

An acoustic analysis of the Cantonese vowels in reduplicated syllables

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There have been studies of the acoustic characteristics of vowels in different positions of an utterance. It is reported that compared to those in the other positions of an utterance, the vowels in the utterance-final position have a longer duration, a lowered F0, and a reduced intensity level, and the vowels in the utterance-initial position are strengthened in articulatory efforts [1,2,3,4]. This study investigates the acoustic characteristics of the Cantonese vowels in reduplicated syllables. In Cantonese, syllable reduplication is a common morphological process, where one or two monosyllables are duplicated to form disyllabic compounds (e.g., /si²¹ si²¹/ 時時 ‘often’; /p^{hak3} p^{hak3}/ 拍拍 ‘to pat’) or quadrisyllabic compounds (e.g., /tsi⁵⁵ tsi⁵⁵ tsa⁵⁵ tsa⁵⁵/ 吱吱喳喳 ‘chattering’; /ka⁵⁵ ka⁵⁵ wu²² wu²²/ 家家戶戶 ‘every family’). While in syllable reduplication a syllable is said to be copied, phonetically the reduplicated syllables, as will be shown, are not exact copies.

This study analyzed a set of meaningful Cantonese disyllabic and quadrisyllabic compounds. The test compounds contain one or two pairs of reduplicated CV or CVS (S = stop) syllables, including CVCV, CVSCVS, CVCV-CVCV and CVSCVS-CVSCVS. The reduplicated syllables contain the peripheral vowels (/i/ /u/ /ɛ/ /ɔ/ /a/) and they are associated with all the nine tonal categories (/55/ /33/ /22/ /21/ /25/ /23/ /5/ /3/ /2/) in Cantonese. Three repetitions of each test compound were recorded of native Cantonese speakers, male and female, who were the local university students in Hong Kong. An acoustic analysis was carried out to obtain phonetic data on duration, F0, intensity, and formant frequencies of the vowels in the reduplicated syllables. Preliminary results of the analysis of the acoustic data of the speakers are presented as follows.

Vowel duration (Table 1). In the reduplicated syllables, regardless of CV or CVS syllable type, the vowel duration is longer in the second or following syllable than in the first or preceding syllable. The difference in duration between the two vowels in the reduplicated syllables is markedly significant (a) in the disyllabic compounds (V1/V2 = 54-70%) and (b) in the final position of the quadrisyllabic compounds (V3/V4 = 52-69%). This is presumably due to the effect of preboundary final lengthening [1,2]. For the reduplicated syllables in the initial position of the quadrisyllabic compounds, the duration of V1/V2 is 82-95%. The data show the vowel duration is also longer in the following duplicated syllable than in the preceding one, though the difference in duration between the two vowels in the reduplicated syllables is reduced in the compound-initial position.

F0 and intensity (Figure 1). In the reduplicated syllables, the F0 value of the vowel tends to be lower in the following duplicated syllable than in the preceding one. This is regardless of the types of tones associated with the syllables. The difference in F0 between the two vowels in the reduplicated syllables is larger when the reduplicated syllables in the preboundary compound-final position. Correspondingly, the vowel has a lower intensity value in the following duplicated syllable than in the preceding one. The differences in F0 and intensity values are assumed to have resulted from the general declination in F0 and intensity over the course of an utterance [3].

Formant frequencies (Figure 2). The differences in the formant frequencies, F1 and F2, between the two vowels in the reduplicated syllables are minimal, compared to the differences in the other acoustic properties of the vowels. The prosodic effect on vowel peripherality in the domain-initial position reported in [4] is not observed in the Cantonese reduplicated syllables.

In conclusion, the Cantonese vowels in reduplicated syllables differ mainly in duration, F0, and intensity, not formant frequencies. The differences, which ascribe to the position effect on the syllables in the compounds, constitute the general prosodic characteristics of the reduplicated syllables in Cantonese.

Table 1. Duration (in ms) of the vowels in the reduplicated syllables of disyllabic and quadrisyllabic compounds for four speakers.

Reduplicated syllables	Vowels	Male 1	Male 2	Female 1	Female 2
CVCV	V1	161	131	170	153
	V2	230	221	247	281
	V1/V2	70%	59%	69%	54%
CVSCVS	V1	119	102	95	110
	V2	172	153	136	183
	V1/V2	69%	67%	70%	60%
CVCV-CVCV	V1	115	98	146	105
	V2	124	103	157	117
	V1/V2	93%	95%	93%	90%
	V3	139	122	150	133
	V4	201	234	216	255
	V3/V4	69%	52%	69%	52%
CVSCVS-CVSCVS	V1	77	76	93	74
	V2	93	92	113	90
	V1/V2	83%	83%	82%	82%
	V3	86	93	99	88
	V4	143	144	147	146
	V3/V4	60%	65%	67%	60%

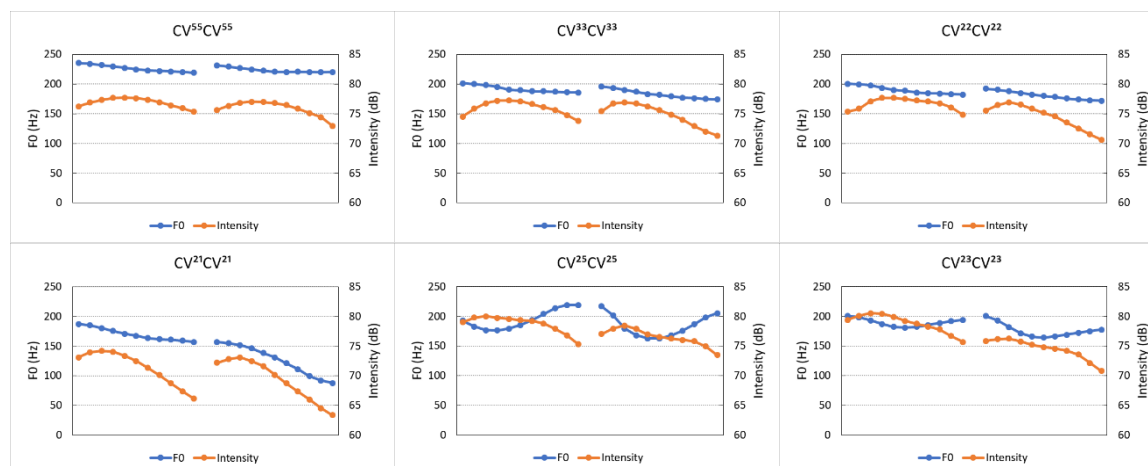


Figure 1. F0 contours and intensity curves of the vowels in the reduplicated CVCV syllables associated with the six types of tones for a female speaker.

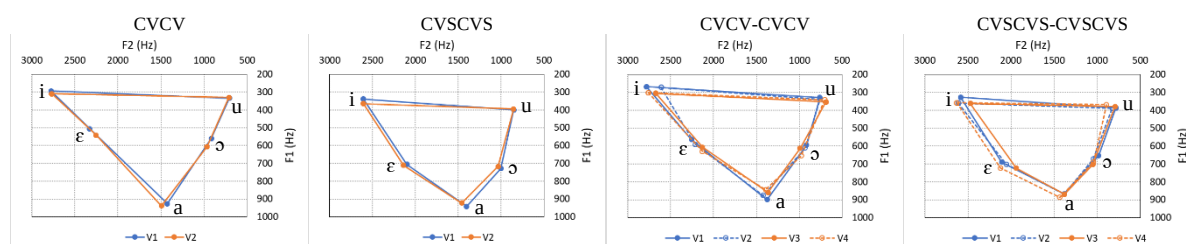


Figure 2. Vowel loops of [i ε a u] in the reduplicated syllables of disyllabic and quadrisyllabic compounds for a female speaker.

References

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