

LINGUOPALATAL CONTACT DIFFERENCES BETWEEN JAPANESE GEMINATE AND SINGLETON STOPS

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1. INTRODUCTION

Japanese is known to exhibit a phonemic contrast between geminate (long, moraic) and singleton consonants (e.g. *itta* ‘went’ vs. *ita* ‘was’; Vance, 1987). This contrast has received considerable attention in phonetic literature, with most studies focusing on its most salient, durational properties – differences between geminated and singletons in the duration of the consonant and the preceding or following vowel (see Kawahara, to appear, for an extensive review). A few recent studies have extended the analysis to non-durational acoustic correlates, such as pitch, amplitude, and creakiness of adjacent vowels (Kawahara, 2006; Idemaru & Guion, 2008). In one of these works, Idemaru & Guion (2008) found that Japanese geminate stops tend to be produced with creaky voice, suggesting a tighter, fortis-like constriction compared to the weaker constricted (lenis) singletons (cf. Sakuma, 1929/1963 cited in Vance, 1987). Previous research on similar contrasts in other languages has revealed that differences in duration tend to be accompanied by differences in the degree of linguopalatal contact (e.g. Payne, 2006 on Italian).

Until now, however, there has been little articulatory work on the contrast, and the differences in degree of contact have not been directly investigated. This paper presents some preliminary results of an electropalatographic (EPG) study of Japanese geminate and singleton stops /t/ k:/ vs. /t k/ evaluating the hypothesis that geminates are characterised by both longer duration and tighter constriction.

2. METHOD

The participants were 3 females, native speakers of Japanese from Shizuoka (JF1), Shiga (JF2), and Ibaraki (JF3), at the time of the study residing in Toronto, Canada. The materials included 4 segmental minimal pairs with voiceless geminate and singleton coronal and velar stops shown in Table 1. The words were randomized and presented in a carrier phrase *kabeni wa ____ mo kaite aru* ‘____ is also written on the wall’. Nine repetitions of each utterance were elicited, resulting in the total of 216 tokens (8 words * 9 repetitions * 3 speakers).

Electropalatographic (EPG) data were collected using custom-made artificial palates with 62 built-in electrodes and a WinEPG system by *Articulate Instruments* (Wrench et al., 2002). The EPG method provides information about the contact between the tongue and the palate over time, at a sampling rate of 100 Hz. Analysis was performed using the *Articulate Assistant* software (Wrench et al., 2002) and

involved measurements of the stop closure duration (in seconds) and the degree of the contact (‘Whole Total’: the number of activated electrodes divided by the total number of electrodes) taken at the point of maximum contact. Statistical analysis involved t-tests with minimal word pairs performed separately for duration and degree of contact, followed by correlations between the two measures (all done separately for each participant).

Table 1. Words used in the study.

Contrast	Geminate	Singleton
/t:/ vs. /t/	<i>matte</i> ‘wait’ (request)	<i>mate</i> ‘wait’ (imper.)
	<i>hetta</i> ‘reduce’ (past)	<i>heta</i> ‘unskilled’
/k:/ vs. /k/	<i>sekki</i> ‘stone tools’	<i>seki</i> ‘seat’
	<i>shikke</i> ‘stormy weather’	<i>shike</i> ‘humidity’

3. RESULTS

The results showed that geminate stops were about twice as long as their singleton counterparts, as shown in Figure 1. On average, the duration of single /t/ and /k/ was 68 ms and 65 ms, while the duration of their geminate counterparts was 143 ms and 147 ms, respectively. The geminate/singleton differences were highly significant ($p < .001$) for all 3 speakers, and for both coronals and velars. More interestingly, geminates showed on average greater degree of linguopalatal contact compared to singletons, as illustrated in Figure 2. These differences were relatively small, being on average .64 vs. .60 for coronals and .63 vs. .57 for velars. Nevertheless, the differences were significant for most of the comparisons: /t:/ vs. /t/ for JF1 ($p < .01$) and JF3 ($p < .001$), and /k:/ vs. /k/ for JF1 ($p < .05$), JF2 ($p < .001$), and JF3 ($p < .01$). There were also some differences in the overall degree of contact among the speakers (JF1 > JF2 > JF3), possibly reflecting individual anatomical differences in the shape of the palate. Correlations between duration and degree of contact (see Figure 3) were significant for all 3 speakers (JF1: $r(72) = .33$, $p < .01$; JF2: $r(72) = .36$, $p < .01$; JF3: $r(72) = .58$, $p < .001$), indicating that longer duration implies greater degree of contact.

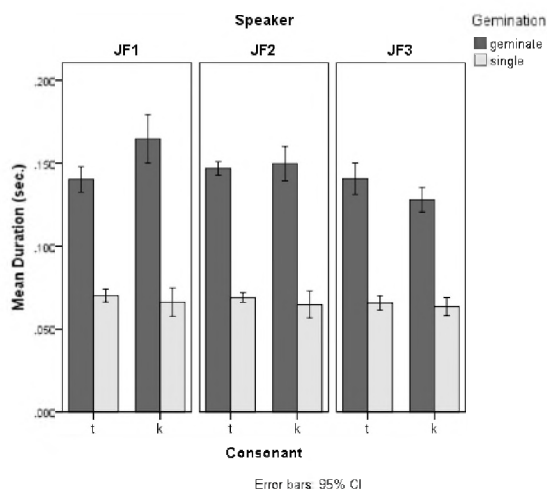


Figure 1. Mean duration (in seconds) of geminate and singleton coronal and velar stops separately by speaker.

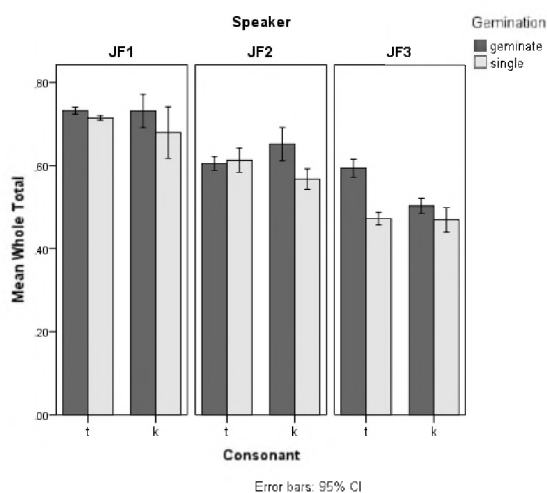


Figure 2. Mean degree of contact (Whole Total) of geminate and singleton coronal and velar stops separately by speaker.

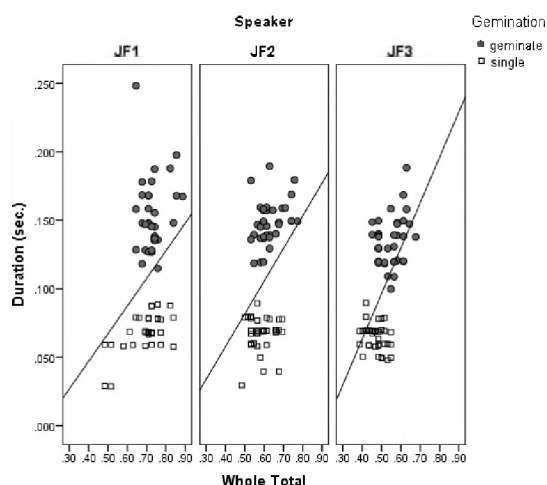


Figure 3. Correlations between duration (in seconds) and degree of contact (Whole Total) for individual tokens, separately by speaker.

4. DISCUSSION AND CONCLUSION

The results of this preliminary study confirm the hypothesis that durational differences in the production of Japanese geminate/singleton stops can be accompanied by differences in the degree of contact. The longer geminates tend to be articulated with a tighter constriction, compared to the shorter and weaker-articulated singletons. The results thus confirm impressionistic observations made by Sakuma (1929/1963) and predictions based on acoustic analysis (vowel creakiness next to geminates) made by Idemaru & Guion (2008). They also show the Japanese geminate/singleton contrast shares some key phonetic properties with similar contrasts in other languages, like Italian (Payne, 2006). More work is necessary to determine whether the results are representative of spoken Japanese in general and can be extended to other segmental/prosodic contexts and to other consonants (e.g. geminate/singleton affricates, fricatives, and nasals). Similarities and differences between languages in the phonetic realization of the geminate/singleton contrast also require further investigation, as these may clarify the nature of the relation (automatic or learned) between duration and degree of contact.

To conclude, the current study presented some evidence for the role of degree of contact in the realization of the Japanese geminate and singleton stops, contributing to the growing body of work on non-durational acoustic and articulatory correlates of the contrast.

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