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PRODUCTION AND PERCEPTION OF ACCENTED DEVOICED VOWELS IN JAPANESE

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1. Introduction

Japanese closed vowels /i/ and /u/ tend to be devoiced between voiceless consonants, and moras with these vowels are considered to be unaccented1)2). In the Tokyo dialect, accent is usually shifted to the following moras except as in some examples like /hasi̥ꜜto/(bridge and) or /atu̥ꜜkatta/(was thick). Shift of accent is often found even in these words. On the other hand, vowels inthe Kinki dialect, which had long been normative Japanese, are pronounced rather carefully and closed vowels are not usually devoiced. In fact, the number of devoiced vowels found in the Kinki dialect of Osaka are about half that found in the Tokyo dialect3). But even if closed vowels in the Kinki dialect are devoiced like /ku̥ꜜsa/(grass) or /ku̥ꜜse/(habit), accent is still on the moras with devoiced vowels and is never shifted to the following moras as in the Tokyo and other dialects.

The reason devoiced vowels without the vibration of the vocal folds are heard to be accented has been discussed, and it has been said that the intensity of voiceless moras may be the main reason4)5). Many experimental materials, however, have shown that the fundamental frequency contours (F0-contours) of the /o/ of /hasi̥ꜜto/ with an accented and devoiced preceding vowel have sharp descending tones while those of /hasi̥to/ have level tones. The /o/ vowels of /hasi̥ꜜto/ and /hasi̥to/ were exchanged in a splicing experiment, and the results of hearing tests using these words showed that words with descending third vowels were heard to be accented, while words with level third vowels were heard as unaccented6). These results suggest that it is the following descending tones that make preceding devoiced vowels heard as accented7).

To prove these hypotheses, the process of the production and perception of accented devoiced vowels were investigated based on laryngeal electromyography (EMG) and on identification tests conducted using synthesized speech stimuli with varieties of F0-contours for /kusa/ with voiced and devoiced first vowels. The purpose of the present paper is to report on the process and the results of these experiments.

2. Physiological Features in Production of Accented Voiceless Vowels

2.1. Experimental Procedure

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2.1.1. Subjects and Test Words

The subjects for this study were two female native speakers ofthe Kinki dialect, Y.I. and M.M., both in their twenties. The subjects read randomized lists of words and sentences con-taining the same test words twelve times each. Table 1 shows the test words used in the present experiment. We have already reported the results of an experiment on the four types of accent of /imi/ and /iki/8). Here we will explain part of the EMG data for /imi/ with a continuing F0-contour, and then discuss the experimental materials for the /HL/ type of accent in /kuꜜsi/, /kuꜜsa/ and /ku̥ꜜsa/ with accented devoiced vowels.

2.1.2. Experimental Procedure

Laryngeal electromyographic (EMG) recordings were made from the lateral cricoarytenoid (LCA), cricothyroid (CT) and sterno-hyoid (SH) of subject Y.I., and from the CT and SH of the other subject, M.M.

Conventional hooked-wire electrodes were used, which were inserted into the muscles through the skin. The EMG signals wererecorded on a multichannel FM data recorder together with the acoustic signals. The signals were then reproduced and computer-processed using a data-processing system9)10). To obtain an averaged pattern for a given test word or sentence, the EMG signals were rectified, integrated and averaged with reference toa predetermined time point on the acoustic signal, the voice onset of the first vowel. In order to investigate the EMG pattern of a single token, the wave form of the integral calculus, taken from an appropriate sample, was smoothed by steps of 50-90 msec to give a time-varying curve. In the present paper, some of the raw data will be shown as the EMG pattern of a single token, so that the timing of the EMG activities can be precicely observed.

2.1.3. Speech Materials

The speech uttered by the subjects was recorded simultaneously with the electromyographic recordings. Wide and narrow band spectro-grams were obtained to observe the F0-contours and to measure the durations of vowels and consonants. The spectrograms showed that subject Y.I. uttered one /u/ of /kuꜜsa/ and /kuꜜse/ voiced, but the /u/ in the eleven other utterances of Y.I. were devoiced, while subject M.M. uttered all the words with voiced vowels as shown in section 2.3.

2.2. The Relationship Between Laryngeal EMG Activities and F0-contours

There was a positive correlation between the pattern of the CT activity and the raising and lowering of F0, as has often been reported in the literature9). In addition, the activa-tion of the SH also seemed to correlate with a descent in the F0-

contours. The onset of voice lowering was found to be after the CT peak and a little before the SH peak. It was also noted in both speakers that the SH activity increases prior to the production of words of the low-start accent type8)11).

Fig.1 shows the averaged F0-contours and EMG activities of the CT and SH of /imi/ in the four different accent types obtained from subject Y.I. The envelopes of the CT (thick line) and the SH (thin line) of each accent type are superimposed on the same horizontal axis8).

Each F0-contour is shown in the uppermost part of the figure with arrows indicating the onsets of voice raising (↑) and lowering(↓). A vertical line shows the voice onset of the utterances. The temporal course of the EMG curves of the CT and SH appear to correlate with the F0-contour. In the case of type A of the high-start group, the CT activity starts prior to the voice onset, and increases sharply to reach its peak. The acti-vity then rapidly declines after the peak, but before the onset of the descent in the F0-contour.

Thus, the decrease in the CT activity appears to correspond to the pitch lowering. Prior to the cessation of the CT acti-vity, SH activity begins to increase. The SH peak occurs later than that of the CT, and the onset of voice lowering. It seems reasonable to conclude that the SH activity is related to the sharp descent in the F0-contour of type A. In the case of types B and C of the low-start group, definite activation of the SH prior to voice onset are observed. The SH activation is also found later than the CT peak in type B. As for type D of the high-start group, the activity of the CT prior to the voice onset is also present, but is less marked than in type A. The CT activity then gradually decreases toward the end of the utterance. There is no apparent activation of the SH in type D, whose F0-contour starts high and has a level tone.

These results suggest that the timing pattern of these two muscles, the decrease in the CT activity and increase in the SH activation, are correlated with a sharp descent in the F0-contours of type A and B. The activation of SH is known to be correlated with jaw opening, and has been suspected whether it is related to voice lowering or not. But, as the test word /imi/ with closed vowels has nothing to do with jaw opening, the activation of the SH, observed in the figures, shows that the SH is evidently related to voice lowering.

2.3. Production of Accented Devoiced Vowels

The item /imi/ is an appropriate test word in order to avoid the influence of jaw opening on the activation of SH. /kusi/ or /kusu/ also have closed vowels with voiceless consonants but their first vowels are never devoiced, while accented voice-less vowels are generally followed by open vowels as in /ku̥sa/ or /ku̥se/.

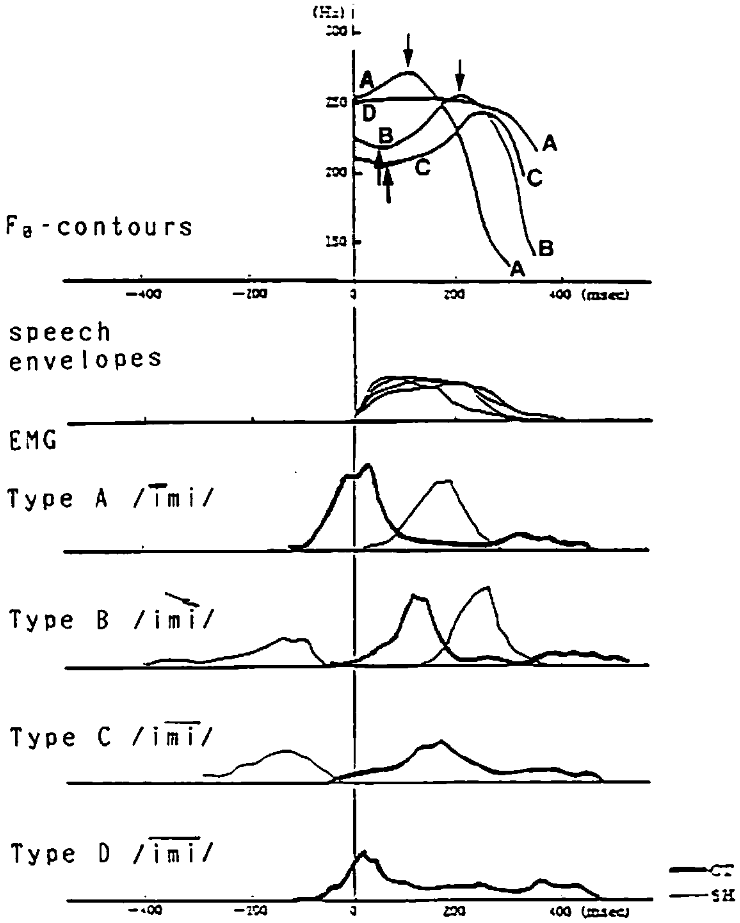

Fig. 1 F0-contours, speech envelopes, and averaged EMG patterns for /imi/ with four accent types (subject Y.I.)

As for /kusi/, /kusu/ and /kusa/, /kuse/, the F0-contours of the second vowels are quite different according to their different qualities, andthe relative length of the durations of the second cosonants.

Fig.2 shows twelve superimposed F0-contours on the same horizontal axis of /kuꜜsi/ and /kuꜜsa/ uttered by Y.I.(1, 3) and M.M.(2, 4). These speech materials were recorded simultaneously with EMG recordings. The dotted lines show parts of the voiceless consonant /s/ of the second moras. The vertical thick lines show the voice onset of the second vowels, and the averaged dura-tions of the consonant /s/ are shown between the thick lines and the thin lines. The durations of the consonant are longer and those of the following vowels are shorter in /kuꜜsi/ than those in /ku̥ꜜsa/ in the utterances of both speakers. As for figure 3, the thick oblique line shows the F0-contour of /kusa/ with the voiced first vowel and the thin lines show eleven contours of the second vowel of /ku̥ꜜsa/ with a devoiced first vowel. The F0-contours of each word uttered by both speakers are similar to each other, but the contours of /i/ and /a/ of /kuꜜsi/ and /kuꜜsa/ (1 vs 3, and 2 vs 4) are quite different. That is, the F0-contours of [i] in /kuꜜsi/ start late and are comparatively low and level, while those of/a/ in /kuꜜsa/ start early and are high pitched, showing a sharp descent. Those of /kuꜜsa/ make a sharper descent. The minimal pairs, /aꜜsi-aꜜsa/, /aꜜki-aꜜka/ and /kuꜜsi-kuꜜsa/, uttered in natural speed, have similar patterns to those mentioned above, suggesting that the F0 descent has some relation to articulation12).

Here, the EMG patterns with the F0-contour of /kuꜜsi/ will be explained first, and then those of voiced and devoiced /kuꜜsa/ will be compared.

Fig.3 shows the spectrogram and the EMG pattern of an appropriate sample of /kuꜜsi/ uttered by subject Y.I. All the other samples of /kuꜜsi/ had similar figures. The left hand figures show the speech envelope and the F0-contour of the narrow band spectogram. The right hand figure shows the speech envelope and the activations of the CT and the SH. The vertical line shows the voice onset of the second vowel /i/.

The F0-contour of the left hand figure shows that the first vowel is high and that the second vowel begins low-pitched and has a comparatively level tone. As for the EMG patterns, the CT acti-vation begins about 60 msec prior to the onset of the first vowel. This is supposedly related to the high fundamental frequencies of the first vowel. The CT activation ends at the end of the first vowel. About 80 msec after the end of the CT activation, the SH activation begins and its evident activation continues a little while. As the activa-tion of the SH in /kuꜜsi/ is not related to jaw opening, the SH activation following the relaxation of CT activity shows that the SH is related to voice lowering, just as in the case of types A and B shown in Fig.1. The second vowel begins about 160 msec after the end of the CT activation. The vowel probably starts low pitched because the

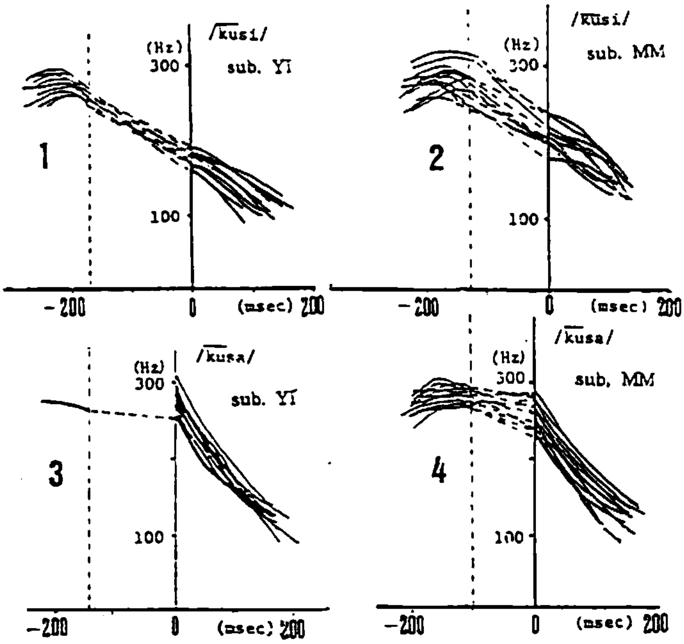

Fig. 2 F0-contours of /kusi/(1, 2) and /kusa/(3, 4).

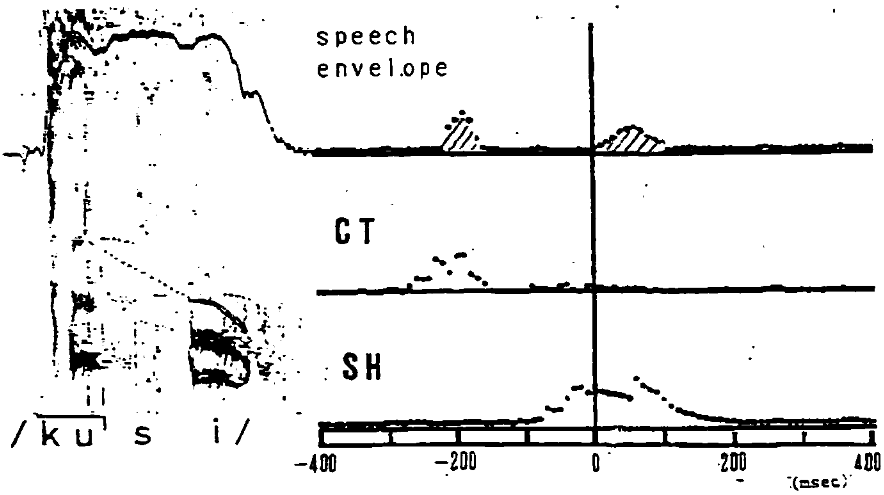

Fig. 3 Narrow band spectrogram (left), and speech envelope and EMG patterns of the CT and the SH(right) of /kusi/.

onset of the vowel is much later than the instant of the onset of voice lowering.

Fig.4 shows the spectrogram and the EMG patterns of the word /$\overline{\text{ku}}$ꜜsa/ with voiced /u/. The speech envelope and the narrow band spectrogram are shown on the left, and the speech envelope and the EMG patterns of the CT and the SH activation are shown on the right.

The F0-contour of /$\overline{\text{ku}}$ꜜsa/ is, as mentioned above, quite different from that of /$\overline{\text{ku}}$ꜜsi/. The second vowel /a/ starts high-pitched and has a falling tone. As for the EMG patterns, the CT activation begins to be active about 60 msec prior to the onset of the vowel, and it probably causes the high fundamental frequency of the first vowel. The activation ends at the end of the first vowel, as in the case of /kusi/. Butanother CT activation is found about 80 msec after the end of the first vowel, and about 50 msec prior to the onset of the second vowel.

With the later CT activation, the evident SH activation begins. The activation, of the CT and SH are believed to cause the high-pitched start of the second vowel. The vowel begins 130 msec later than the end of the first vowel. As the second vowel /i/ of /$\overline{\text{ku}}$ꜜsi/ begins 160 msec later than the end of the first vowel, the beginning of the second vowel /a/ in /$\overline{\text{ku}}$ꜜsa/ is 30 msec earlier than that of the second vowel in /$\overline{\text{ku}}$ꜜsi/. The almost simultaneous timing of the rising of the activation of the CT and the SH and the early start of the second vowel are believed to cause the high-pitched beginning of the F0 contour and the falling tone of the second vowel /a/.

Fig.5 shows the speech envelopes, narrow band spectrogram and the EMG patterns of the CT and the SH of an appropriate sample of /$\overline{\text{ku̥}}$ꜜsa/ with accented devoiced vowel. Figures for all the other samples were similar to the present figures.

The F0-contour of the vowel following the devoiced mora starts high-pitched and has a sharp falling tone. It is notable that the CT activities are found at the similar instant as if the vowel were voiced, just as observed in /$\overline{\text{ku}}$ꜜsi/ or in voiced /$\overline{\text{ku}}$ꜜsa/. This suggests that the accent command to raise voice pitch is set before the first mora begins though the first mora of /$\overline{\text{ku̥}}$ꜜsa/ lacks glottal occilation. Before the complete decay of the CT activities, another activation of the CT is foundprior to the following vowel. The latter activation is probably related to the high-pitched start of the second vowel. A large amplitude for the SH activity is also observed here. These activities are presumed to be a prerequisite for the very sharp descent in the F0-contour of /a/ that follows the accented voiceless mora.

The results of the experiments show that the utterances of devoiced vowels with accent are based on a physiological mechanism, and that their production is related to the coincidence of the timing of voice lowering and jaw opening for articulation of open vowels. Both of these are related to activities of the SH.

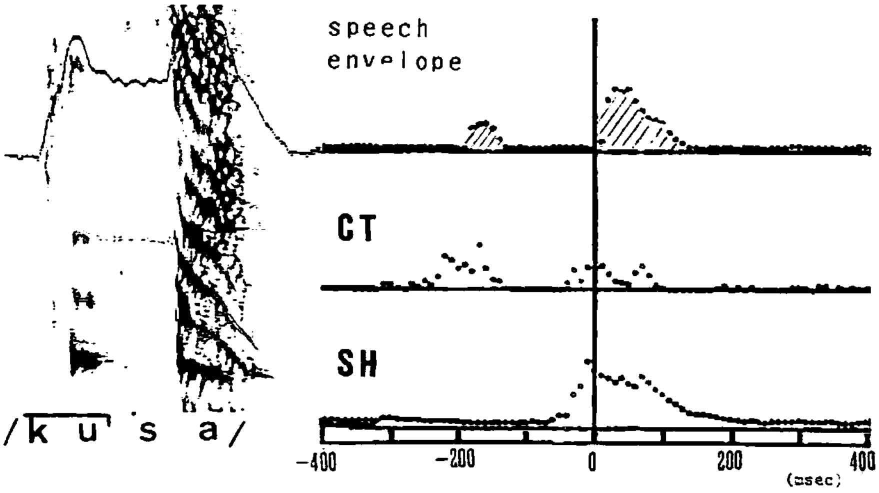

Fig. 4 Narrow band spectrogram (left), and speech envelope and EMG patterns of the CT and the SH(right) of /kusa/.

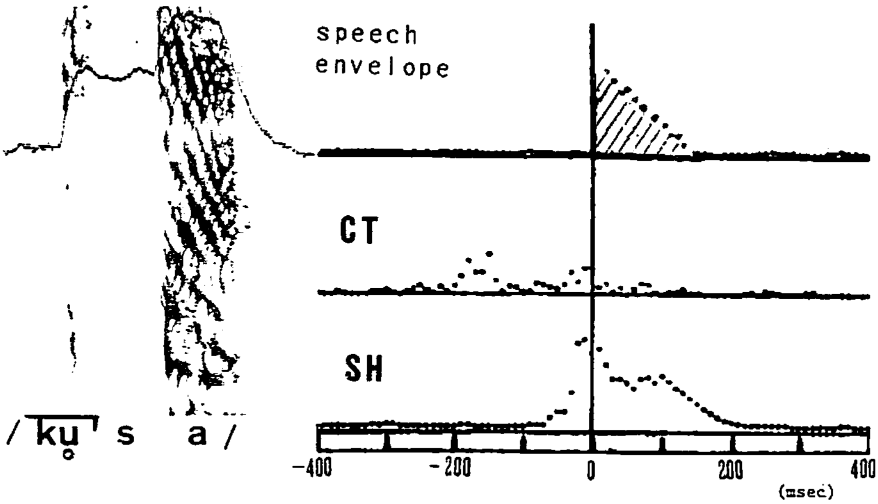

Fig. 5 Narrow band spectrogram (left), and speech envelope and EMG patterns of the CT & the SH(right) of /kusa/ with accented voiceless mora.

3. Characteristics of the Perception of Accent on Devoiced Vowels

3.1. Perception of Word Accent in Japanese

Before discussing the perception of accent on moras with devoiced vowels, Japanese word accent will be explained using examples of words with continued F0-contours. The experiments conducted by Fujisaki and Sugito (1976)13) revealed that perception of accent types did not depend on the values of fundamental frequency at any particular point on the F0-contour, but on the instants of the onset and offset of the accentual command that initiates pitch transition. In these experiments, fundamental frequencies were extracted from /ame/ with four types of accent uttered by a native speaker of the Kinki dialect. Then the essential acoustic parameters were obtained from the F0-contours using the functional model proposed by Fujisaki and Sudo(1970)14).

In order to confirm perceptual relevance by listening tests, the varieties of F0-contours for /ame/ were digitally synthesized by computer by varying the timing parameters of the accent command. Identification tests were conducted on these stimuli, and the results showed that the perception of accent type was based on the relative timing of voice raising or lower-ing and the specific segmental boundarries of words13).

The above experiment suggests that perceptual characteristics of accent on voiced and devoiced vowels are to be compared by the identification tests using the speech stimuli with varieties of F0-contours.

3.2. Perception of Accent on Devoiced Vowels

3.2.1. Synthesis of Stimuli for Perception Tests

In order to obtain parameters for the F0-contours of the synthetic speech stimuli, fundamental frequencies were extracted from /$\overline{\text{ku}}$sa/ uttered by one of the female speakers. Their F0-contours were analyzed and the timing of the onset and offset of the accent commands and other parameters were extracted by the above-mentioned model14). The speech stimuli were synthesized by the parcor method using the extracted parameters. The experiments were conducted by using software developed by one of the present authors for the NEC 9801 Vm2 personal computer15).

The F0-contour of stimuli No.1 of /$\overline{\text{ku}}$sa/ was generated using the parameters of one of the utterances. Then, twenty stimuli with a variety of F0-contours were synthesized by delaying the instants of the offset of the accent command (the onset of voice lowering) by ten msec. The instant of the onset of the accent command (the onset of the voice raising) and other parameters were kept constant in the present experiment.

Fig.6 shows an example of the Analysis-by-Synthesis of F0-contour for /kusa/. The symbol "+" indicates the fundamental frequency extracted at 12.8 msec, and the broken line shows the best approximation by the above model[14)]. The broken thick lines show parts of vowels. They are observed superimposed on the extracted fundamental frequencies. The stepwise pattern shows the timing of the onset of voice raising and voice falling.

Fig.7 shows the F0-contours of the synthesized stimuli No.1, No.11 and No.21. The instant of voice falling (mark↓) in the F0-contour of stimulus No.1 is 250 msec later than the onset of voice raising; that of stimulus No.2 is 100 msec later than that of No.1; and that of No.3 is 100 msec later than that of No.2. In a preparatorty experiment, stimulus No.1 was recognized as having an accent type /HL/, No.11 /L(HL)/ and No.21 /LH/. Twenty-one stimuli were synthesized by delaying the onset of voice falling by ten msec, while the value of the instant of the onset of voice raising and other parameters were kept constant as Tables 2 and 3 show.

Fig.8 shows the Fo-contours of the twenty-one speech stimuli based on /kusa/ with voiced /u/ for tests (1) and (2). The values of the onset of voice lowering delayed by ten msec can be observed as arrows on each F0-contour.

As for /ku̥sa/, the voiceless part of /kus/ in the utterance /ku̥sa/ was connected to a point preceding the vowel /a/ of synthesized /kusa/ instead of to /kus/ with voiced /u/. Thus, another twenty-one stimuli with voiced first vowels were synthesized for tests (3) and (4). The second vowels had the same F0-contours as the stimuli for tests (1) and (2).

Fig.9 shows the Fo-contours of the speech stimuli for tests (3) and (4) for /kusa/ with voiceless first vowels.

Four kinds of recording tapes for the identification tests (1)-(4) were prepared using each of the eleven stimuli. Ten tokens of each stimulus were arranged in randomized order at intervals of four seconds with five dummy stimuli preceding and following these.

Identification tests were conducted on these stimuli. Subjects for the tests were five native speakers of the Kinki dialect, who were instructed to identify the accent of each stimulus as type A /kusa/ or type B /kusa/ in tests (1) and (3), and as type B /kusa/ or type C /kusa/ in tests (2) and (4). The results were analyzed to detect the categorical boundaries. The results are shown in Fig.8 and Fig.9 as circled stimulus numbers or number plus appostrophe, respectively.

Table 4 shows the values of the categorical boundaries (μ) with the standard deviations (SD) obtained for tests (1)-(4). The values for (μ) and the SD of tests (1) and (3), or (2) and (4), obtained from the five subjects are quite similar, and the

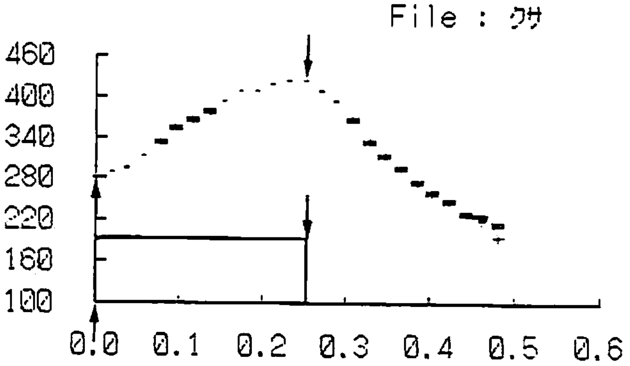

Fig.6 Analysis-by-Synthesis of F0-contour for /kusa/ showing extracted fundamental frequencies (+) and the stepwise patternof theonset of voice raising ( ) and voice falling ( ).

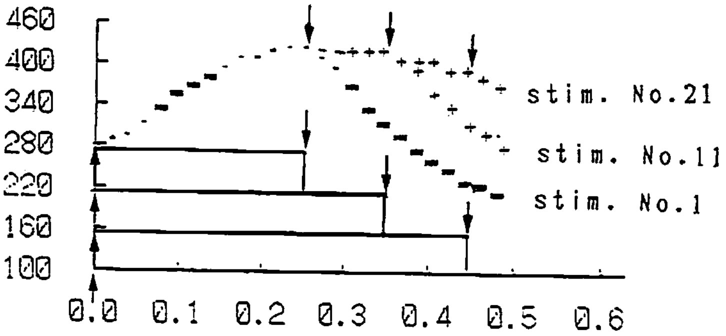

Fig. 7. F0-contours of the synthesized stimuli No.1 (kusa), No.11(kusa) and No.21(kusa) with stepwise patterns of the timing of the onset of voice raising ( ) and voice falling ( ).

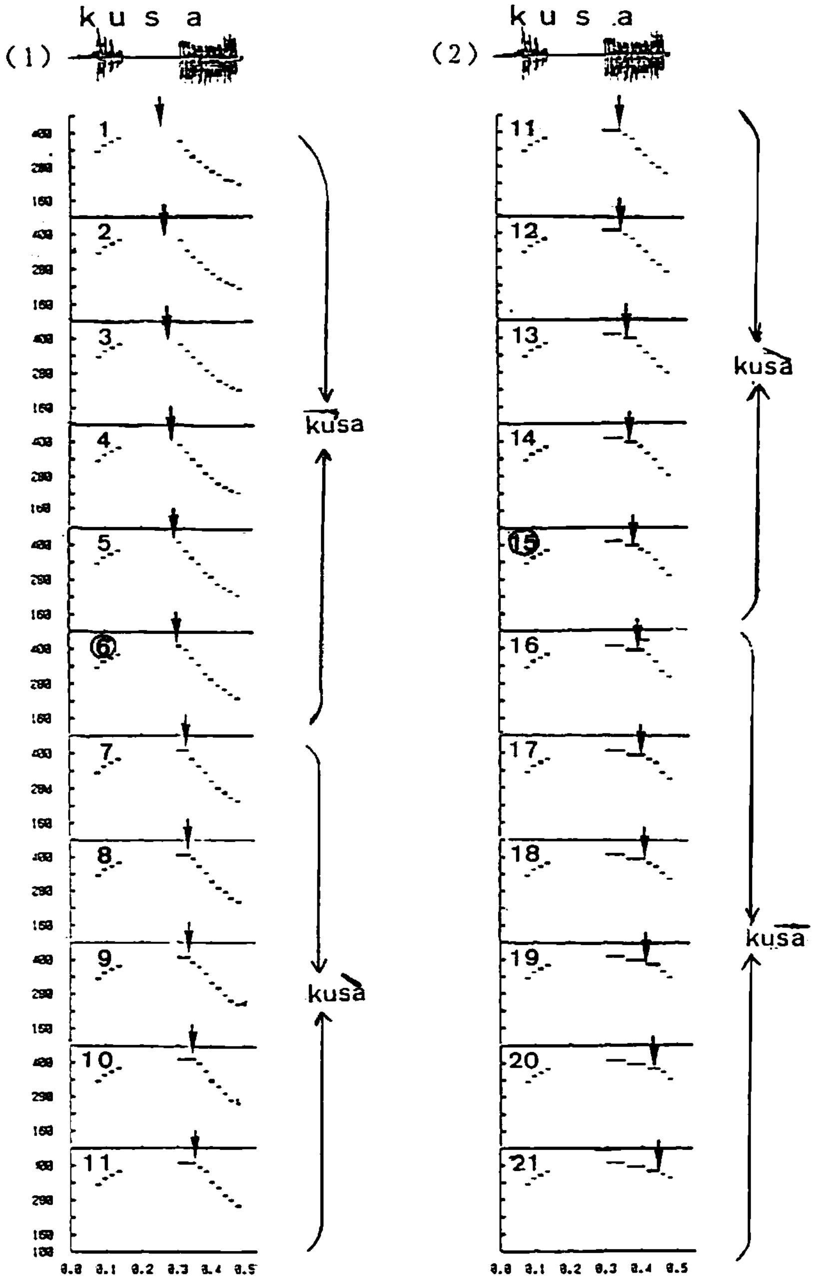

Fig. 8 F0-contours of the speech stimuli for the identification test (1) kusa-kusa and test (2) kusa-kusa.

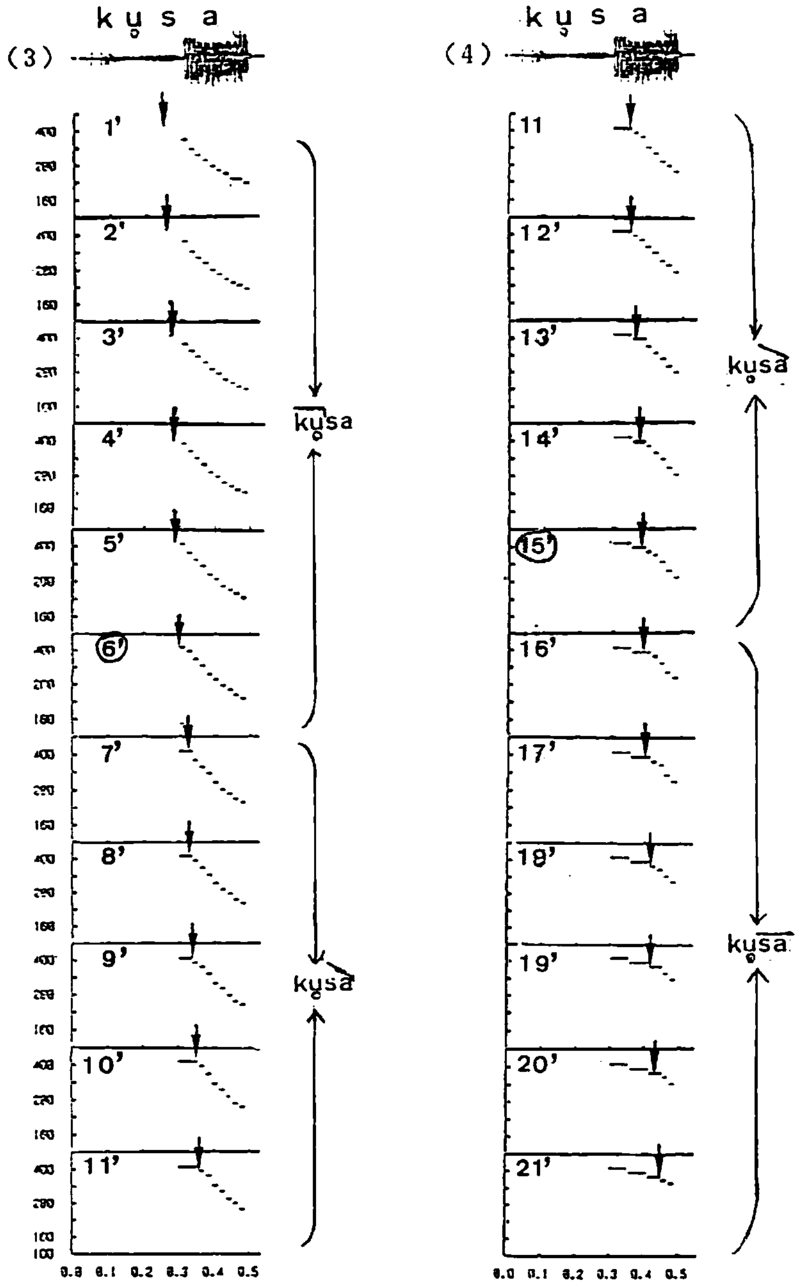

Fig. 9 F0-contours of the speech stimuli with voiceless first moras for tests (3) and (4). Fig. 6. Analysis-by-Synthesis of F0-contour for /kusa/ showing extracted fundamental frequencies (mark +) and the stepwise pattern of onset of voice raising (↑) and voice falling (↓).

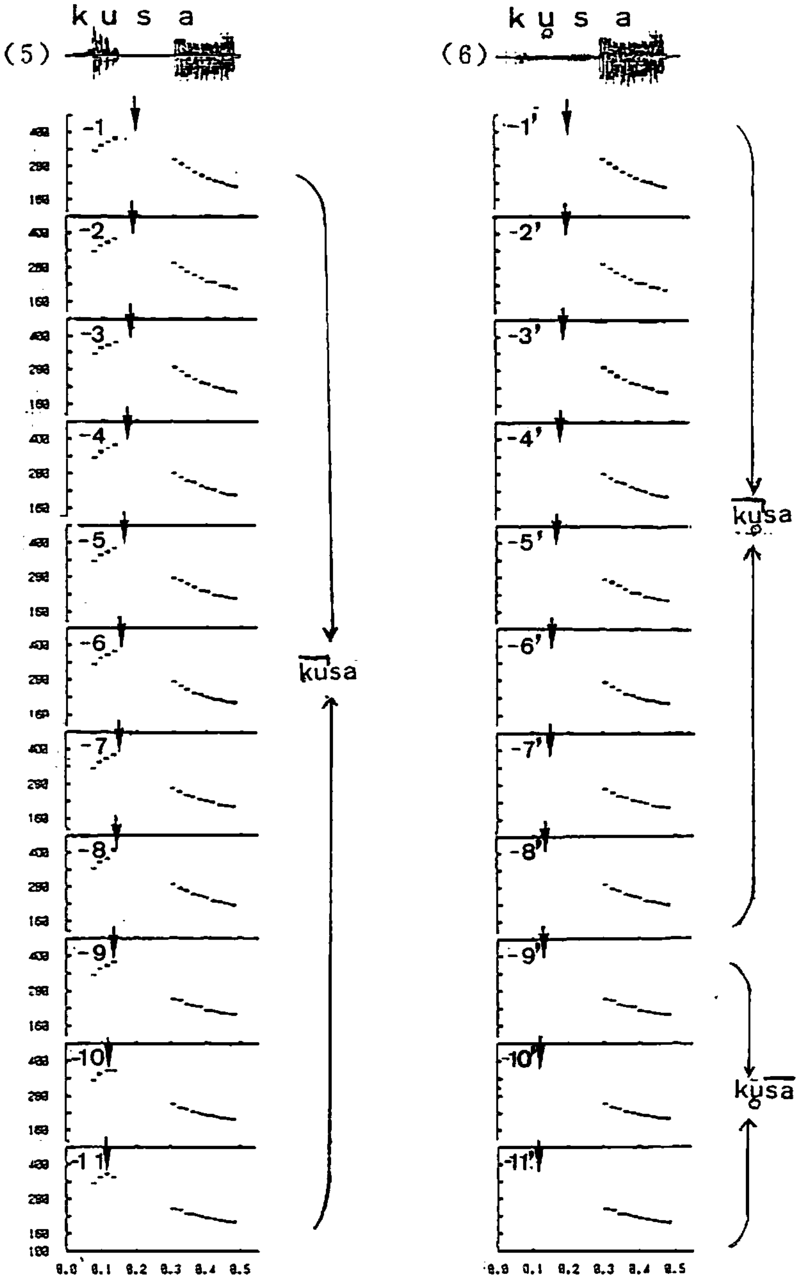

Fig. 10. F0-contours of the speech stimuli for identification tests (5) and (6).

identification of accent for stimuli with devoiced vowels is as stable and consistent as that for the stimuli with voiced vowels.

The results show that perception of accented devoiced vowels is also based on the relative timing of voice lowering and segmental boundaries within words. It also shows that when the onset of voice lowering is at the instant of the onset of the second vowel, the stimulus is heard as /HL/, but when it is a little later than the onset of the second vowel and the F0-contour bends a little at the beginning, then the stimulus is recognized as /L(HL)/. If it is delayed much later and the F0-contour becomes rather level, then it is recognized as /LH/ or /HH/. It is notable that these experiments elucidate the fact that accent is perceived on the first moras when the second moras have sharp falling tones regardless of whether the first vowels are voiced or devoiced.

As for the intensity of the first moras, consonants which were too weak were not recognized as devoiced vowels, and unnaturally strong consonants disturbed judgment of accent types. When the first moras are natural devoiced moras, accent was judged by the F0-contours of the following vowels.

Further experiments were conducted to determine the effect of the timing of the onset of voice falling when moved forward until it was earlier than the offset of the first vowel, and when the second vowel was as level and low pitched as that of /kusi/ shown in Fig.3.

Table 5 shows the timings of the instants of voice raising and voice falling of the F0-contours of the stimuli for experiments (5) and (6).

Fig.10 shows the F0-contours of the stimuli /kusa/ for test(5) with voiced /u/, and /kusa/ for test (6) with devoiced /u/. The identification tests were conducted on these stimuli using the same subjects.

The results were rather different from those of tests(1),(2) and (3),(4). All the stimuli with voiced first vowels in test (5)were identified as accent type /HL/, but numbers -9', -10', and -11' of test (6) were perceived as /LH/ by the subjects, although this judgment was rather inconsistent. When these stimuli were perceived separately, the judgment of /LH/ was quite consistent.

The results show that devoiced first moras are heard to be accented when the onset of voice falling is near the onset of the following vowel, but when the onset is earlier than the offset of the first vowel and the F0-contours of the second vowels are nearly level, devoiced vowels are not recognized as accented. This is the difference in the perception of accent between words with voiced vowels and those with devoiced vowels.

4. Conclusion

Production of accented voiceless vowels was studied physiologically by laryngeal electromyographies and acoustically by comparing perception of accent for the voiced and devoiced first vowels of synthesized speech sounds /$\overline{\text{ku}}$sa/ and /$\overline{\text{k}\underset{\circ}{\text{u}}}$sa/ with variety of F0-contours.

Laryngeal electromyographies revealed that CT activities for raising fundamental frequency were observed at the point where a vowel would be if it were voiced in /$\overline{\text{k}\underset{\circ}{\text{u}}}$sa/ with accented voiceless vowels. The activation of the CT was evident again prior to the onset of the second vowel. The later CT and simultaneous beginning of the SH activiation were presumed to be prerequisites for a high-pitched start and the very sharp descent of the second vowel that followed the accented voiceless mora.

Identification tests showed that accent was perceived on devoiced vowels when voice lowering was at or a little before the onset of the following vowels regardless of whether the first moras were voiced or voiceless, and that perception of accent on the devoiced vowels depends on the descending F0-contours of the following vowels.

As for the intensity of the first moras, consonants which were too weak were not recognized as devoiced vowels, and unnaturally strong consonants disturbed judgment of accent types. When the first moras were natural devoiced moras, accent was judged by the falling F0-contours of the following vowels. Further experiments will be conducted concerning the effect of the intensity of the first devoiced moras on the sonority of accent.

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Table 1 Test words used in the present experiment

	type of accent	two-mora words			
High start	A (HL)	$\overline{\mathrm{i}}{}^{\urcorner}\mathrm{mi}$ (meaning)	$\overline{\mathrm{i}}{}^{\urcorner}\mathrm{ki}$ (spirit)	$\overline{\mathrm{ku}}{}^{\urcorner}\mathrm{si}$ (comb) $\overline{\mathrm{ku}}{}^{\urcorner}\mathrm{se}$ (habit)	$\overline{\mathrm{ku}}{}^{\urcorner}\mathrm{sa}$ (grass)
Low start	B (LHL)	$\mathrm{im}\overset{\diagdown}{\mathrm{i}}$	$\mathrm{ik}\overset{\diagdown}{\mathrm{i}}$ (chic)		
	C (LH)	$\mathrm{i}\overline{\mathrm{mi}}$	$\mathrm{i}\overline{\mathrm{ki}}$ (breath)		
High start	D (HH)	$\overline{\mathrm{imi}}$	$\overline{\mathrm{iki}}$ (going)		

Table 2 Timings of the onset of voice raising and voice falling of stimuli No.1-11 for test (1)

stimuli No.	1	2	3	4	5	6	7	8	9	10	11
onset of voice raising	0	0	0	0	0	0	0	0	0	0	0
voice falling	.25	.26	.27	.28	.29	.30	.31	.32	.33	.34	.35

Table 3 Timings of the onset of voice rasing and voice falling of stimuli No.11 - 21 for test (2)

stimuli No.	11	12	13	14	15	16	17	18	19	20	21
onset of voice raising	0	0	0	0	0	0	0	0	0	0	0
voice falling	.35	.36	.37	.38	.39	.40	.41	.42	.43	.44	.45

Table 4 Categorical boundaries (μ) with standard deviations (SD) detected by five subjects

stimuli	test(1) A-B /kusa/(voiced)		test(3) A-B /kusa/(voiceless)	
subject	μ	(SD)	μ	(SD)
CN	5.98	(0.20)	5.95	(0.28)
HS	6.00	(0.28)	6.74	(0.34)
SK	5.98	(0.24)	5.75	(0.57)
KO	6.09	(0.23)	6.13	(0.26)
MI	6.38	(1.42)	6.09	(1.14)
average	6.09	(0.47)	6.13	(0.52)

stimuli	test(2) B-C /kusa/(voiced)		test(4) B-C /kusa/(voiceless)	
subject	μ	(SD)	μ	(SD)
CN	15.10	(0.22)	15.10	(0.22)
HS	14.75	(0.53)	14.73	(1.25)
SK	15.20	(0.90)	15.02	(0.74)
KO	15.10	(1.46)	15.20	(1.64)
MI	15.50	(0.15)	16.70	(1.55)
average	15.13	(0.65)	15.35	(0.88)

Table 5 Timings of the onet of voice raising and voice falling for stimuli Nos. -1 - -11 for tests (5) & (6)

stimuli No.	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11
onset of voice raising	0	0	0	0	0	0	0	0	0	0	0
voice falling	.20	.19	.18	.17	.16	.15	.14	.13	.12	.11	.10