

ARTICULATORY CHARACTERISTICS OF THE JAPANESE CONSONANTS
/z/ AND /d/ UTTERED BY DIALECT SPEAKERS

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Introduction

The Japanese consonants in /za/, /zi/, /zu/, /ze/ and /zo/ are generally not fricatives but the affricates. As shown in the following table, the consonants /z/ and /d/ preceding [i] and [u] have lost their distinction, and are now identical except in a few dialects of Shikoku and Kyushu. The confusion is a well known example of historical phonemic change in the Japanese language.

	a	i	u	e	o
/za/ line	[dza]	[dʒi]	[dzu]	[dze]	[dzo]
/ca/ line	[da]	[dʒi]	[dzu]	[de]	[do]

Further confusion is found in pronunciation of [dza, dze, dzo] and [da, de, do] mainly in the dialects of Kinki and other districts of western Japan. Among them the most marked confusion was observed in Wakayama Prefecture in the Kinki District¹⁾²⁾. The confusion is supposed to have some relationship with historical phonemic change³⁾. It is also considered one of the important problems in Japanese language education for dialect speakers.

The present paper will present some results of an investigation into the articulation of those consonants uttered by /z/-/d/ confused speakers from Wakayama Prefecture using electro-palatography and the spectrograph.

Outline of Confusion

Fig.1 shows the regional distribution of the confusion of [dza, dze, dzo] with [da, de, do]²⁾³⁾. This distribution has been obtained from the results of questionnaires which were sent out to primary schools at 1,976 points all over the country (Hokkaido excepted.) These points were from the "Japanese Language Atlas" (1973)⁴⁾. The rate of the collected questionnaires was 60.7%.

The confusion is found in areas from the northern part of the mainland to Okinawa, suggesting that it is a problem of Japanese consonants. Some teachers in Wakayama prefecture answered that most of the pupils in their classes confuse [dza, dze, dzo] with [da, de, do] in pronunciation.

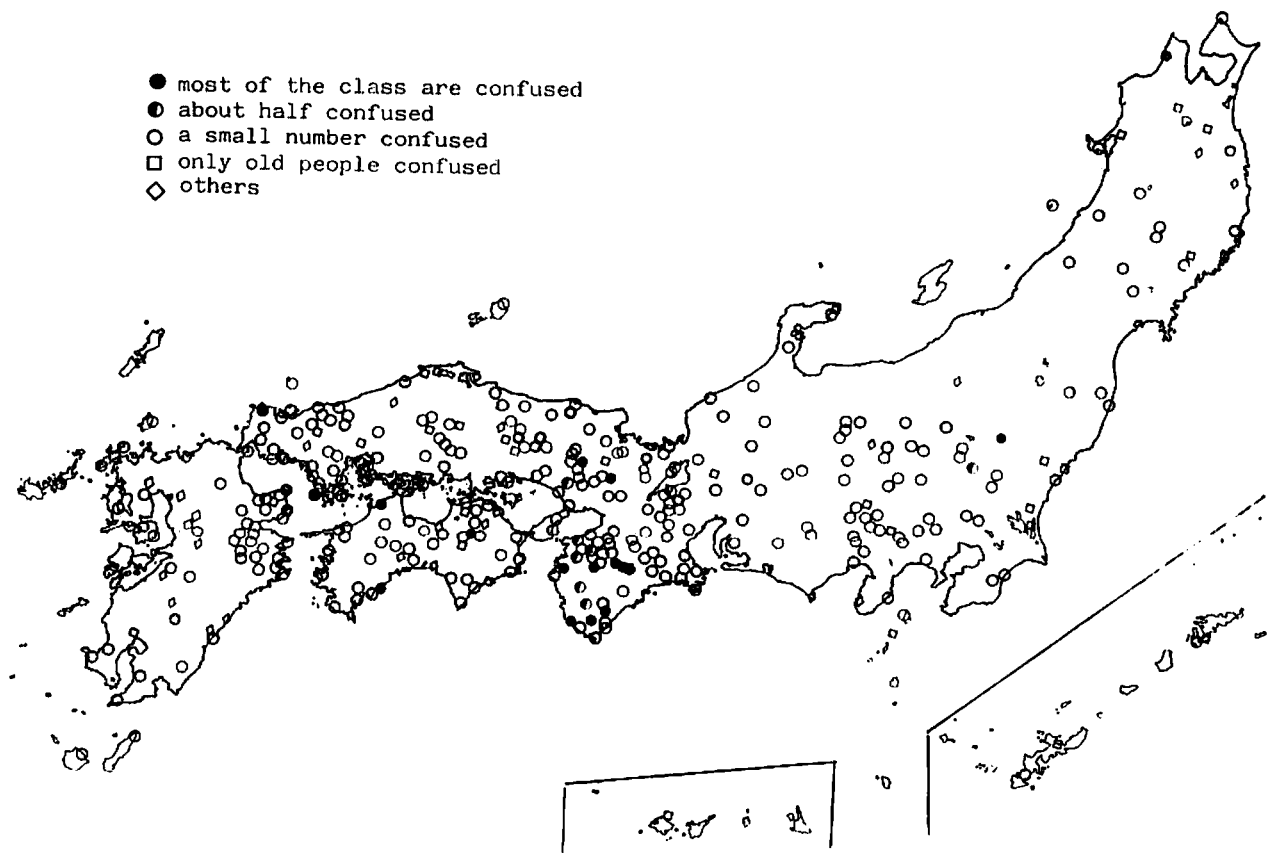


Fig. 1 Regional distribution of /za, ze, zo/-/da, de, do/ confusion.

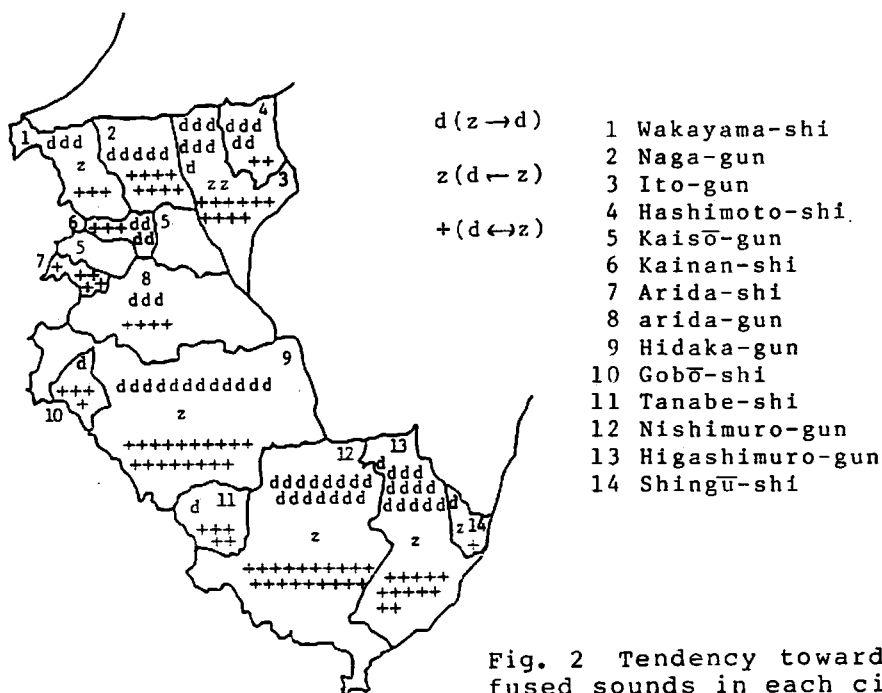


Fig. 2 Tendency toward confused sounds in each city or county of Wakayama Prefecture.

Fig.2 shows the tendency of the confusion in each city or country in Wakayama Prefecture. In Wakayama as well as in other prefectures, the /z/→/d/ confusion is greater than that of either /d/→/z/ or /d/↔/z/. The areas numbered 1 and 4 in this figure, are respectively Wakayama City and Hashimoto City.

Examples of /za,ze,zo/-/da,de,do/ confusion can be found in literature published in and around Kyoto in the Edo Period. This suggests that the confusion occurred following the /zi, zu/-/di, du/ confusion in the Kinki District³⁾. Many examples of confusing words can be found in Ota (1930)⁵⁾, Hikata Girls High School (1933)⁶⁾ and other books, but papers that explain the articulation of these sounds are scarcely to be found except for the following: Y. Ozawa (1960)⁷⁾. Ozawa, a medical doctor, regarded the confusion as a kind of speech impediment, and conducted an experiment on Wakayama dialect speakers and proposed a remedy using the palatograph. But the difference in articulatory characteristics between these sounds uttered by confused and non-confused speakers was not clearly observed. A possible reason for this is that the experimental techniques of those days had not progressed enough to record the temporal course of the contact patterns showing the movement of the tongue touching the hard palate^{8) 9)}.

One of the present authors conducted an experiment using electropalatography, where utterances of /d/ and /z/ by confused and non-confused speakers in Osaka Pref. were compared. The results were that the contact areas and the timing of the tongue movements were different from each other¹⁰). This paper reports on the acoustic and physiological characteristics of the pronunciation of the consonants using two /z/→/d/ confused speakers from Wakayama Prefecture as subjects.

Method

Subjects

The main speakers were SF (born in 1965, female, Wakayama City) and ST (born in 1965, female, Hashimoto City). Both of them have no memory of being taught how to distinguish /z/ and /d/ in pronunciation. Until they were freshmen in college in Osaka Prefecture, they did not realize that their pronunciation of /z/ and /d/ was the same.

Procedure

The test word used in this experiment were as follows. Here we will discuss mainly /z/ and /d/ in (1).

Table 1 Test words

(1)		a	e	o		(2)		zV	dV
	Vz	Vza	Vze	Vzo			zV	zVzV	zVdV
	Vd	Vda	Vde	Vdo			dV	dVzV	dVdV
	Vr	Vra	Vre	Vro					
		(V: a,e,i,o,u)						(V: a,e,o)	

They read the test words embedded in the context "Sore -----" twelve times at natural speed with a /HH/ (high-level) accent. The electropalatograph DP01 was connected to a computer, and each sound and pattern were stored on a disk and the data was printed out. Some experimental materials from a non-confused speaker YY of Osaka Prefecture were made to compare with the pronunciation of the confused speakers. Another twelve non-confused speakers read the test words and their pronunciation was recorded. All the utterances by both confused and non-confused speakers were analyzed with the spectrograph, and their acoustic characteristics were compared to each other. These subjects were also the subjects of a perception test on their ability to distinguish the consonants of confused speakers.

Results and discussion

Acoustic characteristics

Table 2 shows the results of the perception test in which twelve non-confused speakers identified the consonants in VCV tokens uttered twelve times each by the confused speakers, SF and ST. The rate of identification VzV and VdV shows that both of the confused speakers tended to pronounce /z/ as [d]. /r/ was rarely taken for other sounds. However, the pronunciation of /z/ and /d/ by SF was sometimes recognized as /r/.

Table 2 The results of the perception test (%) (subjects: twelve non-confused speakers)

	SF(speaker)		ST(speaker)	
	Sub.12	(ave.)	Sub.12	(ave.)
(V:a,e,i,o,u)				
Vza	6.5	6.3	1.7	6.4
z	86.4		97.9	
r	7.1		0.4	
Vze	9.0	78.8	14.1	92.7
z	53.3		84.9	
r	27.7		1.0	
Vzo	3.3	14.9	3.5	0.9
z	86.7		95.3	
r	10.0		1.2	
Vda	0.4	1.1	2.5	5.2
z	92.9		96.7	
r	6.7		0.8	
Vde	1.7	88.7	10.7	94.2
z	80.7		89.0	
r	17.6		0.3	
Vdo	1.1	10.2	2.5	0.6
z	92.5		96.7	
r	6.4		0.8	
Vra	0.3	0.2	0	0
z	0.4		2.4	
r	99.3		97.6	
Vre	0.3	0.8	0	4.7
z	0.7		11.4	
r	99.0		88.6	
Vro	0	99.0	0	95.3
z	1.2		0.3	
r	98.8		99.7	

Table 3 The results of the perception test (%) (subjects: confused speakers)

	SF(speaker)		ST(speaker)	
	Sub.SF	(ave.)	Sub.ST	(ave.)
(V:a,e,i,o,u)				
Vza	13.3	22.2	0	0.5
z	81.7		100	
r	5.0		0	
Vze	23.3	69.5	1.6	99.5
z	56.7		99.4	
r	20.0		0	
Vzo	30.0	8.3	0	0
z	70.0		100	
r	0		0	
Vda	10.0	17.8	5.0	4.5
z	86.7		95.0	
r	3.3		0	
Vde	6.7	77.8	6.7	95.5
z	83.3		93.3	
r	10.0		0	
Vdo	36.7	4.4	1.7	0
z	63.3		98.3	
r	0		0	
Vra	0	0	0	0
z	0		0	
r	100		100	
Vre	0	100	0	1.1
z	0		3.3	
r	100		96.7	
Vro	0	100	0	98.9
z	0		0	
r	100		100	

Table 3 shows the results of the perception test with the confused speakers themselves as subjects. The test was conducted nine months after the above experiment and their perception ability had already improved substantially. However, the results were different from those of the non-confused speakers shown in Table 2.

In Fig.3, the acoustic characteristics of /aza/ (1-3 and 5-7) and /ada/ (4 and 8) uttered by the confused speakers are shown in the spectrograms. Below each figure, the results of the test

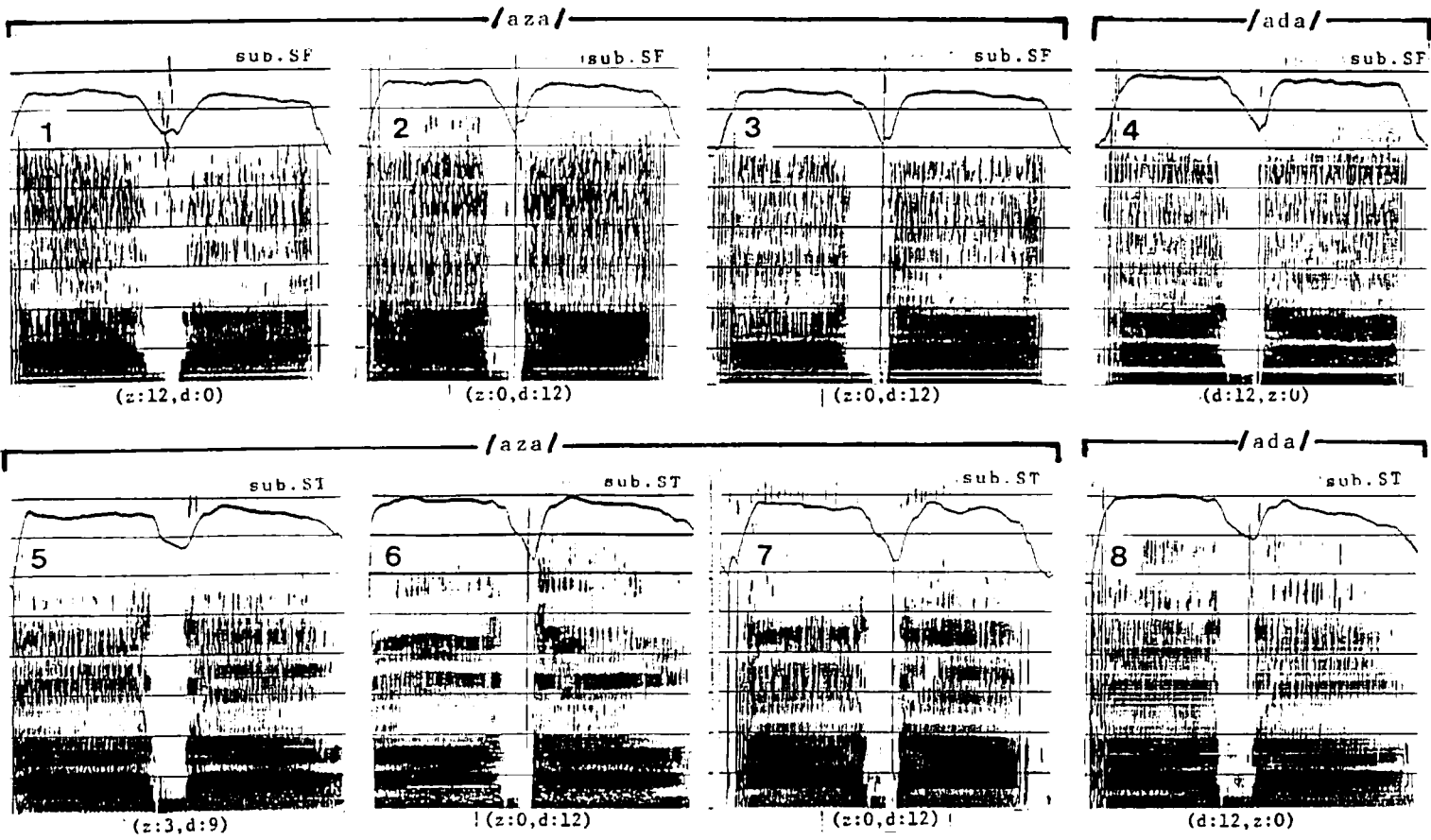


Fig. 3 Spectrograms of /aza/ and /ada/ uttered by confused speakers SF and ST.

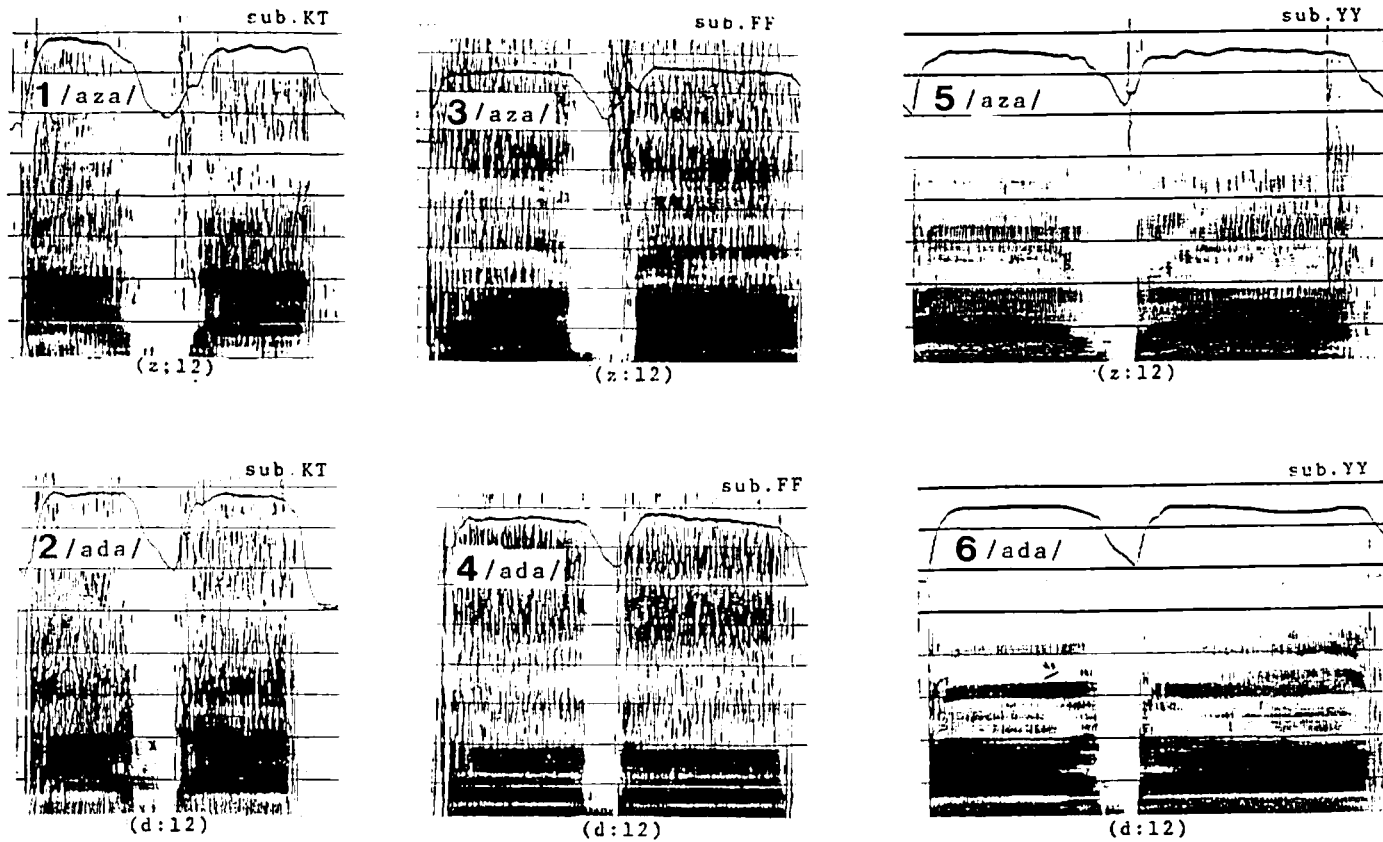


Fig. 4 Spectrograms of /aza/ and /ada/ uttered by non-confused speakers.

with the twelve non-confused speakers are shown in parentheses. Utterance No.1 made by SF was perceived as /aza/ by all twelve subjects, while utterance No.5 made by ST was perceived as /aza/ by three out of these twelve, and was recognized as /ada/ by the rest of the subjects. Utterances Nos.2 & 3 and Nos.6 & 7 were recognized as /ada/, though the speakers intended to say /aza/. Their features were similar to those of Nos.4 and 8 uttered as /ada/.

Fig.4 shows the spectrograms of /aza/ (1, 3, 5) and /ada/ (2, 4, 6) uttered by non-confused speakers. The /z/s in /aza/ are affricates and show features different from those of the confused speakers. In /aza/ No. 5 uttered by YY, the frication is weak and is somewhat similar to that uttered by confused speakers. But YY's /aza/ is completely different from the same speaker's /ada/ (6). The durations of the consonant /z/ uttered by non-confused speakers are longer than those uttered by confused speakers.

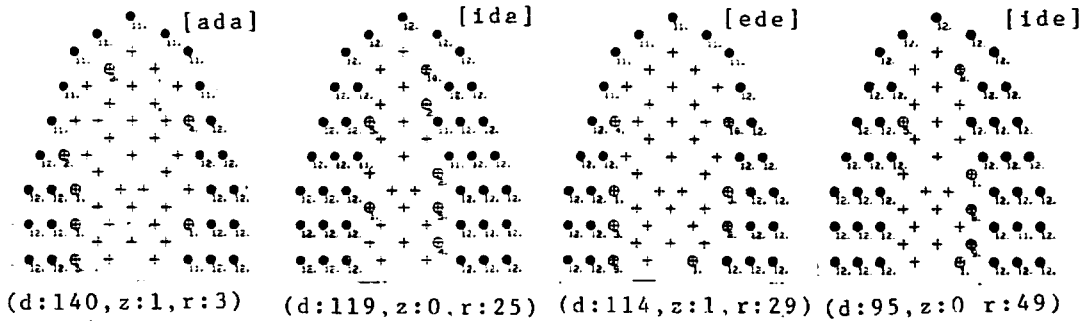
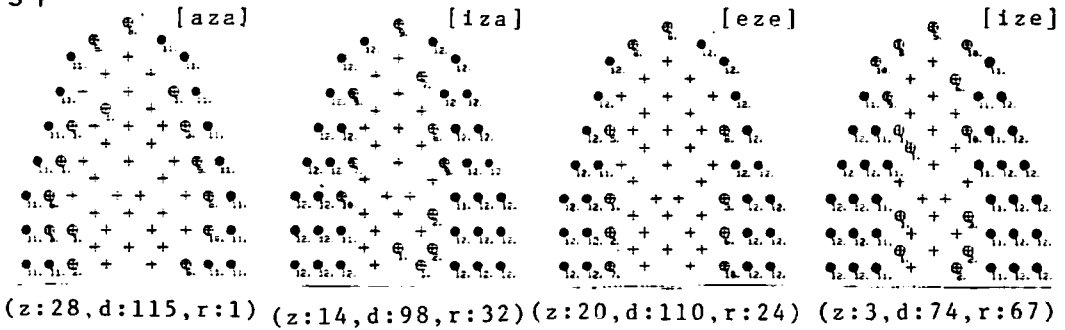
Articulatory Characteristics

Fig.5 shows superimposed displays of the maximum contact patterns of 12 tokens of each utterance by speakers SF and ST. The black dots are the electrodes which showed contact in all the twelve or eleven tokens. The circles with crosses (⊗) show that the frequency of the contact was from six to ten, while the marks ⊕ show that the frequency of the contacts was from one to five. The crosses are the electrodes which showed no on-contact at all. The /z/ in VzV words had less on-electrodes at the anterior center position, suggesting the /z/ to be a fricative. But as the spectrograms of Fig.3 show, the frication was too weak to be heard as /z/. Therefore, the patterns that had off-contact electrodes at the anterior center do not always present the fricative sounds. The results of the perception test conducted on the twelve subjects using these twelve tokens are shown in parentheses under each figure.

Fig.6 shows the time sequence of the patterns of palato-lingual contact for /aza/, that are shown in Fig.3 Nos.1 & 2, and /ada/, No.4, uttered by SF. The patterns in the squares show the maximum contact patterns. Nos, 84-92, 84-89 and 88-94 indicate that these respective frames were identical. /aza/ No.1, which was perceived as /aza/ by the twelve subjects, shows the tongue never touched the anterior center, and /aza/ No.2, which was perceived as /ada/, shows the anterior center was closed in frames 84-89. The contact patterns in /aza/ No.2 are similar to those of /ada/ shown below. These characteristics were also observed in the utterances by ST.

As for the non-confused speaker YY, the consonant /z/ in /aza/ was usually an affricate, but one token was found where the consonant was a fricative. These were good examples for comparison with the confused examples of SF as shown in the following.

S F



S T

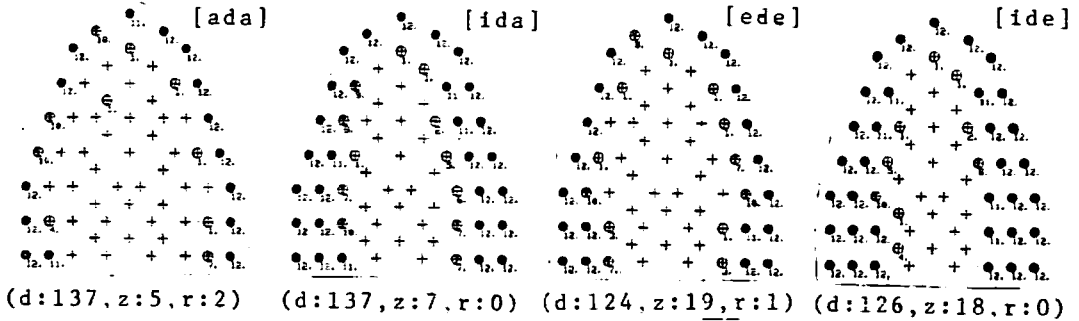
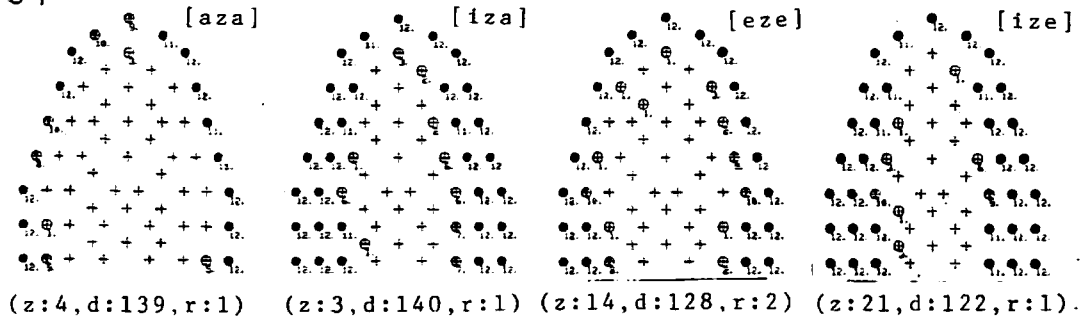


Fig. 5 Twelve maximum contact patterns of /z/ and /d/ superimposed on each other (subjects: confused speakers SF and ST).

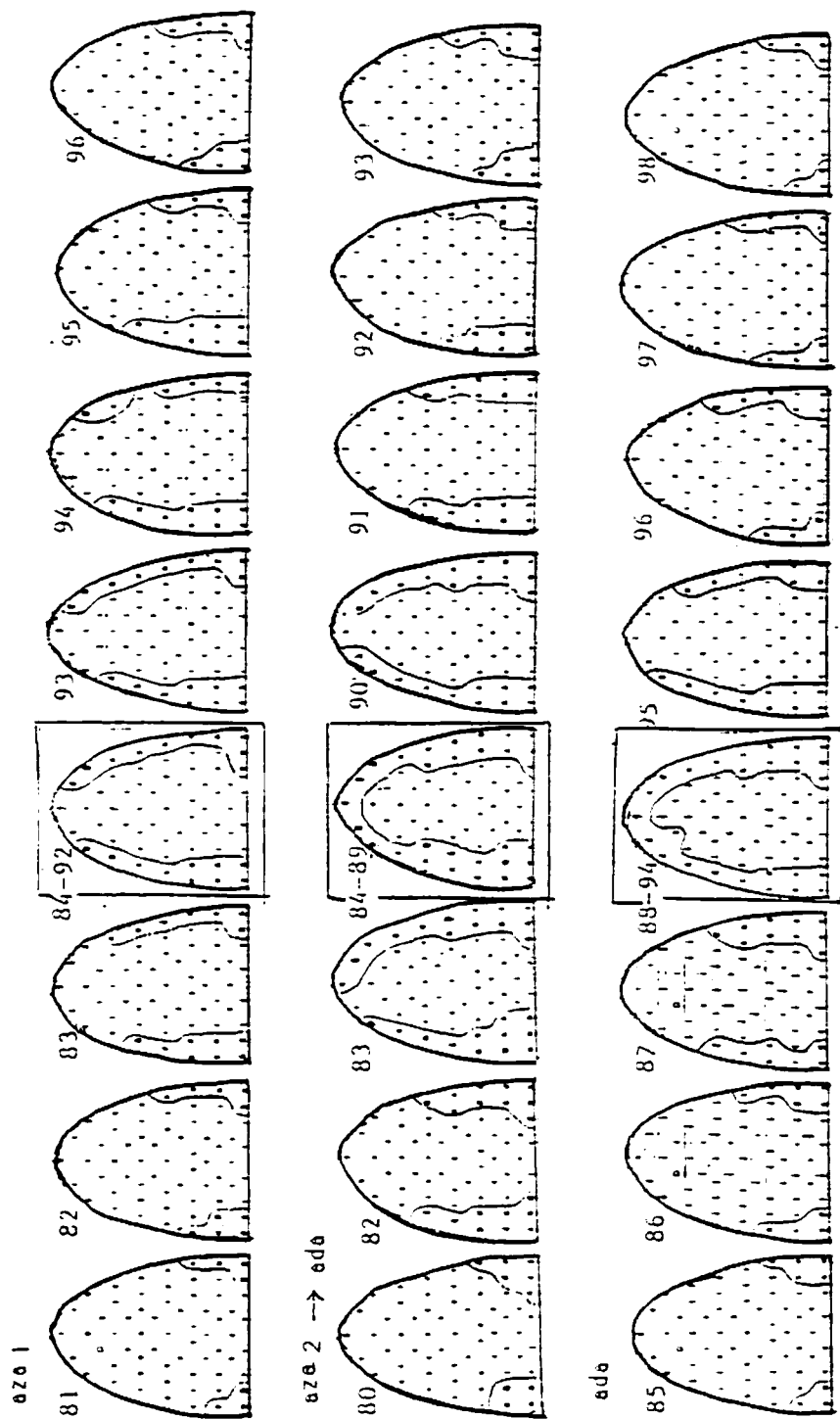


Fig. 6 Frames showing the continual patterns of the palato-lingual contact of /aza/ and /ada/ (subjects: confused speakers SF and ST).

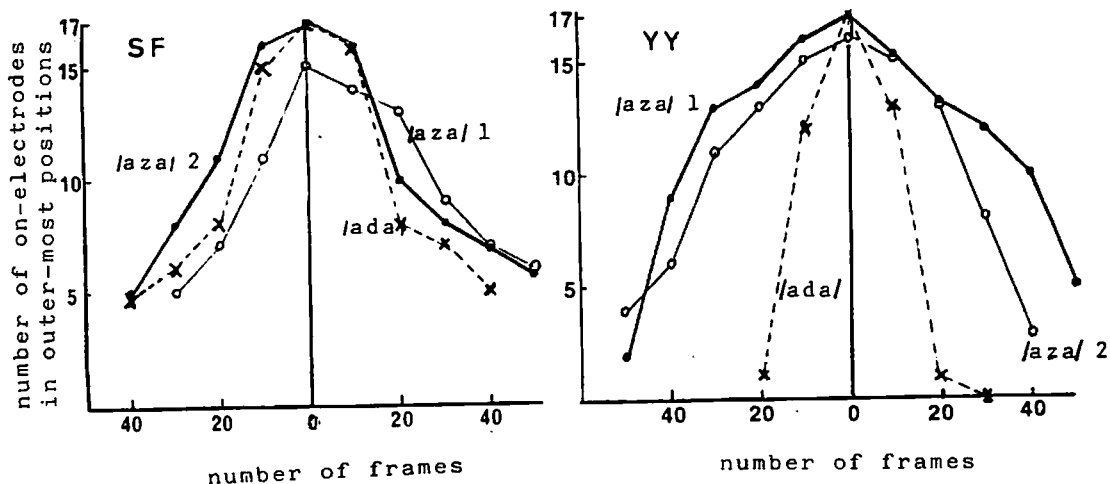


Fig. 7 Timing of the tongue movement before and after the maximum contact patterns in /aza/ and /ada/ (subjects: SF--confused, YY--non-confused speaker).

Fig.7 shows the temporal characteristics of the fricative [z] of /aza/ No.1, the affricate [dz] of /aza/ No.2 and the plosive [d] of /ada/ uttered by both speakers. The abscissa is the number of on-electrodes in the outer-most positions and the ordinate is the number of the frames. The zero shows the time of the maximum contact pattern. Even when the maximum patterns continued for several frames, they are represented as one point on the ordinate. The curves of the two /aza/s and the /ada/ of speaker SF in Fig.7 show that her tongue moved similarly in their pronunciation, while those of speaker YY show that the tongue movement of the fricatives and affricates /z/ were slow and that of plosive /d/ was fast. These clearly elucidate the difference in articulatory characteristics of /z/ and /d/ uttered by the confused and non-confused speakers.

Conclusion

The articulatory characteristics of /z/ and /d/ in VCV words were investigated in (confused) dialect speakers. It was found that these speakers have some difficulties in pronouncing affricates, though the consonant in /aza/ is generally pronounced as [dz] in Japanese. They pronounce [d] or sometimes [z] instead of [dz]. Their fricative [z]s are too short in duration and too weak to be heard as /z/. The tongue movement (of the speakers in question) found in the temporal patterns of the palato-lingual contact before and after the maximum patterns of /za/ and /da/ were similar to each other, while those consonants uttered by a

non-confused speaker were quite different. Her tongue obviously moved for [dz] or [z] more slowly than for [d].

The above results will be useful for remedial education of such dialect speakers.

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