ISSN 1799-2591
Theory and Practice in Language Studies, Vol. 13, No. 11, pp. 2910-2917, November 2023
DOI: https://doi.org/10.17507/tpls.1311.22

An Acoustic Study of the Stop Consonants in Lettered-Words Produced by Chinese Mandarin Speakers

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***Abstract*—This paper presents key findings from an acoustic study on Chinese Mandarin Speakers' realization of the stop consonants in lettered-words and the stop consonants in Chinese phrases. The research was conducted through voice recording and analysis of data collected from Chinese Mandarin speakers. Recordings of 2000 overall tokens were collected and analyzed using Praat phonetic software. The mean VOT values obtained from both lettered-words and Chinese phrases were compared and statistically tested using the Independent Samples t-test. The research findings show that first, the stop consonants in lettered-words produced by Chinese Mandarin speakers are all voiceless stop consonants, distinguished as being [+aspirated] and [-aspirated]. Second, the VOT values of [p] [t] [k] in lettered-words are significantly lower than their counterparts in Chinese phrases. Third, the stop consonants in lettered-words have the same stop pattern as those in Chinese phrases. The research presents proof that where there is phonemic similarity (but phonetic dissimilarity) across Chinese Mandarin and English, L1 phonetic properties are strong for Chinese Mandarin speakers to produce lettered-words in L1 environment, which further confirms former scholars' conviction of mother tongue interference in L2 learning. Similar phonemes in L1 and L2 are realized identically to L1 sounds, and there is significant interference from the speaker's native language on phonetic properties produced in L2. In addition, the research presents implication for future research that might explore other acoustic features of lettered-words in Chinese Mandarin.**

***Index Terms*—Voice Onset Time, stop consonants, lettered-word, Chinese Mandarin**

I. Introduction

Lettered-words are a new word unit in Chinese Mandarin. It is "a word composed of Latin alphabet or Greek alphabet or with marks, numbers, and Chinese characters mixed in" (Liu, 2002, pp. 85-89). In the past decades, lettered-words have been more and more popular in use in Mandarin context. In the academic community, the pronunciation of lettered-words has been a subject of much controversy, which focuses on whether to adopt Chinese Phonetic Alphabet system or English alphabet system in reading lettered-words in Mandarin context (Cao, 2000; Zhou, 2000; Wang, 2000; Jia, 2000; Liu, 2002; Shen, 2003). Social researches showed that Mandarin speakers prefer using English alphabet system in reading lettered-words (Li, 2002; Wang, 2008). It should be noted that these researches were carried out in large scale and were quite persuasive, but they all depended on listening comprehension in describing the pronunciation of lettered-words, and thus difficult to distinguish those similar sounds between Chinese and English, such as stops, fricatives, and some vowels and diphthongs. None of the studies scientifically analyzed the pronunciation of lettered-words so as to disclose their influence on the phonetic system of Mandarin.

Acoustic phonetic analysis is the most scientific and accurate way to study the acoustic features and further distinguish and describe speech sounds. Among all kinds of consonants, "stop consonants are the only kind which appear in every language in the world" (Henton et al., 1992, pp. 65-101). Thus acoustic phonetic analysis is adopted in this study to analyze the acoustic features of the stop consonants in Mandarin lettered-words. The classification of stop consonants differs in English and Chinese. "In English, the stop consonants appear in voiceless/voiced pairs like /p/ and /b/, /t/ and /d/, /k/ and /g/" (Roach, 2000, p. 30); whereas "in Chinese Mandarin the stop consonants appear in aspirated/unaspirated pairs like [p^h] and [p], [t^h] and [t], [k^h] and [k]" (Zhou, 2003, p. 41). As a new number of Chinese Mandarin, most lettered-words originated from English. Thus, the aims of the given research are as follows:

1. To identify the distinctive features of the stop consonants in the lettered-words produced by Chinese Mandarin speakers.
2. To provide a comparison of the VOT values of the stop consonants in the lettered-words and those in Chinese phrases produced by Chinese Mandarin speakers.
3. To provide a comparison of the stop consonant pattern of the lettered-words and that of Chinese phrases.

II. Literature Review

Opinions on the pronunciation of lettered-words have varied. Cao (2000, pp. 11-12) hold that "Chinese Mandarin phonetic system should be adopted in reading lettered-words since they have already been a part of modern Chinese

lexicon". Zhou, Wang and Jia each put forward one way to read lettered-words. Zhou (2000) suggested Beijing accent be used; Wang (2000) suggested mathematical chemistry teachers' accent be used; Jia (2000) suggested Chinese Phonetic Alphabet (or Chinese Pinyin) be used. Meanwhile many scholars believed the pronunciation of English letters should be adopted in reading lettered-words, instead of Chinese Phonetic Alphabet (Liu, 2002; Shen, 2003; Liu, 2002). Li's (2002, pp. 93-99) social research showed that:

> Chinese people tended to use the pronunciation of English letters even if some lettered-words originated from Chinese, like "HSK", the acronym of Chinese Phonetic Alphabet "Hanyu Shuiping Kaoshi", Chinese Proficiency test in meaning, was read as a sequence of English letters /eɪtʃ es keɪ/.

Wang's (2008) research on the distribution of lettered-words originated from Chinese Phonetic Alphabet showed that most members of Chinese community intentionally or unintentionally used the pronunciation of English letters to replace Chinese Phonetic Alphabet. All of the researches above on the pronunciation of lettered-words were based on listening of the researchers, which were subjective but not scientific enough.

Voice Onset Time or VOT is one of the critical features prevalent in the production of consonants. It is the "duration of the time between the release of a plosive and the beginning of vocal fold's vibration" (Bilá & Eddy, 2012, p. 49). There are three types of VOT: zero VOT (the plosive release and vibration happen together), positive VOT (the plosive is released and vocal folds start vibrating with a delay), and negative VOT (vocal folds start vibrating and then the plosive is released) (Urazbaev & Sukhrobbekov, 2021).

VOT is "an immediate parameter, which can be distinguished in terms of time between the discharge of the full oral constraint for producing the voice in a plosive manner and onset vibration s of the glottal" (Lisker & Abramson, 1964, pp. 384-422). In many languages, there are stops [b], [d], [g], which are voiced, and [p], [t], [k], which are voiceless. Moreover, one of the key indicators of voiceless and voiced stop consonants are their VOT values (Olson, 2017; Urazbaev & Sukhrobbekov, 2021).

As mentioned above, Lisker and Abramson (1964) were the pioneers in investigating the VOT of NSs of American English. After their contributions, many studies have been conducted regarding VOT of native speakers (NSs), bilingual speakers, and non-native speakers (NNSs) of various languages. (Klatt, 1975; Caruso & Burton, 1987; Kessinger & Blumstein, 1997; Macleod & Stoel-Grammon, 2005; Taechong & Ladefoged, 1999; Fowler et al., 2006) Further studies suggest that VOT plays a vital role in distinguishing individual talker differences (Allen et al., 2003; Allen & Miller, 2004; Urazbaev & Sukhrobbekov, 2021).

Meanwhile, many studies have been conducted in regarding VOT of stop consonants in Chinese Mandarin produced by Chinese NSs. Ren (1981) studied the VOT values of 2 Chinese NSs and established that the VOT values of the stop consonants [p^h], [p], [t^h], [t], [k^h], and [k] were as follows: 78.75, 4.16, 60.29, 4.21, 56.20, and 12.36 ms respectively. Qi and Zhang (1982) studied the VOT values of 13 Chinese NSs and found that the VOT values of the stop consonants were as follows: 98.1, 14.2, 106.3, 9.6, 94.3, and 22.8 ms respectively. Wu (1986) in his research found that the VOT values of the stop consonants were 85, 8, 104, 10, 89, and 15 ms respectively. In the study conducted by Shi and Liao (1986), the VOT values of the stop consonants were 94, 7, 100, 7, 103, and 18 ms respectively. Gao (2001) conducted a research on 6 Chinese NSs and found that their VOT values of the stop consonants were 79, 1, 76, 4, 88, and 18 ms respectively.

The studies above are not comparative studies and do not provide a comparative analysis of the mean VOT values of the stop consonants in lettered-words and those in common Chinese phrases. Nevertheless, the mean values found in the studies above are to be used as a baseline to compare the findings in this research.

Since lettered-words have been a member of Chinese Mandarin lexicon for decades and the views on their pronunciation have varied, this study aimed at conducting an instrumental comparative analysis of the stop consonants in lettered-words and those in common Chinese phrases produced by Chinese NSs.

III. Methodology

A. Participants of the Study

Convenience sampling was used in deciding the subjects of the study. Subjects were chosen among the graduate students and teachers in Tianjin University of Science and Technology. The total number of subjects was 10 (5 male and 5 female). The age range of subjects was 23 to 40.

B. Experimental Words

Since there was no letter in English beginning with the stop consonant [g], the VOT values in the production of the five stop consonants [p], [b], [t], [d], [k] in lettered-words were the object of the study. The experimental words used in this study were composed of two parts. Part 1 was 100 lettered-words, composed of 5 sets, with 20 lettered-words for each set. Each set had one of the five stop consonants above as the onset of the second or the third letter. Part 2 was 100 double-syllable Chinese phrases, each syllable in a consonant-vowel (C-V) syllabic structure. It is composed of 5 sets as well, with 20 phrases for each set. Each set of the phrases had one of the stop consonants [p^h], [p], [t^h], [t], and [k^h] in Chinese Mandarin as the onset of the second syllable.

The 10 study subjects were asked to pronounce each of the 200 words with a slight pause in between them, and, in total, 2000 tokens were analyzed in the research (See Appendix for experimental words).

C. Instruments

The voice recording and analyzing products used in the acoustic recording and processing are as follows.

The device used for the acoustic recording of the participants' voices was Sony Linear PCM Recorder PCM-D100. 44.1 kHz/ 16 bit was set on the recorder, and the output file was in "wav" format, which is compatible with Praat software.

Processing the recorded voices and measuring the VOT values and closure durations (or GAPs) were conducted using Praat software version 6.3.04 (Boersma & Weenink, 2023).

The numerical data obtained were further processed with IBM SPSS Version 22.0.

IV. Results and Discussion

A. VOT Values

In this section, the VOT values of the 5 stop consonants [p], [b], [t], [d], [k] in lettered-words and the 5 stop consonants [p^h], [p], [t^h], [t], [k^h] in Chinese phrases will be analyzed in 5 pairs as follows.

(a). VOT of [p] and [ph]

In the experimental lettered-words with the stop consonant [p], like "APC", "CPI", et al., the mean VOT value was 78 ms. In Chinese phrases with the stop consonant [ph], like "开辟" ("kai pi" in Chinese Phonetic Alphabet), "精辟" ("jing pi" in Chinese Phonetic Alphabet), et al., the mean VOT value was 98 ms. The standard deviation (SD) for lettered-words was 18.06 and 17.51 for Chinese phrases.

When the mean VOT values were statistically tested in SPSS for significance, it was found that the mean VOT of [p] in lettered-words was significantly lower (p = .000) than that of [ph] in Chinese phrases.

(b). VOT of [b] and [p]

In the production of lettered-words with the stop consonant [b], like "ABC", "BBS", et al, the mean VOT value was 13 ms (SD = 4.51). In Chinese phrases with the stop consonant [p], like "关闭" ("guan bi" in Chinese Phonetic Alphabet), "封闭" ("feng bi" in Chinese Phonetic Alphabet), et al., the mean VOT value was 12 ms (SD = 4.36).

An independent samples t-test was conducted to compare the mean VOT value for [b] in lettered-words and [p] in Chinese phrases. There was no significant difference (p = .287) between them.

(c). VOT of [t] and [t^h]

The mean VOT value for lettered-words with the stop consonant [t], like "IT", "ETC", et al. was 83 ms (SD = 15.09). The mean VOT value for Chinese phrases with the stop consonant [t^h], like "鼻涕" ("bi ti" in Chinese Phonetic Alphabet), "警惕" ("jing ti" in Chinese Phonetic Alphabet), et al. was 95 ms (SD = 21.41).

The results of an independent samples t-test indicated that the mean VOT value of [t] in lettered-words was significantly lower (p = .000) than that of [t^h] in Chinese phrases.

(d). VOT of [d] and [t]

In the pronunciation of lettered-words with the stop consonant [d], like "GDP", "VCD", et al., the mean VOT value was 18 ms (SD = 6.03). In Chinese phrases with the stop consonant [t], like "兄弟" ("xiong di" in Chinese Phonetic Alphabet), "子弟" ("zi di" in Chinese Phonetic Alphabet), et al., the mean VOT value was 16 ms (SD = 5.81).

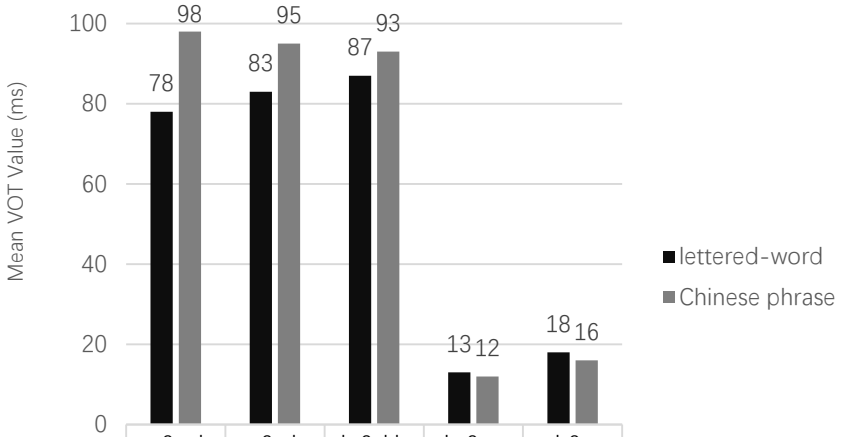
An independent samples t-test showed that the mean VOT of [d] in lettered-words was significantly higher than that of [t] in Chinese phrases (p= .008)

(e). VOT of [k] and [k^h]

In the [k] sound production, the mean VOT value in lettered-words, like "PK", "OK", et al., was 87 ms (SD = 17.95). In Chinese phrases, like "干枯" ("gan ku" in Chinese Phonetic Alphabet), "水库" ("shui ku" in Chinese Phonetic Alphabet), et al., the mean VOT value of the stop consonant [k^h] was 93 ms (SD = 17.36).

An independent samples t-test indicated that the mean VOT of [k] in lettered-words was significantly lower than that of [k^h] in Chinese phrases (p = .012).

According to the research results, the mean VOT values in the production of stop consonants [p], [t], [k] in lettered-words were significantly lower than their counterparts [p^h], [t^h], [k^h]in Chinese phrases, the mean VOT value of [d] in lettered-words were significantly higher than its counterpart [t] in Chinese phrases, and for the stop consonant [b], there was no significant difference between the mean VOT value of [b] in lettered-words and that of [p] in Chinese phrases (See Figure 1).



	p & ph	t & th	k & kh	b & p	d & t
lettered-word	78	83	87	13	18
Chinese phrase	98	95	93	12	16

Figure 1. Vot Values of Lettered-Words and Chinese Phrases

These findings above fulfilled the aims of this study. First, English stop consonants are classified as being [+voice] or [-voice], though "in word-initial position they only have a long voicing lag vs short voicing lag distinction" (Kent & Read, 2002, p. 141; Raphael et al., 2011, pp. 129-135). Whereas the stop consonants in Chinese Mandarin are all [-voice], or voiceless stops, and they are distinguished as being [+aspirated] or [-aspirated] (Luo & Wang, 2009). From the Praat analysis and Figure 1 above, it can be concluded that the stop consonants in the lettered-words produced by Chinese Mandarin speakers, though all in intervocalic positions, are all voiceless stops, and they are distinguished as being [+aspirated] or [-aspirated]. This finding, therefore, indicated that lettered-words, though most of which originate from English, are actually governed by the phonetic pattern of Chinese Mandarin, in which the stop consonants are all voiceless stops and are distinguished as being [+aspirated] or [-aspirated]. In other words, the acoustic analysis of the stop consonants in lettered-words confirms the Target Language's influence on the Source Language phonetic properties in Target Language context.

Second, data analysis showed that within the five groups of stop consonants, the VOT values of [p] [t] [k] in lettered-words were significantly lower than those of [p^h] [t^h] [k^h] in Chinese phrases. These significant differences in aspirated voiceless stops lie in the fact that the stop consonants in English and those in Chinese Mandarin have different distinctive features. Distinguished as being [+aspirated] or [-aspirated], stops in Chinese Mandarin have a larger range of VOT values, sine the degree of aspiration is closely related to the VOT value. In other words, the aspirated voiceless stops in Chinese phrases have a significantly higher degree of aspiration than those in lettered-words. As for the VOT values of [b] and [d] in lettered-words and [p] and [t] in Chinese phrases, the results only showed significant difference between [d] in letter-words and [t] in Chinese phrases. This result cannot confirm any significant differences between the voiced stops in lettered-words and unaspirated voiceless stops in Chinese phrases. Furthermore, both [b] and [d] sounds in lettered-words, though in intervocalic position, showed a voicing lag (ranging from 4 ms to 28 ms). Since the English stop consonants [b] [d] [g] in an inter-vocalic position are voiced (Ladefoged, 1982) and "show a voicing lead (within the range -19 ms to -143 ms)" (Docherty, 1992), finding in this study highlights a negative transfer of Chinese Mandarin phonetic system on the phonetic realization of the voiced stop consonants in lettered-words. Voiced stops in lettered-words are actually realized as unaspirated voiceless stops in Chinese Mandarin context.

Moreover, the VOT values of the stop consonants in the lettered-words and Chinese phrases got from this study are in line with those former studies on the stop consonants in Chinese Mandarin, as shown in Table 1.

The data in Table 1 show that when producing lettered-words, Chinese Mandarin speakers tend to use similar stop consonants in Chinese Mandarin to replace the original pronunciation of lettered-words so that the stop consonants in lettered-words keep the basic acoustic features of the stop consonants in Chinese Mandarin. In the five stop consonants in lettered-words, the two voiced stop consonants [b] and [d] are actually unaspirated voiceless stop consonants [p] and [t]. Both of them have a short voicing lag (that is, a short lag VOT), which means "the length of time between plosive release and the initiation of voicing is either relatively short (less than 30 ms) or the plosive is released simultaneously with the start of vocal fold vibration" (Kent & Read, 2002, p. 141; Borden et al., 1994; Shahidi & Aman, 2011). The three voiceless stop consonants [p] [t] [k] in lettered-words and their counterparts [p^h] [t^h] [k^h] in Chinese Mandarin are all stop consonants with a long voicing lag (that is, long lag VOT), which applies when "the length of the time between plosive release and voicing onset is relatively long (exceeding around 35ms)" (Kent & Read, 2002, p. 141; Shahidi & Aman, 2011).

TABLE 1
VOT VALUES OF CHINESE STOP CONSONANTS REPORTED

Authors	Stop Consonants and Reported VOT Values [p^h]	[p]	[t^h]	[t]	[k^h]	[k]	Subjects
Ren Hongmo (1981)	78.75	4.16	60.29	4.21	56.20	12.36	CHINESE NSS
Qin Shiyin & Zhang Jialu (1982)	98.1	14.2	106.3	9.6	94.3	22.8	Chinese NSs
Wu Zongji (1986)	85	8	104	10	89	15	Chinese NSs
Shi Feng & Liao Rongrong (1986)	94	7	100	7	103	18	Chinese NSs
Gao Meishu (2001)	79	1	76	4	88	18	Chinese NSs
Lettered-words (this research)	78	13	83	18	87	n/a	Chinese NSs
Chinese Mandarin (this research)	98	12	95	16	93	n/a	Chinese NSs

Overall, the acoustic findings of the research in terms of the realization of the stop consonants in lettered-words in Chinese Mandarin context are conformant with the studies carried out by Cao (2000), Zhou (2000,), Wang (2000), and Jia (2000), all of whom insisted that Chinese phonetic system should be adopted in reading lettered-words. Meanwhile, the findings rejects the claims put forward by Liu (2002), Shen (2003), Liu (2002), Li (2002), and Wang (2008), all of whom insisted that the original pronunciation of Latin letters, or English phonetic system, be adopted in reading lettered-words.

B. Stop Patterns

The patterning of language is an interconnected relationship. The sound pattern in the same language is relatively stable. In this way it mediates the mutual exchange of information between different speakers. Sound pattern comes about by the quantitative analysis, and the statistical graphical representation of the kinds of corresponding consistent relations in a system via phonetic experimentation. The two important acoustic features of stops are the GAP (closure duration) and VOT. Using VOT and GAP as coordinates, constructing a stop acoustic space is a simple and easy method (Shi et al., 2010). Table 2 shows the mean values of VOT and GAP of the stop consonants in this research. Figure 2 is the consonant pattern of stops in lettered-words and Figure 3 is the consonant pattern of stops in Chinese phrases.

TABLE 2
VOT VALUES AND GAP VALUES OF THE STOP CONSONANTS

Stop	[p]	[t]	[k]	[b]	[d]	[p^h]	[t^h]	[k^h]	[p]	[t]
VOT	78	83	87	13	18	98	95	93	12	16
GAP	56	42	40	94	55	27	15	25	36	25

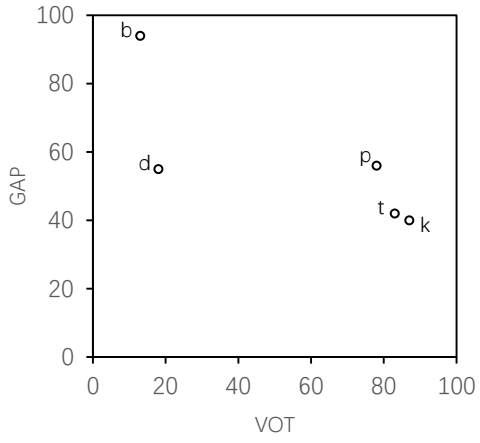


Figure 2. Stop Pattern Chart of Lettered-Words

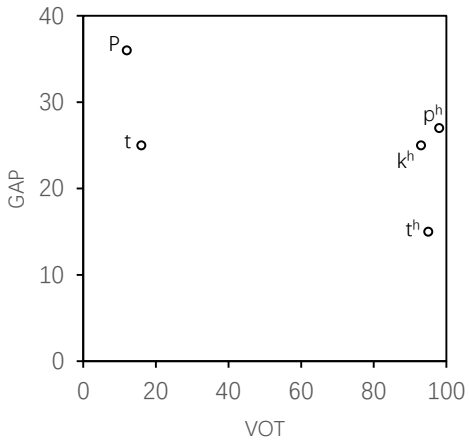


Figure 3. Stop Pattern Chart of Chinese Phrases

On the stop pattern chart, the ordinate axis expresses the features of stops themselves, mainly reflecting the degree of muscle tension and the characteristics of tensity/ laxity of pronunciation. The abscissa axis expresses the attributes of the manner of stop pronunciation. It relates to whether the plosive is voiced and the degree of aspiration. On the stop pattern chart, stops of the same category have aggregative properties, different stop categories can be easily distinguished and the characteristics of different stops can be also well manifested (Shi et al., 2010).

An obvious distinction between Figure 2 and Figure 3 is the range of ordinate axis. In Figure 2, the range of ordinate axis is 0-100 ms while in Figure 3 it is 0-40 ms, which is due to the research subjects' different closure durations in reading lettered-words and Chinese phrases. As L2 of English, Chinese Mandarin speakers have a higher degree of

muscle tension when pronouncing lettered-words, while they are quite relaxed when pronouncing Chinese phrases, which results in the different ranges of GAP in the experiment. In spite of the difference in closure durations, the stop distributions in the two charts are the same. The two unaspirated voiceless stops are aggregated into the upper left part, and the three aspirated voiceless stops are aggregated into the middle right part. The stop consonants in lettered-words have the same stop pattern as those in Chinese phrases, which further confirms the fact that Chinese Mandarin phonetic system is adopted to Chinese Mandarins' pronunciations of the stop consonants in lettered-words.

V. Conclusion

The aims of this research were to identify the distinctive features of the stop consonants in lettered-words and to provide a comparison of the VOT values, as well as the stop patterns, of the stop consonants in the lettered-words and those in Chinese phrases produced by Chinese Mandarin speakers. The research findings indicate that first, the stop consonants in lettered-words produced by Chinese Mandarin speakers are all voiceless stop consonants, distinguished as being [+aspirated] or [-aspirated]. Second, as the indicators of the degree of aspiration, the VOT values of [p] [t] [k] in lettered-words are significantly lower than their counterparts in Chinese Mandarin, which is due to the different distinctive features of the stop consonants in English, distinguished as being [+voice] or [-voice], and in Chinese Mandarin, distinguished as being [+aspirated] or [-aspirated]. Third, the stop consonants in lettered-words, though with much longer closure durations, have the same stop pattern as those in Chinese phrases.

The results show that the wide spread and application of lettered-words haven't brought voiced stop consonants into Chinese Mandarin, and that phonetic the system of stop consonants in Chinese Mandarin hasn't changed. The results reject former researches which claimed that lettered-words should be pronounced in standard English pronunciation, for most of them come from English, and the original pronunciation is to be adopted by Chinese Mandarin speakers along with the global communication (Li, 2002; Liu, 2002; Shen, 2003; Liu, 2002). It is demonstrated in this study that where there is phonemic similarity (but phonetic dissimilarity) across Chinese Mandarin and English, L1 phonetic properties are thus found to be strong for Chinese Mandarin speakers to produce lettered-words in the L1 environment, which further confirms Corder's (1994), Selinker's (1972), and Lado's (1957) conviction of mother-tongue interference in L2 learning. Similar phonemes in L1 and L2 are realized identically to L1 sounds. There is significant interference from the speaker's native language on phonetic properties produced in English.

The findings of the study will contribute to the body of knowledge on the instrumental study of lettered-word pronunciation by Chinese Mandarin speakers, which will serve as a basis for carrying out further studies on acoustic phonetic analysis of the affricates, nasal, and vowels in lettered-words.

Appendix. List of Experimental Words Used in the Study

Lettered-words

[p] APC BP 机 CPI GDP EPA GPS HPC VIP KPT LPG MP3 GNP PPA ERP SPF TPO UPS VP WPS XP

[b] ABC BBC CBA DB EBD FBI GB HB IBO KB LB MBA NBA PBX QBE RBC SBS TB USB UVB

[t] ATM 机 CCTV HDTV ETC FTA GTC HTTP IT JT 票 KTV LT MTV TNT OTC PT RTV ST TTL UT WTO

[d] ADSL CBD CDR IDD EDI FDA GDP HDTV IDC KDJ 指标 LD NMD NDF 合约 VOD PDA QDII SDR STD UDC VCD

[k] GBK 码 CKD NHK CJK MKSA 键 OK 键 PK HSK WSK TKS AQ BQ ICQ EQ HQ IQ LQ MQ QQ RQ

Chinese phrases

[p^h] 开辟 精辟 透辟 怪癖 孤僻 生僻 冷僻 砖坯 土坯 毛坯 一批 牛皮 地皮 粉皮 顽皮 调皮 橡皮 毛皮 去皮 脸皮

[p] 关闭 封闭 隐蔽 货币 作弊 包庇 礼毕 奴婢 复辟 躲避 左臂 右臂 硬币 银币 金币 纸币 枪毙 完璧 峭壁 密闭

[t^h] 鼻涕 代替 警惕 喷嚏 抽屉 笼屉 衰替 兴替 电梯 楼梯 阶梯 挑剔 马蹄 命题 出题 问题 审题 前提 猪蹄 切题

[t] 上帝 大地 皇帝 称帝 反帝 真谛 妙谛 二弟 小弟 胞弟 堂弟 表弟 妻弟 兄弟 子弟 科第 落第 门第 府第 宅第

[k^h] 清咖 奶咖 石窟 干枯 啼哭 水库 国库 仓库 短裤 棉裤 毛裤 残酷 冷酷 唠嗑 一棵 牙科 眼科 文科 理科 学科

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