Ann.Bull.RIPL No.30(1996)23-28

Discrimination of the single and geminate stop contrast in Japanese by five different language groups

Y. Minagawa and S. Kiritani

1. Introduction

A mora-timed, Japanese language, has a contrast between single and geminate stops such as in the 2-mora word *kata* (shoulder) and 3-mora word *katta* (bought). It is generally assumed that native speakers of Japanese use closure duration as a primary cue in discriminating between 2- and 3-mora words (Fujisaki et. al, 1973). For learners of Japanese whose native language does not make use of an opposition between single and geminate consonants, it is always a problem to perceive the difference between single and geminate stops in terms of the durational difference. There are many studies that examine the mechanism of the difficulties (Min, 1987). Most of these studies, however, focused only on acoustic factors such as absolute stop closure duration as the non-native speakers' perceptual cue for the non-native contrast. They did not take into consideration the factors of Japanese word accent which is realized by pitch.

This experiment investigated how accent type influences the discrimination between single vs. geminate, and which acoustic factor serves as a crucial cue.

2. Method

Subjects

30 native speakers each of Korean, Thai, Chinese , English and Spanish presented at the experiment as subjects. They were all beginning learners of Japanese. The Chinese, English and Spanish speakers were from Taiwan, North America and Mexico respectively.

Stimuli

As shown in Table 1, naturally spoken 2-mora words containing single stop and 3-mora words containing geminate stops were used as the stimuli sound. They consisted of 21 natural words and 15 non-words varying in pitch accent LH (Low High), HL (High Low), and stop consonant type (p,t,k) in the second syllable. The word accent of standard Japanese is based on the assignment of high and low pitch in each mora and accent variations of 2-syllable words are of 2 types which is LH and HL. The preconsonantal vowels were all /a/. Recordings were made in a sound-proof studio on a digital audio tape corder by a young female speaker. The recorded stimuli were digitized onto a computer with a sampling rate of 22 kHz and an accuracy of 16 bits.

Procedure

Each stimulus was repeated twice in random order with 7 second intervals between them. On the answer sheet, the stimulus words were transcribed in Roman orthography with a bracket between the first and second syllable, for example "ka ( ) ta". After being instructed in the task and given several trials, the subjects were asked to draw a circle in the brackets if they perceived gemination in the stimulus.

Table 1. Stimulus words. *=non-word

consonant		/p/				/t/		/k/		
CC	LH	happa	appi	pappa*	satto	katta	tatta*	kakke	yakko	kakka*
	HL	tappu	hyappo	pappa*	tatte	matta	tatta*	zakku	sakki	kakka*
C	LH	sapi*	papu*	papa*	nata	kate	tata*	raku	gaki	kaka*
	HL	tapa	chapo*	papa*	hato	rate	tata*	shake	waka	kaka*

3. Results

Perceptual Results

Figure 1 presents the incorrect ratio for each type of accent. Incorrect responses were of 2 types, that is misperceiving a single (C) for a geminate (CC) and misperceiving a geminate for a single. Five different language speakers demonstrated various error patterns.

English and Spanish speakers show lower incorrect ratios in general, and their perceptual performance did not vary significantly in different accent contexts.

Among Korean and Chinese speakers, differences in response according to accent type can be observed. There was a considerable difference between the C→CC and CC→C error pattern in a HL accent context. In a HL accent, the incorrect ratio of C→CC type was high, while that of CC →C was low. For LH accent, the incorrect ratio of the 2 types was almost the same.

Speakers of Thai were conspicuous for their much higher incorrect ratio for single consonant perception. The ratio for misperceiving a single for a geminate was high for both accent types. The incorrect ratio for CC→C type was low.

Acoustic Measurement

Having observed accent effects as pointed out from the Korean and Chinese data, characteristic differences in the acoustic factors between each accent type were examined. Measurement of preconsonantal vowel duration (V_1D), closure duration (CD), VOT and postconsonantal vowel duration (V_2D), was conducted.

The results are shown in Figure 2. There were no statistically significant differences between LH and HL accent type in the average value of each V_1D, CD and VOT. V_2D in a LH context, however, showed longer duration as compared with in a HL context. A t-test showed a statistically significant difference between them ($p<.001$). Accordingly the difference in durational features was only observed for V_2D value.

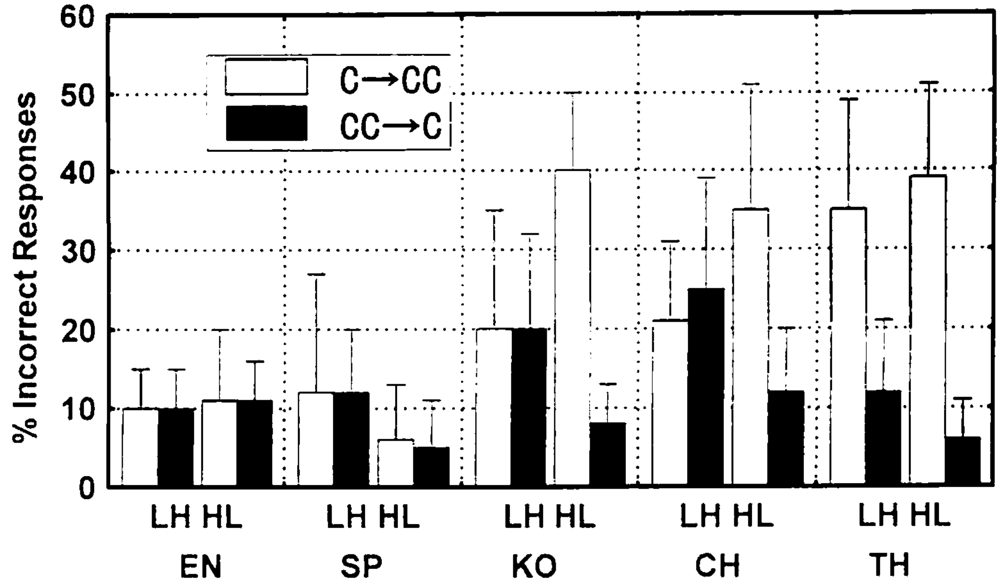

Figure 1. Mean percentage of incorrect response to stimuli in LH and HL accent, for English, Spanish, Korean, Chinese and Thai speakers. C→CC=Mistaking single for geminate, CC→C=Mistaking geminate for single

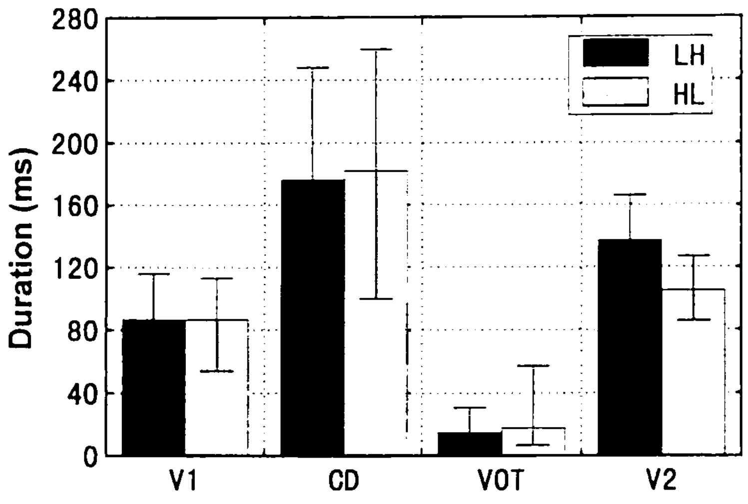

Figure 2. Average values of preconsonantal vowel duration (V_1D), closure duration (CD), VOT and postconsonantal vowel duration (V_2D) for the stimuli in different accent type.

4. Discussion

The results revealed that the different language speakers perceive stop consonants differently. In particular, from the Korean and Chinese data, differences of accent types were found to affect discrimination between single and geminate. Two-syllable words of a HL accent type tended to be perceived as geminate. For a LH accent type the incorrect ratio of C→CC and CC→C type was nearly the same. Since the acoustic measurement of the stimuli revealed durational differences of V_2D between HL and LH type i.e. the average duration of V_2D in a HL accent is shorter than in a LH accent, closure duration to V_2D duration ratio (CD/V_2) was suggested to be a possible acoustic cue for Korean and Chinese speakers to judge the single vs. geminate contrast.

Figure 3 (a) indicates mean percentage geminate responses at different closure durations for each stimulus by Korean subjects. In Figure 3 (a), the geminate responses are divided into 2 groups depending on the accent type. The LH group is located downward which means that even when LH and HL stimuli have the same absolute closure duration, there are considerable differences in the geminate response ratio between them.

Figure 3 (b) indicates the mean percentage geminate responses at different CD/V_2 for each stimulus by Korean subjects. CD/V_2 seems to explain the Koreans' perceptual patterns. In Figure 3 (b), the clear correlation of CD/V_2 with the responses is observed. As CD/V_2 increases, geminate responses increase linearly.

Figures 4 (a) and (b), in contrast, show the response pattern of Spanish speakers. In this case, the correlation of closure duration with the geminate responses is clear. However, in Figure 4 (b) the groups are set apart and CD/V_2 seems not to be directly related to the Spanish speakers' perception of a geminate stop.

Previous studies have focused solely on absolute closure duration as a primary cue in the perception of consonant length contrast in a foreign language. It has been generally concluded that inaccurate perceptual boundaries of absolute closure duration for the single *vs.* geminate discrimination cause faulty non-native perception. In this experiment as described before, the Spanish and English speakers also relied on absolute closure duration in the discrimination. However, the present experiment suggested an additional case. For some non-native speakers like Korean and Chinese, besides closure duration, postconsonantal vowel duration appeared to serve as a significant cue. This result is interesting considering the fact that the perception of the single *vs.* geminate stop contrast by native Japanese speakers is not affected by the postconsonantal vowel length (Hirato & Watanabe, 1987). In the case of Japanese, Watanabe and Hirato (1985) reported that only the duration of preconsonantal vowels influences the single *vs.* geminate judgment. There may be a language-specific difference between Japanese and Korean speakers in the processing of rate information based on durational pattern of speech signal.

Thai subjects demonstrated unique perceptual performance. For both accent types, they tended to misperceive a single for a geminate. Further study is required to explain their perceptual pattern.

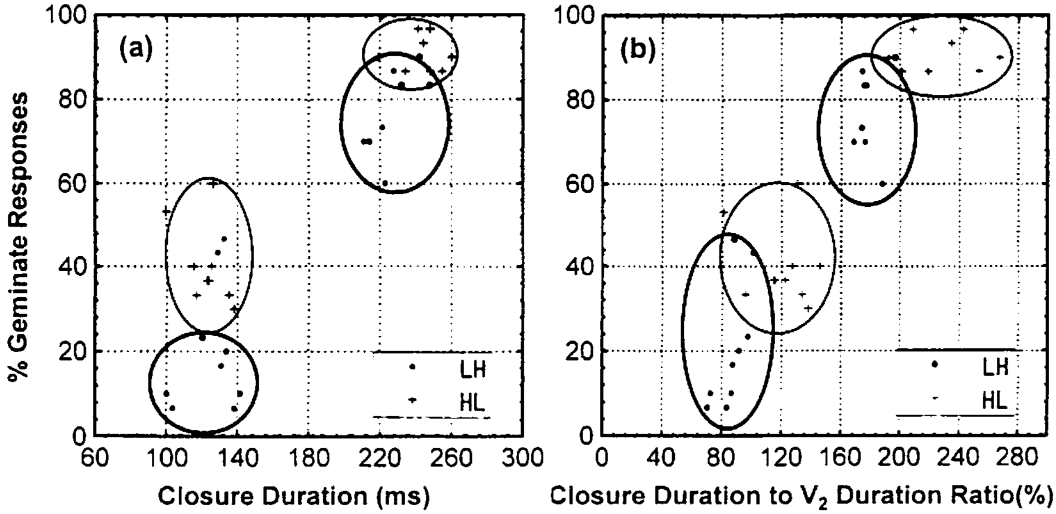

Figure 3. Mean percentage geminate responses at different closure duration (a) and closure duration ratio to the postconsonantal vowel length (b) of each stimulus, for Korean speakers. Accent difference of the stimuli. LH and HL is shown as • and +. The tokens are grouped according to accent type.

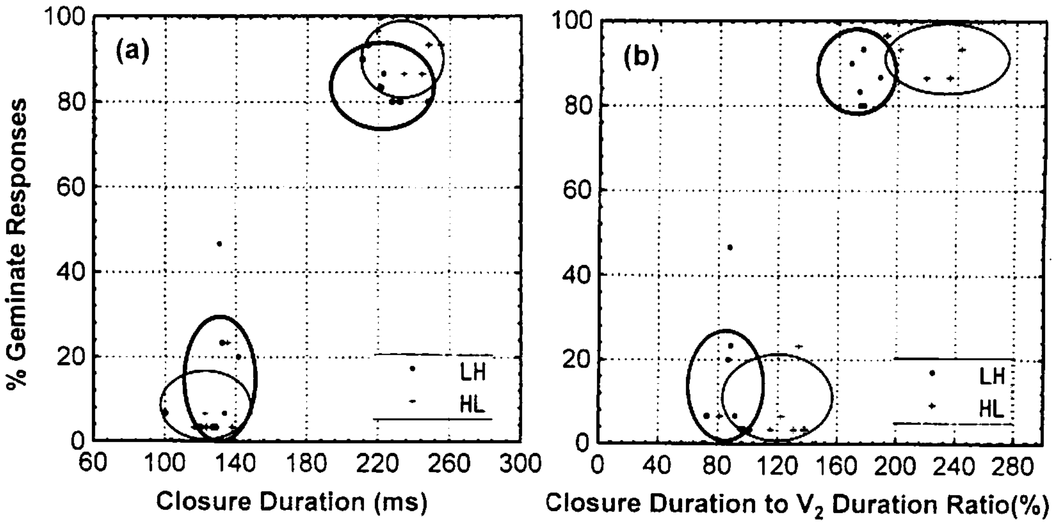

Figure 4. Mean percentage geminate responses at different closure duration (a) and closure duration ratio to the postconsonantal vowel length (b) of each stimulus, for Spanish speakers. Accent difference of the stimuli, LH and HL is shown as • and +. The tokens are grouped according to accent type.

References

1) Fujisaki,H., Nakamura,K. and Imoto,T. :Auditory perception of duration of speech and non-speech stimuli. Annual Bulletin. Research Institute of Logopedics and Phoniatrics 7, 45-64,1973.

2) Min.K.:On the phonetic perception of Japanese sokuon by Korean learners. Journal of Japanese Language Teaching Association 62.179-193.1987.

3) Hirato, N. and Watanabe,S.: The relation between the perceptual boundary of voiceless plosives and their moraic counterparts and the length of vowels following closure. Onse Gengo II, 99-106,1987.

4) Watanabe,S. and Hirato, N.: The relation between the perceptual boundary of voiceless plosives and their moraic counterparts and the duration of the preceding vowel. Onse Gengo I ,1-8,1985.