position than for the medial position. The opening for [k] appears to be larger than that for [t] and [p], the values for the initial [k] being comparable to those for [s]. As with the stops, the glottal opening for the affricate [ts] shows a greater value in the initial position as compared with the medial position. For /kiC/'s involving devoiced vowels, there is an opening of the glottis which is comparable to, or even larger than, that for [s].

In addition to this common pattern, there should be noted some individual variations. The geminate fricative [ss] shows a greater opening than for non-geminate [s] in Subj. 3 and Subj. 0, but not in the other subjects. In the stops and the affricate, the glottal opening for geminates is

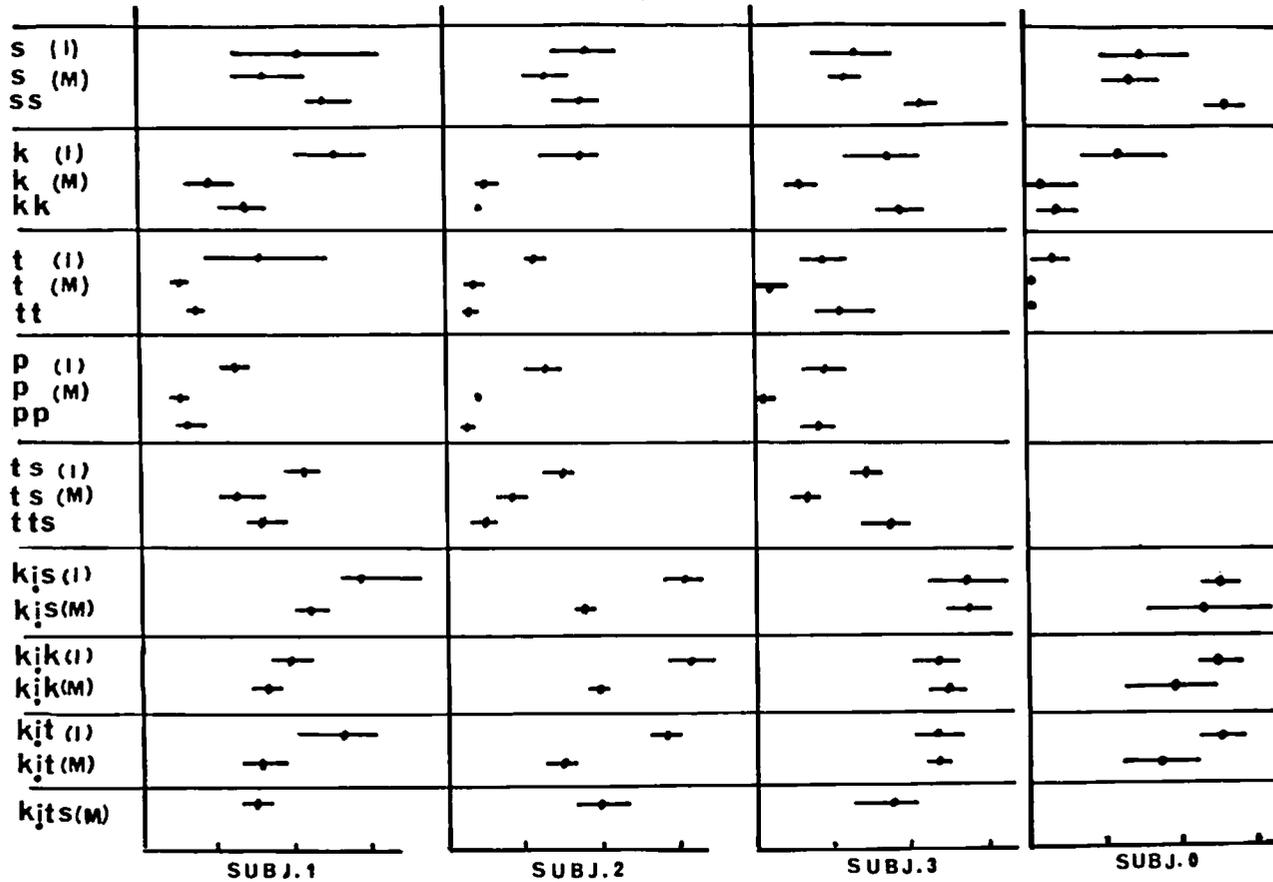


Fig. 1: Glottal width (peak value) for voiceless segments.

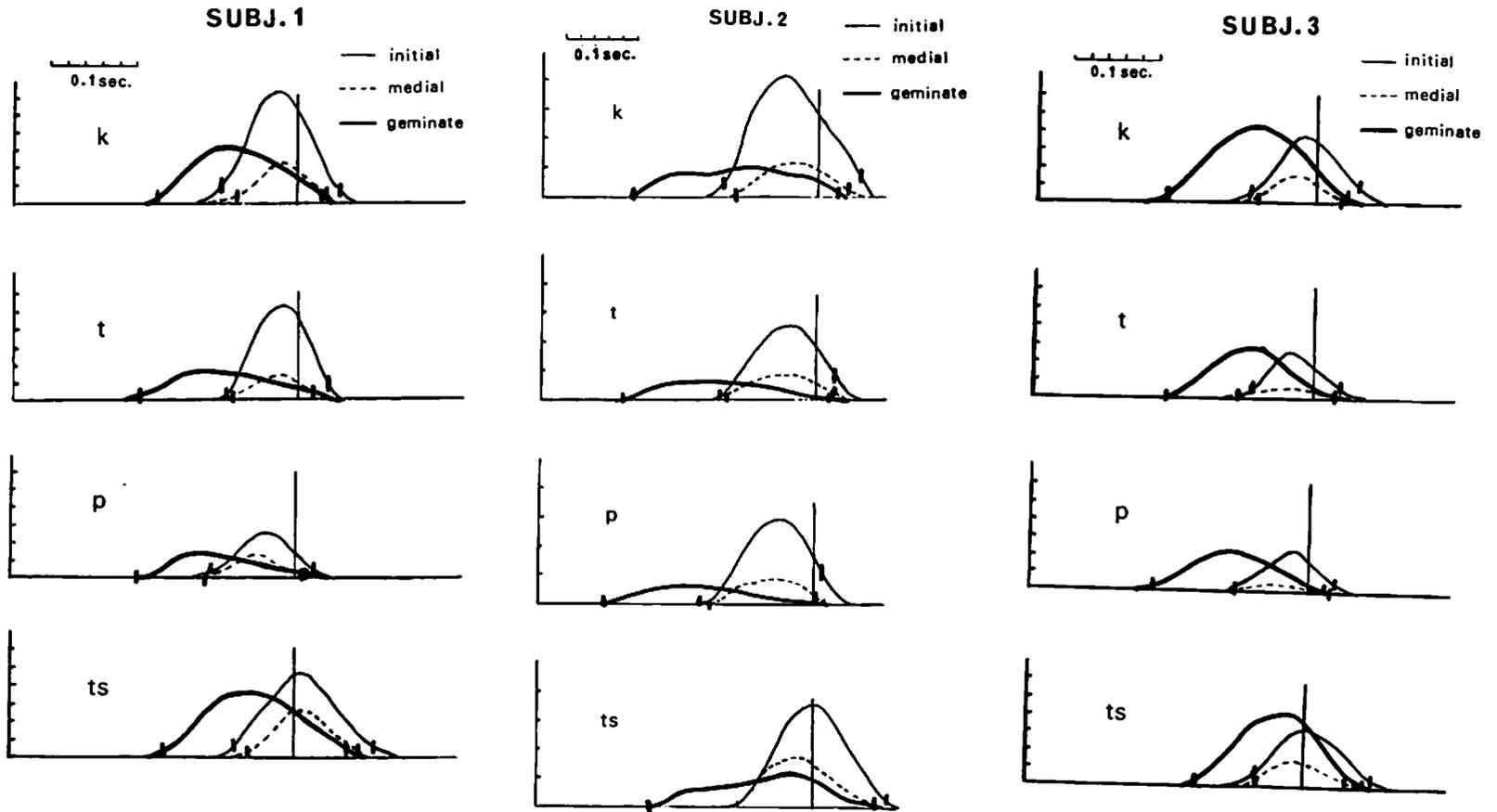


Fig. 2: Average time courses of the glottal abduction and adduction for voiceless consonants. Curves are lined up at the release of stop closure (vertical line).

as large as that for the initial non-geminates in Subj. 3, while it is as small as that for the medial non-geminates in the other subjects. The glottal opening for word-initial /kiC/'s is definitely larger than for the medial ones in Subj. 2. This tendency is also observable in Subj. 1 and Subj. 0, but not in Subj. 3.

Average time courses of glottal opening and closing for stops and affricates, except for [k] followed by [i], are displayed in Fig. 3. Numbers of samples vary with different items and subjects within the range from 10 to 5. In the figure, each of the averaged courses is lined up at the time point where the oral closure is released. A vertical line in each graph indicates the line-up point. Short vertical bars on each curve delimit the time interval of the voiceless segment. In stops there is a greater opening of the glottis at the release in initial position than in medial position. In geminates, there is a longer duration of the stop closure and of the glottal opening. Near the end of the stop closure and after the release, however, the curves of the geminates become almost identical with those of the medial non-geminates. In the affricate, the release of the stop closure takes place approximately at the time point where the maximum glottal width for the non-geminate is reached. In the initial position, the glottal aperture at the voice onset appears to be somewhat smaller as compared with the stop consonants. Otherwise the temporal pattern of the glottal condition in the affricate [ts] is nearly identical with that in the stop [k].

References

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- 2) M. Sawashima and S. Miyazaki: "Glottal Opening for Japanese Voiceless Consonants." Annual Bulletin (Research Institute of Logopedics and Phoniatics, University of Tokyo) No. 7, 1-9, (1973).

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