

Durational vowel-coda interaction in spontaneous Japanese utterances

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*The Keio Institute of Cultural and Linguistic Studies***Keywords:** corpus, the CSJ, spontaneous speech, syllable, duration**PACS number:** 43.70.+i, 43.70.Bk, 43.70.Fq

1. Introduction

This short letter reports an analysis of the effect of syllable structure on vowel duration in spontaneous Japanese speech. Since [1], Japanese has been classified as a “mora-timed” language, and the role of syllables in the language has been questioned from time to time. [2] offers the most recent version of this proposal, arguing that Japanese has no syllables at all. Part of the basis for this claim comes from the (putative) “[a]bsence of phonetic clues for the existence of a rhyme-like constituent” [2] (p. 120), implying that vowels and coda consonants do not interact in Japanese phonetically. [3] argues that this claim is empirically false, as vowels and coda consonants do interact phonetically in several different ways. For example, previous studies have shown that vowels are longer before geminates than before singletons (see [3] for a summary). In [4], vowel intervals were on average 75 ms before geminates, whereas they were 59 ms before singletons. [5] investigated a corpus of Japanese speakers reading 503 phrases and sentences, and showed that vowels are longer before a coda nasal than they are in open syllables: the median vowel durations were 90 ms for open syllables and 110 ms when closed by a coda nasal.

This paper reexamines these observations in further detail, using the Corpus of Spontaneous Japanese, the Relational DataBase (henceforth the CSJ-RDB). The previous studies were often limited in several aspects; no studies, for example, examined the interaction between vowels and coda consonants for each vowel type separately, often studying only a subset of the full list of Japanese vowels. [6] for example studied only non-high vowels, and collapsed their results; [4] studied only /e/. Moreover, most studies, except for [5], are based on lab speech rather than spontaneous speech. (It is not meant to imply here that lab speech is unreliable for phonetic analyses, but rather that it is important to examine natural speech as well: [7]). The CSJ-RDB is large enough to overcome these limitations, thereby shedding new light on vowel-coda interaction in spoken Japanese.

2. Method

The duration of each vowel interval was extracted from the CSJ-RDB text file, and sorted by the vowel’s syllabic environments, based on the annotations provided by the CSJ, which uses the traditional labels /N/ (a coda nasal) and /Q/ (an obstruent geminate) to mark

Table 1 Duration of the five Japanese vowels in the three syllabic environments.

	Open syll.				Pre-/Q/		
	median	mean (SD)	N		median	mean (SD)	N
/a/	72.2	76.0 (28.0)	95,532		73.9	74.9 (22.3)	2,859
/e/	63.3	72.9 (38.4)	50,431		71.1	74.4 (24.4)	787
/o/	60.6	65.5 (28.2)	81,386		65.9	66.9 (20.7)	1,052
/i/	48.1	52.8 (23.4)	66,624		55.4	57.6 (19.4)	1,673
/u/	44.2	48.8 (23.3)	44,610		57.9	59.7 (22.6)	590
Pre-/N/							
	median	mean (SD)	N				
/a/	83.9	85.5 (24.6)	5,770				
/e/	81.4	83.6 (26.4)	4,002				
/o/	81.7	84.1 (27.3)	2,757				
/i/	63.2	66.9 (25.4)	2,237				
/u/	66.6	67.9 (24.6)	2,213				

coda consonants. Long vowels were excluded from this analysis, as long vowels do not occur in closed syllables [8]. Within each vowel quality in the three separate environments, outliers—those that were more than 2 standard deviations away from the mean—were excluded.

3. Results

Table 1 shows medians, means, and the standard deviations around the means. The standard deviations are generally large, even after excluding outliers. Inspection of the data shows that the distributions are heavily right-skewed; therefore medians should be more reliable measures than means for the current analysis.

As previous studies have shown, the median and mean duration of the five vowels follow the order of /a/ > /e/ > /o/ > /i/ > /u/ in Japanese [5, 9, 10], and this order generally holds across the all three syllabic environments (except for the reversal between /i/ and /u/ in closed syllables, and the reversal between /e/ and /o/ in the pre-/N/ environment). Within each vowel, vowels are generally shortest in open syllables, slightly longer before a geminate, and longest before a coda nasal. These results replicate the general lengthening effects in closed syllables identified in the previous phonetic studies. The only reversal is /a/ in the pre-/Q/ environment in terms of mean (76.0 vs 74.9), but this reversal does not hold in terms of median (72.2 vs 73.9).

Table 2 shows the differences, in terms of median and mean, between open syllables and the two types

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Table 2 Differences in vowel durations between open syllables and the two types of closed syllables.

	Pre-/Q/			Pre-/N/		
	median	mean	p -value	median	mean	p -value
/a/	1.7	-1.0	$p < .001$	11.7	9.5	$p < .001$
/e/	7.7	1.6	$p < .001$	18.0	10.8	$p < .001$
/o/	5.4	1.4	$p < .001$	21.1	18.7	$p < .001$
/i/	7.3	4.8	$p < .001$	15.1	14.1	$p < .001$
/u/	13.8	10.9	$p < .001$	22.4	19.2	$p < .001$

of closed syllables. Since the distributions are right-skewed, the statistical significance of the differences was assessed by a non-parametric Wilcoxon rank-sum test. The results show that lengthening before an obstruent geminate and lengthening before a coda nasal are both statistically significant at the $p < .001$ level, for all types of vowels.

Since we observe that lengthening is more extensive before a coda nasal than before a geminate, this difference was assessed for each vowel, again with a non-parametric Wilcoxon test. The differences are significant at $p < .001$ level for all of the vowels: vowels are statistically longer before nasals than before obstruent geminates.

We also observe that different vowels lengthen to different degrees. Shorter vowels (e.g. /u/) tend to be affected more, and longer vowels tend to be affected less (e.g. /a/). It may be the case that there is a limit on how long a short vowel can be—given that Japanese has a short/long contrast—so that a vowel like /a/, which is already long, cannot be lengthened too much.

One prominent difference between the current result and the previous studies is the magnitude of difference between vowels in open syllables and vowels before obstruent geminates. As reviewed in the introduction, [4] found that vowels get longer on average by 16 ms before an obstruent geminate. Their stimuli only contained [e]; in Table 2, the differences that the current study found for /e/ were 1.6 ms in terms of means and 7.7 ms in terms of medians. [6], like [4], found that pre-geminate lengthening can on average be as long as 20 ms, using the stimuli containing /a/, /e/, and /o/. These comparisons indicate that pre-geminate lengthening may be exaggerated in lab speech, and is less clearly observed in spontaneous speech.

4. Discussion

The results confirm the previous findings, mostly based on lab-speech, that vowels are longer before obstruent geminates than in open syllables. The results also confirm the results of [5] that vowels are longer before a coda nasal than in open syllables. Not only does the current study replicate these findings based on a large spoken-speech corpus, it offers several new findings. First, existing data on pre-geminate lengthening has mainly come from lab-read speech, and this effect was replicated in spontaneous speech. Second, it demonstrates that lengthening before a geminate and

lengthening before a coda nasal hold for each of the five vowels in Japanese. These findings are important in supporting the role of syllables in the prosodic organization of Japanese [3], as they instantiate the phonetic interaction between a vowel and a coda consonant, which is not predicted by the syllable-less theory of Japanese [2]. Note that recent studies have found that both closed syllable shortening and lengthening are found cross-linguistically, and thus the fact that coda consonants lengthen the preceding vowels is not a cross-linguistic anomaly (see [3] for actual examples).

Third, the current study found that lengthening before a coda nasal is more extensive than lengthening before a geminate, which is a new finding that no previous studies have found. Even [5], who reported both pre-geminate and pre-nasal lengthening, did not find this systematic difference. Fourth, the current study shows that vowels lengthen to different degrees; [a] seems least susceptible to closed-syllable lengthening, whereas [u] is the most “stretchable” vowel. Overall, we can conclude that vowels and coda consonants in Japanese do interact phonetically, despite the claim to the contrary by [2], although the way they interact is more complex than previously thought: the degree of lengthening depends on which vowel interacts with which consonant. A remaining task for future research is to address why these patterns hold.

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