

Influence of Accent and Tone on the Realization of Vowel Devoicing in Japanese -analysis of a sentence database-

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ABSTRACT

Influence of accent and tone on the realization of vowel devoicing in Japanese was explored in a sentence corpus. Though all the previous works with words in isolation form have reported strong influence of accent in preventing devoicing, neither an overriding effect of accent nor the systematic influence of accent and tone was observed in the present material.

INTRODUCTION

Influence of accent on the realization of vowel devoicing has been pointed out for a long time in Japanese linguistic and phonetic literature (cf. Sakurai 1985 for detailed description). A standard description of the vowel devoicing in Japanese is that the high vowels /i/ and /u/ tend to be devoiced between two voiceless consonants, or between a voiceless consonant and a pause. However, a potentially devoiceable vowel often resists devoicing once it is accented. Recent data obtained from an analysis of a database and a controlled material, all agree that accent indeed has a strong influence in preventing devoicing (Takeda & Kuwabara 1987, Kimura et al. 1988, Yoshida & Sagisaka 1990). Furthermore Yoshida & Sagisaka (1990) notes that the rate of devoicing declines in the order of L>H>H*, i.e. devoicing becomes less if the vowel has a H tone and even less if it has a pitch accent (H*). However, it can be seen from their results that the difference in devoicing rates with respect to H or L tone is larger and consistent for the 2- and 3-mora words but not so remarkable for the 4- and 5-mora words across the three speakers. One possible hypothesis is that the influence of accent and tone appears stronger on a shorter word and utterance than on a longer one. Since all the previous works which have claimed the strong influence of accent have used words in isolation form, different results may be obtained from a more natural connected speech material. In addition, recent analysis of an accent dictionary presented by Kawai et al. (1993) indicates that influence of accent can vary depending on the segmental contexts, i.e. influence of accent seems to appear stronger in the fricative contexts than in the stop contexts. In the present study, the effect of accent and tone are explored by bringing these two new aspects into consideration.

MATERIAL

Data was obtained from the ATR Sentence Database. The database consists of 503 phonemically balanced short sentences which are read by 10 announcers of NHK. The recording time is approximately 1 hour for each speaker. Speech data are labelled on different layers and the information on devoicing was obtained from the phonemic layer and allophonic layer combined with accent information obtained from another file which contains prosodic information. Devoicing is defined acoustically by the absence of voice bar.

ANALYSIS AND DISCUSSION

As a preliminary analysis, the data from a single speaker was examined closely. Table 1 presents an analysis of 728 devoiced vowels from the speaker MYI together with accent and tone information. It can be seen that the largest proportion of devoiced vowels have a L tone followed by a H tone and finally by a pitch accent (H*).

Table 1. Analysis of the 728 devoiced vowels (speaker MYI) according to accent information.

tone and accent	L	H	H*
percentage	56.5%	35.4%	7.9%

As a second step, the ten most frequent sequences which have a voiceless vowel were listed with their accent and tone information for the same speaker (cf. Table 2). Then out of the 503 sentences, all the sequences which have the same segmental contexts were chosen and the actual devoicing rates were calculated. It is seen from the table that the majority of them have a stop as a post-vocalic consonant and they are the ones which are expected to be devoiced without any influence from the accent and position in a word according to Kawai et al.'s (1993) analysis. Their devoicing rates are all very high, often being 100%, and indicate that there is a good match between an analysis of the accent dictionary (c.f. Kawai et al. 1993) and the actual tokens obtained from a sentence corpus. It can be seen that neither pitch accent nor high tone has an overriding effect in preventing devoicing. Though there are some instances where the devoicing rates vary, no systematic influences due to accent and tone type can be observed.

Table 2. 10 most frequent sequences which were devoiced and their devoicing rates according to accent and tone (speaker MYI). Figures in brackets show the number of tokens.

segmental sequence	overall devoicing rates (%)	devoicing rates (%) according to tone and accent		
		L	H	H*
jit	100 (87)	100	100	100
çit	100 (38)	100	100	-
tsuk	100 (38)	100	100	100
su#	100 (36)	100	100	100
jik	84 (33)	84	81	100
kus	96 (29)	100	95	100
fuk	100 (28)	100	100	100
kut	96 (26)	94	100	100
kit	95 (22)	100	85	100
kik	90 (22)	100	66	100

Since the influence of accent on devoicing is reported to vary more in the fricative contexts than in the stop contexts (cf. Kawai et al. 1993), the devoicing rates of those sequences which have a fricative in postvocalic position were examined for the 10 speakers. All the potentially devoiceable sequences which fit into this category were selected and their actual devoicing rates were calculated according to accent/tone information (Table 3).

It is seen that the occurrence of the [p]-syllables as well as [f] and [ç] as postvocalic consonants are rare. The devoicing rates for those sequences with fricative as postvocalic consonant are, in general, much lower than those sequences which have stop consonants in postvocalic position shown in Table 2. In particular, when [h] or [f] is in postvocalic position, devoicing rates are very low. The effect of [ç] may not be very convincing

because there is only one example of this segment as postvocalic consonant and because there was only one token for each speaker. These results on the postvocalic fricatives agree with Yoshida's (1993) results which were obtained from a well-controlled word material. Most sequences show good correspondence to the analysis of an accent dictionary (Kawai et al. 1993) but there are some which deviate greatly from the prediction: they are [tʃis, kuf, tʃij, tsuf], and [ʃis]. Except for [ʃis], they are expected to be devoiced without any further conditions but they all showed much lower rates of devoicing than expected.

Table 3. Devoicing rates in % according to the postvocalic consonants (10 speakers pooled). The figures in brackets indicate the number of tokens.

syllable	post-vocalic consonant				
	s	ʃ	h	ç	f
pi	100 (10)	-	-	-	-
pu	-	0 (10)	-	-	-
tʃi	20 (30)	25 (20)	10 (120)	-	30 (10)
tsu	66 (90)	50 (110)	12 (110)	-	30 (10)
ki	61 (110)	61 (80)	0 (60)	-	-
ku	84 (330)	44 (220)	34 (230)	100 (10)	30 (10)
su	48 (70)	5 (20)	-	-	-
ci	99 (100)	-	-	-	-
ʃi	57 (200)	5 (20)	9 (160)	-	0 (10)
ʃu	-	15 (69)	0 (10)	-	-
fu	99 (100)	-	-	-	-

In order to examine the influence of tone and accent, the devoicing rates were calculated according to accent/tone information and totalled for [s, ʃ, h] and [ç/f] (cf. Table 4). The results show no systematic influence of tone and accent, i.e. influence is stronger in the order of H* > H > L, as indicated from the analysis of word database (Yoshida & Sagisaka 1990).

CONCLUSION

The vowel devoicing rates in a sentence corpus were explored with focus on segmental and accentual variations. The realization of vowel devoicing was found to vary greatly depending on the segmental contexts, in particular depending on whether the postvocalic consonant is a stop or a fricative. When [h] and [f], the allophones of /h/, are in postvocalic position, the devoicing rates were found to be very low. Devoicing rates were generally lower for [ʃ] than for [s] when they are postvocalic. These findings from a sentence corpus are in good agreement with the analysis of an accent dictionary by Kawai et al. (1993). Although previous studies from words in isolation form have reported strong influence of accent in preventing devoicing, no overriding effect of pitch accent was found in the current material of sentence corpus. Likewise there was no systematic influence of tone and accent depending on their phonological status, i.e. H* > H > L, in influencing devoicing rates. It is indicative that the influence of accent and tone appear stronger on words in isolation form, and in particular on short words consisting of 2 or 3 moras (cf. Yoshida and Sagisaka 1990). However, the present study did not take into account some other factors which might have influenced devoicing, i.e. position in word and cases where the succession of devoiceable syllables are present. In order to confirm some of the findings from the present study, much further studies which control other factors are necessary.

Table 4(a)(b)(c)(d). Devoicing rates in % according to post-vocalic consonant and accent information (10 speakers pooled).

(a)	L	H	H*
s	-	100	-
pi	-	100	-
tʃis	0	30	-
tsus	20	72	-
kis	80	40	-
kus	75	87	100
sus	48	-	-
his	98	-	100
ʃis	23	86	45
fus	100	80	-
total	65	77	78

(b)	L	H	H*
ʃ	-	-	-
pu	0	-	-
tʃi	0	50	-
tsu	60	34	95
ki	100	38	100
ku	51	40	-
su	5	-	-
ʃi	5	-	-
ʃu	22	0	-
fu	100	-	77
total	28	35	93

(c)	L	H	H*
h	-	-	-
tʃih	5	12	40
tsuh	0	23	0
kih	0	0	0
kuh	22	37	-
suh	10	80	-
ʃih	12	8	-
juh	0	-	-
fuh	0	-	-
total	8	24	13

(d)	L	H	H*
ç/f	-	-	-
kuç	-	100	-
tʃif	30	-	-
tsuf	-	30	-
kuf	-	30	-
ʃif	0	-	-
total	15	53	-

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