ACOUSTIC DISTINCTION BETWEEN CANTONESE LONG AND SHORT VOWELS

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ABSTRACT

This study focuses on the acoustic analysis of Cantonese vowels, using a database containing speech data from two subjects, comprising approximately 1860 monosyllable words per subject. The acoustic analysis concerns vowel (acoustic) duration and vowel spectral quality (F1-F2 formants).

INTRODUCTION

Cantonese is spoken in Hong Kong, Guangzhou and Macao by over 98 % of the population and many overseas Chinese in America, Australia and Canada. It is the standard variety of the Yue dialect. There is scarce published phonetic investigation and description of Cantonese in general and Hong Kong Cantonese in particular. Cheung K.H. (1986) presents a good summary of previous work on Cantonese phonetics and phonology but provides more phonological descriptions than phonetic ones. Since limited phonetic data is available in the literature, there is a need to obtain more instrumental phonetic data of Cantonese speech sounds. This paper reports a project of the investigation of the properties of Cantonese vowels.

CANTONESE VOWEL SYSTEM

There are eleven vowels in Cantonese /i, y, e, ɛ, ɔ, œ, ɐ, a, u, ʊ, ɪ/ Zee, 1991. There are ten diphthongs in Cantonese /ai, ɐi, au, ɐu, ei, ey, ɔi, ui, iu, ou/. In this paper, the vowels are labelled differently as machine readable alphabets need to be used. Hence the vowels are written as [i, I, u, U , oe, OE, aa, a, e, o, yu]. The vowels [I, U, OE, a] are short vowles while the others are long ones.

METHOD

Speech data recording

Two subjects were asked to read aloud 1863 real Cantonese words in the carrier sentence, "I want to read _____ for you to hear". The word list is made up by selecting all real

Cantonese words from theoretically possible combinations of consonants, vowels and tones. One subject is male and the other is female and both were 21 years old. The recordings were done in sound proof rooms in the Dept. of Speech and Hearing Sciences in The University of Hong Kong. Recordings were divided into three sessions to avoid fatigue.

Segmentation and labelling

The speech data was digitised at 20 kHZ on a Sunsparc system running Entropic's WAVES+. Segmentation and labelling were done in WAVES+ too. A set of Machine Readable Phonetic Alphabets (MRPA) were created for Cantonese based on the International Phonetic Alphabets and the Cantonese romanization system.

Cantonese mu+

The mu+ Speech Database System (Harrington, Cassidy, Fletcher and McVeigh, 1993) which is useful in automatically assisted hierarchical labelling, has been adapted for use with Cantonese speech data. The Cantonese mu+, which enables extract of speech labels from hierarchical structures of Cantonese, is developed and used in the Hong Kong Spoken Cantonese Database.

RESULTS

Vowel duration

The results show that vowel duration varies significantly according to its phonological long/short status and the structure of syllable containing the vowel. Five degrees of vowel length can be found - long vowels in open syllables, in syllables closed by nasals and in syllables closed by oral stops; and short vowels in syllables closed by nasals and in vowels closed by oral stops. For the last two categories, however, the difference is significant only for high vowels, but not for the mid/low vowels. Table one shows Cantonese vowel durations and formants based on speech data of two subjects. Figures 1 and 2 show nplots of duration of close vowels [i, I] and open vowels [aa, a] in differnt contexts respectively.

Vowel formants

Apart from the significant differences in duration, vowel quality can also be distinguished in terms of its phonological long/short status and open/closed syllables. Significant differences in formants can be seen across three groups: long vowels in open syllables and in closed syllables, and short vowels in closed syllables. Short vowels in closed syllables tend to be much centralised than their long counterparts in both open and closed syllables. However, long vowels in closed syllables seem to have a significantly higher F1 than their counterparts in open syllables, and there is no general tendency for centralization in terms of changes in both F1 and F2. Moreover, the difference for low vowels in terms of their spectral qualities is smaller than for high vowels, and this smaller quality difference for low vowels is compensated by a larger durational difference. Figure 3 shows an ellipse plot for the Cantonese vowels.

Vowels in syllables	Mean duration (ms)		F1 (Hz)		F2 (Hz)	
	M	F	M	F	M	F
LV [i]						
ip, it	63(19)*	97(18)	329(59)	389(42)	2482(274)	2600(179)
in, im	93(25)	136(29)	315(77)	393(41)	2501(299)	2529(401)
I	184(58)	218(31)	288(94)	385(37)	2494(483)	2860(81)
SV [I]						
Ik	53(16)	70(14)	499(94)	544(106)	2199(373)	2009(281)
IN	70(26)	82(14)	570(83)	592(126)	2109(299)	1939(330)
LV[u]						
[ut/p]	76(14)	117(17)	404(39)	434(36)	1082(144)	929(168)
[um/n]	97(28)	130(41)	452(109)	424(42)	1017(182)	853(147)
[u]	200(55)	227(34)	321(58)	379(36)	697(151)	746(58)
SV [U]						
[Uk]	47(13)	64(15)	571(67)	550(41)	1079(210)	976(126)
[UN]	66(23)	73(15)	638(143)	573(66)	1042(224)	946(122)
LV [oe]						
[oek]	96(16)	150(27)	579(103)	680(59)	1640(333)	1568(37)
[oeN]	134(89)	190(42)	605(112)	708(52)	1722(235)	1498(102)
[oe]	207(33)	284(25)	447(59)	588(56)	1718(154)	581(82)
SV [OE]						
[OEt]	67(26)	86(21)	636(120)	615(33)	1427(197)	1318(126)
[OEn]	72(250)	98(37)	650(130)	675(80)	1459(220)	1310(94)
LV [aa]						
[aap/t/k]	104(26)	146(25)	985(120)	919(126)	1487(208)	1516(132)
[aan/m/N]	153(36)	191(28)	986(120)	931(122)	1456(186)	1487(157)
[aa]	217(47)	264(27)	948(95)	921(125)	1351(141)	1396(157)
SV [a]						
[ap/t/k]	66(27)	80(20)	861(134)	770(96)	1420(244)	1436(158)
[am/n/N]	70(27)	86(14)	871(105)	804(122)	1431(237)	1422(145)
LV [e]						
[ep/t/k]	99(19)	136(21)	609(104)	738(71)	1991(355)	2046(143)
[eN]	143(32)	201(30)	615(104)	717(75)	2180(242)	2096(314)
[e]	195(51)	258(30)	494(70)	652(66)	2366(316)	2206(286)
LV [o]						
[ot/k]	93(21)	127(24)	728(97)	733(71)	1023(146)	1064(82)
[om/n/N]	138(34)	189(23)	718(83)	727(66)	1072(167)	992(63)
[o]	197(49)	252(26)	573(83)	625(56)	838(134)	891(72)
LV [yu]						
[yut]	66(12)	96(17)	333(61)	444(42)	2147(252)	2097(90)
[yun]	101(20)	153(34)	329(42)	395(36)	2146(238)	2042(141)
[yu]	177(49)	221(30)	262(17)	388(35)	2084(95)	2217(148)

Table 1. Cantonese Vowel Duration and Formant Frequency Values

(LV-long vowel, SV-short vowel, *numbers in brackets are the standard deviation, M-male subject, F-female subject)

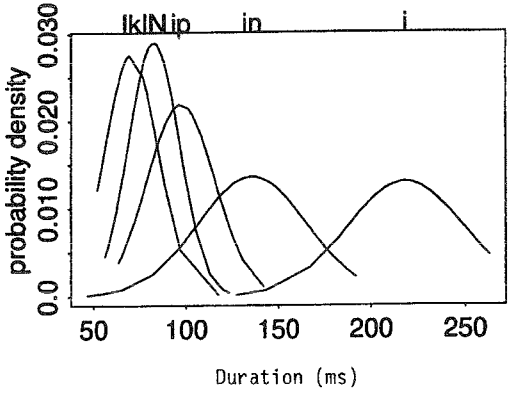

Figure 1. A nplot of duration of close vowels [i,I] in different contexts

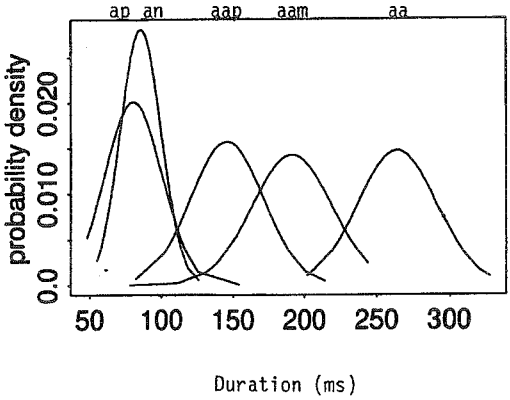

Figure 2. A nplot of duration of open vowels [aa, a] in different contexts

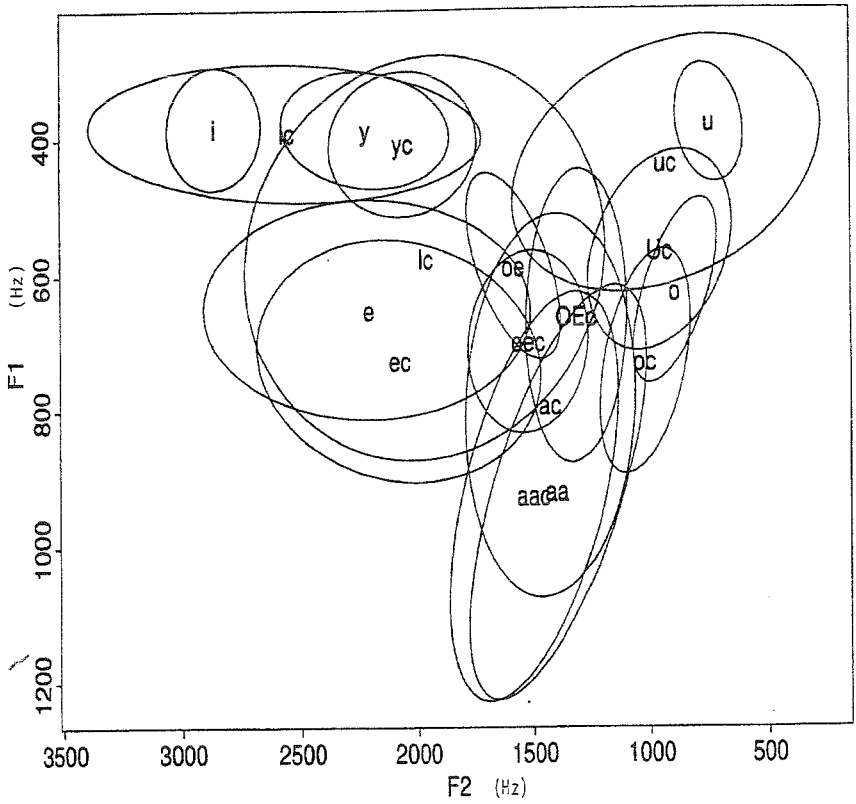

Figure 3. An ellipse plot of the Cantonese vowels

*v - long vowel in open syllables,
vc - long vowels in closed syllables,
Vc - short vowels in closed syllables.

CONCLUSIONS

This study provides insights into how vowel duration and qualities function in forming Cantonese vowels, particularly in contrasting long/short vowels, both phonetically and phonemically.

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