Linguistic Phonetic differences in the Acoustics of Plosives in Chinese Dialects

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ABSTRACT

This paper investigates phonetic linguistic differences between three Chinese dialects, Cantonese, Peking and Shanghai, focussing on bilabial plosives in particular. The results show that the three dialects in question hold certain distinguishing linguistic phonetic characteristics and, furthermore, the observations suggest that it is necessary to reassess the nature of linguistic phonetic differences. Linguistic phonetic differences are thus not only manifested as 'between-language differences' (or between-dialect differences in this study) in phonetic parameters, but must also be understood in terms of variances in the realisation of certain phonetic phenomena in languages.

INTRODUCTION

Chinese dialects are classified into seven major groups, mainly according to the development of the Middle Chinese plosive consonants (Norman 1988:181). These dialect groups differ from each other in various ways, but especially in their phonology. Some earlier descriptions of Chinese dialects (Chao 1935, Yuan et. al 1960) indicate that these dialect groups are also distinguishable in the auditory impressions of certain segmental phonemes (Yuan et. al 1960). This suggests that linguistic phonetic differences among Chinese dialects may also be found in the acoustics of these dialects. This paper demonstrates the existence of linguistic phonetic differences among Chinese dialects on the basis of the acoustic analysis of the plosives, focusing on some of their durational characteristics. The dialects investigated are Cantonese, Peking and Shanghai, which respectively belong to the Yue, Mandarin, and Wu dialect groups.

PROCEDURE

TARGET SOUND

In this research, syllables consisting of bilabial plosives and nasals followed by the vowels /a/ or /i/ (/iu/ for Cantonese because of Phonological constraints) were chosen as target syllables. The target syllables and the Chinese characters for them are listed below. Tone was also controlled in the course of the selection of the target words. As far as the phonology of the dialects allows, high level tone is employed in this paper.

		unaspirated	aspirated	voiced
Cantonese	low vowel	/pa/(44) 巴	/pha/(44) 怕	N/A
	high vowel	/piu/(44) 标	/phiu/(44) 飘	N/A
Peking dialect	low vowel	/pa/(55) 巴	/pha/(55) 趴	N/A
	high vowel	/pi/(55) 逼	/phi/(55) 批	N/A
Shanghai dialect	low vowel	/pa/(44) 爸	/pha/(44) 派	/ba/(22) 罢
	high vowel	/pi/(44) 比	/phi/(44) 骗	/bi/(22) 皮

TABLE 1. List of the syllables used in the corpus for the recording.

RECORDING

Recording was carried out in the recording studio of the ANU phonetics Laboratory, and each dialect group consisted six to seven native speakers as informants. In recording, informants were asked to read out cards on which one Chinese sentence was written. A Chinese character with the appropriate segmental composition and controlled for tone was embedded in each sentence. These sentences were read five times in random order. The sentences are:

Cantonese 呢个系 字 [li kɔ haj _ tʃi]
55 33 22 22

Peking 这是 字 [tsə s1 _ t1]
41 41 41

Shanghai 迭个是 字 [d1 g0 z1 / 1 4 11 / * z1]

(all mean "This is the character X", and tone for * differs depending on the tone of the preceding syllable because of tone sandhi.)

MEASUREMENTS

The measurements were taken via the program "Signalyze version 3.0". "VOT" here means "voice onset lag" not "voice onset lead" since no voicing in the production of the plosives was observed during this research. The third category of Shanghai plosives, namely the voiced plosive, is supposed to have voicing in the non-word initial inter vocalic position, but in the data for this study, no Shanghai speaker displayed voicing in their hold phase. The results of the measurements were analysed statistically (T-Test and ANOVA).

RESULT

CANTONESE

Summarising the durational characteristics of the Cantonese plosives, the first observation concerns the effect of the following vowel. Contrary to previous studies (Ladefoged and Maddieson 1992), no constant relationship between the following vowel and plosive consonants was discernible. Secondly, the aspirated plosives were longer than the unaspirated ones. This was true for all speakers. The third point to be mentioned was the relationship between the hold phase and VOT in the aspirated plosive. The proportion of the hold phase to VOT of the aspirated plosive in Cantonese was not constant.

	/pa/		/pha/		/pi/		/phi/	
	hold	VOT	hold	VOT	hold	VOT	hold	VOT
Mean	13.27	1.28	11.28	8.38	14.48	1.53	10.25	8.88
St.d.	1.84	0.238	2.39	1.81	2.12	0.41	2.01	1.91

TABLE 2 Mean values and standard deviations for all Cantonese speakers (n = 6)

		/pa/		/pha/		/pi/		/phiu/	
		hold	VOT	hold	VOT	hold	VOT	hold	VOT
D	Mean	13.7	1.66	10.37	10.22	13.32	2.24	9.4	11.34
	St.d.	1.64	0.28	0.89	1.56	0.54	0.28	0.99	2.09
J	Mean	10.04	1.44	8.84	10.16	11.36	1.62	8.4	9.92
	St.d.	0.74	0.23	1.6	0.77	0.47	0.4	0.27	1.089
W	Mean	13.86	1.04	12.26	7.58	15.14	1.22	9.66	8.44
	St.d.	1.76	0.18	2.49	1.72	1.22	0.33	0.89	0.62
A	Mean	14.53	1.1	14.08	9.45	16.02	1.64	12.31	8.89
	St.d.	2.82	0.07	4.41	1.94	1.77	0.23	2.02	0.83
I	Mean	15.14	1.3	13.63	6.92	17.32	1.36	13.18	5.58
	St.d.	2.14	0.28	1.99	1.69	1.48	0.06	0.72	0.74
M	Mean	12.33	1.13	8.54	5.94	13.72	1.1	8.5	9.13
	St.d.	3.43	0.1	1.06	1.76	2.46	0.31	0.92	2.2

TABLE 3 Mean values of the duration for each speaker (n = 5). /a/ and /iu/ in the first row indicate following vowels. The unit is csec.

PEKING

The observations of the duration of Peking dialect can be summarised as follows. Firstly the following high vowel causes longer duration in the consonants. This was constant among all the speakers, and in both hold phase and VOT. Secondly the aspirated plosives were longer than the unaspirated ones

when part of a whole consonant. Finally, it is noted that the relationship of the hold phase to the VOT of the aspirated plosive was stable. VOT was longer than the hold phase in all the speakers, with one exception.

	/pa/		/pha/		/pi/		/phi/	
	hold	VOT	hold	VOT	hold	VOT	hold	VOT
Mean	11.4	1.59	9.12	11.51	12.74	1.71	9.64	11.93
St.d.	2.24	0.6	1.95	0.57	1.44	2.75	1.39	2.39

TABLE 4 Mean values and standard deviations for all the speakers (n = 7, but n = 6 for /pha/ because of R's misreading)

		/pa/		/pha/		/pi/		/phi/	
		hold	VOT	hold	VOT	hold	VOT	hold	VOT
X	Mean	12.38	2.11	8.95	12.27	12.38	2.11	8.95	12.27
	St.d.	1.41	0.49	1.89	1.4	1.41	0.49	1.89	1.397
P	Mean	10.88	1.13	7.56	11.03	12.81	1.17	10	11.98
	St.d.	1.28	0.06	0.51	0.94	1.56	0.05	0.94	1.01
D	Mean	15.47	2.5	11.77	16.31	14.9	2.62	9.43	15.65
	St.d.	2.58	0.22	1.88	4.18	3.44	0.56	1.52	2.44
R	Mean	8.24	1.85			8.97	1.95	7.12	7.83
	St.d.	1.64	0.32			0.95	0.66	1.05	0.82
K	Mean	11.84	0.75	8.59	11.4	12.16	1.15	9.77	11.13
	St.d.	1.7	0.21	1.55	1.11	0.64	0.17	1.82	0.75
Y	Mean	10.99	1.49	8.41	8.16	14.46	1.83	10.75	11.18
	St.d.	0.69	0.15	0.9	0.44	1.1	0.4	0.82	1.94
YL	Mean	9.97	1.32	9.43	9.9	13.5	1.16	11.45	13.45
	St.d.	1.01	0.27	0.69	1.16	1.31	0.2	1.47	2.65

TABLE 5 Mean values of the duration for each speaker (n = 5). /a/ and /iu/ in the first row indicate following vowels. The unit is csec. The results for speaker R do not have data for /pha/ because of his misreading of the character '泌'. He read this as an unaspirated plosive /pa/ although the character is supposed to be read as an aspirated plosive /pha/.

SHANGHAI

As mentioned previously, Shanghai dialect has a third phonemic category of obstruents, voiced obstruents, in addition to the unaspirated and aspirated plosives. Earlier descriptions of the phonology of Shanghai dialect claim that the voiced obstruents are only realised as voiced under limited circumstances, namely in the intervocalic position (Chao 1935). There was no example of this voicing, however, in the data gathered for this research. This is probably because speakers interpreted "__字" as one word and treated the consonant in the position of __ as a word initial, but not intervocalic. Thus VOT as used in this context remains equivalent to VOT lag.

Now to summarise the observations made on the durations of Shanghai dialect. First, there was no consistent effect of the following vowels in Shanghai dialect. Some speakers had a longer duration when the plosives preceded the high vowel, but others did not. Secondly, the ranking in the length of hold phase and VOT are, from longest to shortest, hold phase /p/ > /b/ > /ph/, and VOT /ph/ > /b/ > /p/. It is noteworthy that exceptions are found only in the case when the following vowel is the high vowel. Thirdly and finally, in respect of the relationship of the hold phase to VOT in the aspirated plosive, the proportion varied from speaker to speaker in Shanghai dialect.

	/pa/		/pha/		/ba/		/pi/		/phi/		/bi/	
	hold	VOT	hold	VOT	hold	VOT	hold	VOT	hold	VOT	hold	VOT
Mean	1.33	1.14	9.08	10.9	10.9	1.26	13.1	1.73	10.2	12.3	11.7	2.04
St.d.	1.73	0.21	0.9	2.47	1.95	0.23	1.88	0.57	1.54	1.77	1.57	0.58

TABLE 7 Mean values and standard deviations for all the speakers (n = 7, but n = 6 for /ba/ because of F's misreading)

		/pa/		/pha/		/ba/		/pi/		/phi/		/bi	
		hold	VOT	hold	VOT	hold	VOT	hold	VOT	hold	VOT	hold	VOT
Q	Mean	11.8	0.99	9.61	8.67	11.0	1.13	10.7	2.02	8.95	12.4	10.4	2.6
	St.d.	1.36	0.25	1.02	0.77	0.78	0.1	0.65	1.29	0.66	1.18	0.72	0.09
XJ	Mean	11.2	0.82	8.04	8.97	10.0	0.98	13.3	1.49	8.87	11.8	10.9	1.59
	St.d.	1.37	0.05	0.4	0.99	1.58	0.06	1.35	0.6	1.14	0.73	0.19	0.25
XN	Mean	14.8	1.43	9.43	14.7	11.8	1.63	13.8	2.83	11.3	11.1	13.0	1.83
	St.d.	1.76	0.29	1.16	2.37	0.98	0.09	2.19	1.28	2.2	1.93	1.96	0.18
W	Mean	12.2	1.2	8.31	9.03	11.3	1.21	12.4	1.45	11.2	10.0	11.0	1.92
	St.d.	0.96	0.14	0.64	1.39	1.05	1.14	0.06	0.33	0.77	1.34	1.09	0.58
F	Mean	15.2	1.19	9.9	10.1			11.8	1.75	9.56	13.1	9.27	3.09
	St.d.	3.86	0.18	1.18	2.27			1.54	0.79	1.87	0.89	0.77	1.66
J	Mean	12.4	1.33	8.11	10.8	7.7	5.46	13.0	1.54	9.05	11.9	10.3	1.77
	St.d.	1.56	0.234	0.59	0.51	0.51	9.46	1.22	0.25	0.78	1.17	0.99	0.35
Y	Mean	15.3	1.03	10.1	13.9	13.5	1.17	16.6	1.04	12.8	15.6	13.7	1.51
	St.d.	2.85	0.15	1.48	1.6	1.13	0.17	2.48	0.2	1.42	0.66	1.27	0.35

TABLE 8 Mean values of the duration for each speaker (n = 5). /a/ and /iu/ in the first row indicate following vowels. The unit is csec. The results for speaker F do not contain the data for /ba/, the voiced plosive + low vowel. This is due to her misreading of the relevant character. She read the character "爸" as /pa/ instead of its proper reading of /ba/.

SUMMARY AND COMPARISON

First of all, two sets of figures and a table are shown to facilitate the comparison. Figures 1 and 2 display the mean durations of each dialect. The first two are the figures for the unaspirated plosive, and the latter two are that of the aspirated plosive. It is noticeable in the case of the unaspirated plosive in Figure 1 below that Peking dialect has the shortest hold phase. The other two dialects have durations similar to each other but different to Peking dialect. Thus we can form a sub group; Peking dialect and the other dialects. Statistics (ANOVA), however, did not reveal a significant difference. This might mean there is no significant difference between dialects in terms of the hold phase of unaspirated plosive, but it might be attributable to large individual differences within a dialect group.

The aspirated plosive (Figure 2), however, has a different tendency. We can see that Cantonese has a much shorter VOT when compared with the other two dialects. Statistics (ANOVA) indicate that the VOT of Cantonese is significantly shorter than that of Peking dialect when the consonant is followed by a low vowel, and when the following vowel is a high vowel, the VOT of Cantonese is significantly shorter than that of both Peking and Shanghai dialects. Additionally, the other two dialects have a longer VOT than hold phase while Cantonese has a shorter VOT than hold phase.

As mentioned earlier in the observation of Cantonese, the proportion of the hold phase to VOT of the aspirated plosive varies from speaker to speaker meaning that the mean duration of Cantonese speakers presented in the figures above is not necessarily representative of the actual duration in Cantonese. However, for two reasons I suspect that this proportional difference might be a part of a linguistic phonetic difference. Firstly recall that in the observation of Cantonese, it was found that the number of examples which have a longer hold phase than VOT exceeded the number of examples which have a longer VOT than hold phase. Compare this with the other two dialects which, with very few exceptions, had a longer VOT than hold phase. Secondly, the size of the durational difference is notable. In the figures of Cantonese speakers' mean duration, the largest difference between VOT and hold phase where VOT is longer was 2 csec. Contrast this with examples where the hold phase is longer where the largest difference was 6.5 csec. The fact that this noticeable contrast is unique to Cantonese duration suggests that it is more than a mere coincidence. It is also unlikely that, even with a larger set of data, we would find Cantonese VOT to be longer than hold phase in a similar

way to the other two dialects. Thus it is probably valid to say that the Cantonese aspirated plosive has a relatively shorter VOT compared with the other two dialects.

The effect of the following vowel also seems to differ between dialects. Despite a preceding study which reports that the high vowel is associated with a longer VOT (strong aspiration in the original description by Ladefoged and Maddieson 1992), the current study revealed that only Peking dialect consistently has a longer duration when the consonants precede the high vowel. The effect on the other two dialects was not systematic. Thus no relationship between the change in duration and the following vowel was recognised, and it is assumed that there is none.

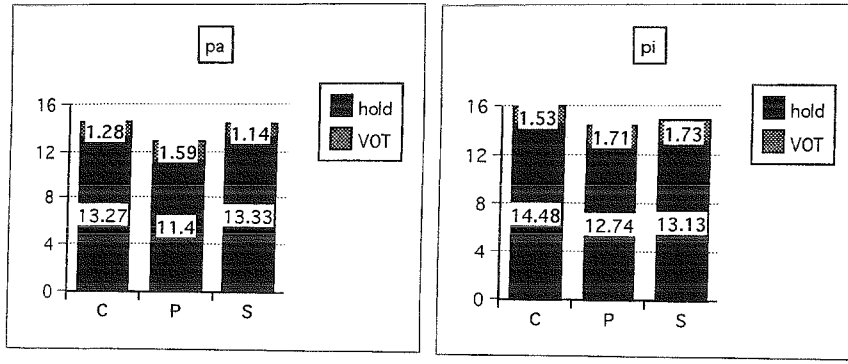

FIGURE 1 Mean durations of the unaspirated plosive for each dialect. The characters C, P, and S represent Cantonese, Peking and Shanghai dialects respectively, and the unit of the Y axis is csec.

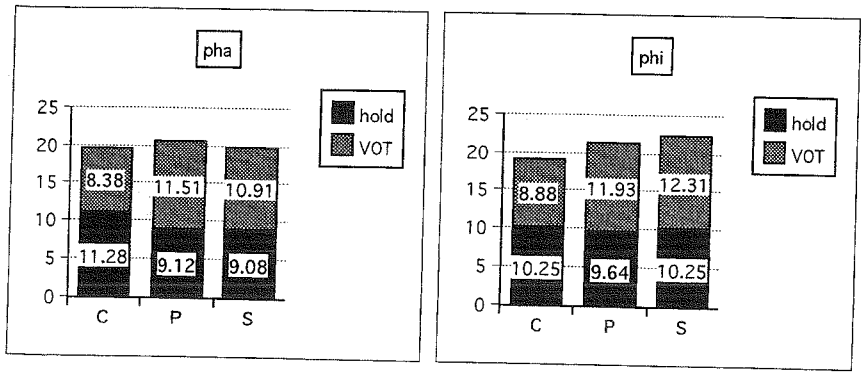

FIGURE 2 Mean durations of the unaspirated plosive for each dialect.

The following (Figure 3) summarises the observations made so far in terms of how the three dialects are distinguished from each other in their durations. The numbers in the brackets indicate by which parameter these dialects are distinguished. (1) denotes the case where "the VOT regularly becomes larger before a high vowel in the dialect", (2) indicates examples of "length of hold phase for the unaspirated plosive", and (3) denotes "a constant relationship between the hold phase and the VOT of the aspirated plosive". So, for instance, Cantonese and Shanghai dialects are distinguished in the sense that /ph/ in Shanghai dialect always has a longer VOT than a hold phase, whereas Cantonese /ph/ does not have a constant durational relationship.

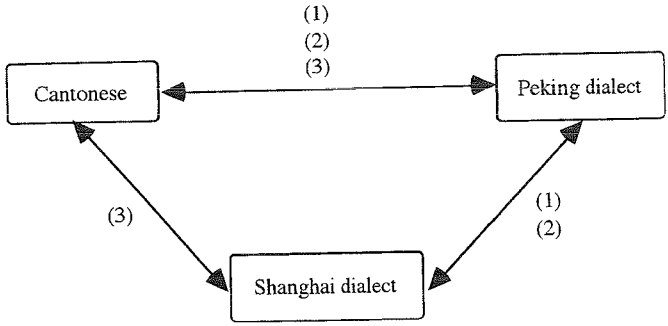

FIGURE 3 The model of the linguistic phonetic difference between dialects.

Peking dialect is possibly distinguished from the other two dialects in two aspects, although one of them is not statistically verified. The plosive in Peking dialect is regularly affected by the following vowel, whereas in Cantonese and Shanghai dialects it depends on individual speakers. This suggests that Peking dialect's configuration for the vowel /i/ is constantly narrow enough to cause the effect of the following vowel on the VOT. This is because the narrow path of the air flow from the configuration of the tongue position for the closed vowel /i/ makes the VOT longer, while the other two dialects reveal individual differences in terms of the realisation of the effect. This result also implies another difference between dialects; the degree of freedom in the articulatory position of the vowel. Peking dialect is homogeneous in terms of the realisation of the effect of the following vowel, whereas Cantonese and Shanghai dialects included speakers some of whom were influenced by the vowel and some of whom were not. This implies that /i/ in these two dialects can be articulated in a manner as closed as that of Peking dialect, or in a manner with a more open articulation; open enough not to affect the VOT. This observation constitutes another linguistic phonetic difference. Peking dialect seems also to possess a shorter hold phase for the unaspirated plosive than the other two dialects. Although statistics did not reveal significant differences between the dialects, it is suspected that this is attributable to large individual variances within the dialect.

The VOT of the aspirated plosives in Cantonese is not constantly longer than the hold phase, while the VOT in Peking and Shanghai dialects is regularly longer than the hold phase.

These results seem to demand a reassessment of the nature of linguistic phonetic differences. Linguistic phonetic difference is not only about the phonetic features found in one language and not in others. As observed above, the effect of the following vowel on VOT was found in all the dialects, and not only in Peking dialect. In Cantonese and Shanghai dialect, however, the effect of the following vowel was optional and was not found in all the speakers' data. Similarly, some Cantonese speakers had a longer VOT than hold phase just like the speakers of the Peking and Shanghai dialects, but this was not as consistent as it was in the other two dialects. Linguistic phonetic differences thus involve not only the differences between languages revealed in phonetic data, but also include how certain phonetic phenomena are realised in language.

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