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Articulatory Characteristics of the Coronal Consonants in Malaysian Mandarin: With Special Reference to the Non-"Canonical" Sibilants*

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ABSTRACT

This study is an articulatory investigation of the coronal consonants in Malaysian Mandarin, with special reference to the non-"canonical" realization of the sibilants. Our principal findings are: (i) *d* is *apico-laminal dentialveolo-alveolar* [t], (ii) *s* and *sh* are mostly *laminal alveolar* [s̻], and *z*, *zh* are the same as those of the corresponding fricatives, (iii) *x* has two phonetic variants: *laminal alveolar* [ɕ] ("canonical") and *laminal (denti-)alveolar* [ɕ̪] (non-"canonical", fronted), and (iv) *j*, as compared to *z* and *zh*, has a wider midsagittal contact, i.e., *apical dentialveolo-alveolar* [tɕ]. Another important new finding is that the two variants of *x* are contextually conditioned. Specifically, the high front vowel [i] and the palatal glide [j] often co-occur with the non-"canonical", fronted *x* (i.e., [ɕ̪]), while the "canonical" [ɕ] is found elsewhere. The phenomenon in question is attributable to language contact-induced sound change.

Key words: Malaysian Mandarin, coronal consonants, sibilants, palatography, linguography, language contact

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1. Introduction

This study is an articulatory investigation of the syllable-initial coronal consonants of Malaysian Mandarin (henceforth MM), with special reference to the non-"canonical"[1] realization of the sibilants before the high front vowel and the palatal glide. Like many other regional varieties of Mandarin Chinese, MM also contrasts three voiceless fricatives, represented as *s - sh - x* in the Pinyin Romanization system. Together with the aspirated affricates *c - ch - q* and non-aspirated affricates *z - zh - j*, these sibilants are formed at three distinct places of articulation, namely *dental, retroflex* and *palatal*, respectively (cf. Chao 1968; Duanmu 2000/2007; Karlgren 1915-1926; Ladefoged and Wu 1984; Lin 2007; among many others), as in (1). For ease of cross-dialectal comparison (see, e.g., Mohanan 1992), the Pinyin symbols are used to refer to the consonantal category (which may or may not differ in actual places of articulation).

(1) Three-way contrast of the sibilants in Malaysian Mandarin

Pinyin	*IPA*	*Examples*			*Place of articulation*
z, c, s	[ts], [ts^h], [s]	[tsa]	紮	'to tie up'	"Dental"
		[ts^{h}a]	擦	'to erase'	
		[sa]	撒	'to cast'	
zh, ch, sh	[tʂ], [tʂ^h], [ʂ]	[tʂa]	渣	'dregs'	"Retroflex"[2]
		[tʂ^{h}a]	插	'to insert'	
		[ʂa]	殺	'to kill'	
j, q, x	[tɕ], [tɕ^h], [ɕ]	[tɕa]	家	'home'	"Palatal"
		[tɕ^{h}a]	掐	'to strangle'	
		[ɕa]	蝦	'shrimp'	

[1] The term non-"canonical" here does not imply that these forms in Malaysian Mandarin are not "standard" and/or inferior to their counterparts in "Standard Chinese". It is meant to highlight the fact that the phenomenon in (2) is not attested in many other varieties of Mandarin Chinese (see also section 4.2).

[2] We follow the "convention" to transcribe the sibilant *sh* in Mandarin Chinese as [ʂ]. But see Lee and Zee (2003) for a dissenting view: *sh* is transcribed as an apical post-alveolar [ʃ̺]. Note also that [ɕ] ([tɕ], [tɕ^h]) is a non-standard IPA symbol. They are used in Ladefoged (1957), Ladefoged and Wu (1984) and Lee and Zee (2003) to represent the alveolo-palatal sibilants. See also section 4 for more discussion.

While there is extensive discussion on the acoustic and articulatory characteristics of the three-way contrast of the sibilant sounds in Mandarin Chinese, little is known about the articulatory properties of the sibilants (and more generally, the coronal sounds) in understudied varieties of Mandarin Chinese in Southeast Asia, where the Chinese immigrants (as well as their descendants) have had long-term language contact with non-Chinese speech communities (e.g., Chen 2014; Xu and Zhao 2011). To fill the gap, this paper aims to document the places of articulation in the MM coronal sounds using palatography and linguography.

In addition, of particular interest are some non-"canonical" contextual variants of the sibilants. Specifically, one of the most salient hallmarks of Malaysian Mandarin, so to speak, is that *x* may (optionally) undergo "fronting" when preceded by the high front vowel [i] and/or the palatal glide [j], resulting in variants of ("canonical") [ɕ] and (non-"canonical", fronted) [*s*]. Note that here we use an italicized [*s*] to represent the non-canonical, fronted *x* in (2a), simply for ease of understanding. The experimental results indicate that the non-canonical variant of *x* (i.e., [*s*] here) is better characterized as a fronted alveolo-palatal [ɕ̟], as will be discussed in §4.1. Interestingly enough, we see in (2b) that "palatal" affricates are more resistant to fronting, even though the sibilants *j, q, x* are supposed to be homorganic. Specifically, our impressionistic data (N=270) from ten speakers of MM (mean age=24.4) showed that [ɕ] is "replaced" by [*s*] more frequently when followed by [i] (62.2%) than by [a] (44.4%), and [t*s*] is rarely found across the board (3.3%). More discussion regarding this asymmetry will be given in §4.2.

(2) a. Fronted vs. non-fronted (canonical) "palatal" fricatives in Malaysian Mandarin

Pinyin	*Malaysian Mandarin*	*Remarks (see text)*
xi	[*s*i]	[ɕi] is infrequently found
xia	[ɕa]	[s^{j}a] is infrequently found

b. "Palatal" affricates not subject to fronting

ji/qi	[tɕi/tɕ^{h}i]	[tsi/ts^{h}i] are rarely found
jia/qia	[tɕa/tɕ^{h}a]	[ts^{j}a/ts^{hj}a] are rarely found

In fact, similar dialectal variation has already been reported in Chen's (1986) corpus study: a portion of the underlying palatal consonants (29.3% for [tɕ], 23.2% for [tɕ^{h}], 86.5% for [ɕ]) in Singaporean Mandarin (across ten speakers) are transcribed as their dental counterparts. Chen also notes that this palatal-to-dental "substitution" cannot be attributed to a fast speech effect, as it is found even in careful speech. To this end, this effort can also be regarded as a follow-up study of Chen (1986), investigating whether or not the sibilants in question undergo "fronting" in MM as well.

This paper is organized as follows. Section 2 introduces the methodology used, including a palatographic and linguographic experiment. Section 3 presents the articulatory characterization of the coronal sounds, followed by the discussion of their articulatory variations. Section 4 offers a comparison of the places of articulation for coronal sounds produced in Penang, Malaysia and in Beijing, China and argues that the contextual neutralization of the three-way contrast in MM may not be accidental. Also, it is worth noting that syllables like [*s*i] in (2) are not found in many other varieties of Mandarin Chinese. Some possible explanations for this phenomenon will be discussed. Finally, section 5 concludes this paper.

2. Method

2.1 Participants

Seven speakers (six males and one female) participated in this study. The data from three of them (two males and one female) were excluded from analysis due to a data quality issue.[3] Two of the remaining participants were in their 30s (M01, M02) and the other two (M03, M04) were in their 20s at the time of data collection. All participants were born and raised in Penang, Malaysia and have never left Penang for more than one year except for college. They all speak Penang Hokkien as their L1, and Malaysian Mandarin as their L2 and English or Malay as their L3 (see also section 4.2).[4] All the

[3] Some of our participants were very nervous during the experiments, resulting in obscured contact. They were not asked to be involved in the same task for research ethical reasons. Another problem was that female speakers in Penang were reluctant to take part in the experiments at night due to security reasons. So only the data from the male speakers are reported in this study.

[4] Note that there may be cross-dialectal differences in the varieties of Mandarin Chinese spoken in Malaysia. We leave this issue for further studies. It is also remarkable that unlike Johor and Melaka in southern

speakers had a set of healthy teeth and reported no speech and hearing problems.

2.2 Articulatory Experiments: Palatography and Linguography

2.2.1 Data Collection

This experiment aimed to investigate the places of articulation of the seven coronal consonants, including voiceless stop *d*, voiceless fricatives *s, sh, x*, voiceless affricates *z, zh, j*. The aspirated affricates and stops were not examined, since no systematic differences were found in the contact patterns between the unaspirated and aspirated sounds (see also Ladefoged and Wu 1984). Table 1 shows the test material in the frame of CV, where C = {t, s, ʂ, ɕ, ts, tʂ, tɕ} and V = {i, a, u}. The dentals [s, ts] and retroflexes [ʂ, tʂ] cannot co-occur with the high front vowel [i] and the palatal glide [j], but with the syllabic approximant [ɻ̩] (Lee and Zee 2003). The wordlist was also controlled for lexical tone by choosing Tone 1, a high level tone, or more precisely, an upstepped mid tone /33↑/ (see also Huang 2016 for more details), wherever possible.

Table 1: The test material for palatograms and linguograms

Target	Post-consonantal vocalic elements		
	a [a]	*i* [i]	*u* [u]
d [t]	[ta$^{33\uparrow}$] 瘩 'pimple'	[ti$^{33\uparrow}$] 低 'low'	[tu$^{33\uparrow}$] 督 'to supervise'
s [s]	[sa$^{33\uparrow}$] 撒 'to cast'	[sɻ̩$^{33\uparrow}$] 司 'to manage'	[su$^{33\uparrow}$] 稣 'Christ'
sh [ʂ]	[ʂa$^{33\uparrow}$] 殺 'to kill'	[ʂɻ̩$^{33\uparrow}$] 師 'teacher'	[ʂu$^{33\uparrow}$] 書 'book'
x [ɕ]	[ɕa$^{33\uparrow}$] 蝦 'shrimp'	[ɕi$^{33\uparrow}$] 西 'west'	[ɕu$^{33\uparrow}$][5] 休 'rest'
z [ts]	[tsa$^{33\uparrow}$] 紮 'to tie up'	[tsɻ̩$^{33\uparrow}$] 資 'source'	[tsu$^{33\uparrow}$] 租 'to rent'
zh [tʂ]	[tʂa$^{33\uparrow}$] 渣 'dregs'	[tʂɻ̩$^{33\uparrow}$] 知 'to know'	[tʂu$^{33\uparrow}$] 豬 'pig'
j [tɕ]	[tɕa$^{33\uparrow}$] 家 'home'	[tɕi$^{33\uparrow}$] 基 'foundation'	[tɕy$^{33\uparrow}$][6] 居 'to live'

(Tones are transcribed with Chao's tone letters, in which 5 represents the highest pitch and 1 the lowest.)

Peninsular Malaysia, non-Mandarin Sinitic languages are still widely spoken in Penang (and Kuala Lumpur), although nationwide, only Mandarin Chinese is allowed in school nowadays. A language background screening was carried out before the experiments to ensure if the participants' first language is Penang Hokkien, for example, questions such as whether or not they speak Penang Hokkien with their family and friends or which language they use to count money. In sum, it is not surprising that Penangites are "officially" exposed to Mandarin Chinese only after they enter primary school.

5 The "expected" form of 'rest' is [ɕou$^{33\uparrow}$], but forms like this undergo monophthongization in Malaysian Mandarin.

6 *[tɕu] is a gap due to the phonotactics of Mandarin Chinese.

2.2.2 Data Analysis

The direct method for palatography and linguography (Dart 1991; Ladefoged 1997, 2003) was adopted in this study.[7] For palatography, a liquid medium of one part charcoal powder to two parts olive oil was painted onto the tongue with a small brush. During the utterance of the target word, the black marking medium was transferred from the tongue to the palate. A mirror (the one that comes with a Polaroid dental camera (Polaroid MACRO 5)) was then inserted into the speaker's mouth at a 45° angle to the plane of the teeth. A photograph of the reflected image of the upper surface of the mouth was immediately taken using a CANON EOS M digital camera with an EF-M 22 mm STM lens. For linguography, the experimental procedure was reversed. The medium was applied on the upper articulators (the palate and the inner surface of the upper teeth), and transferred to the tongue during utterance. The speaker was asked to protrude the tongue for photographing. For each test word, two utterances were made for the palatogram and the linguogram, respectively. Therefore, it is not unlikely that the contact patterns of the upper articulator and lower articulator do not exactly match.

A dental-palate impression was made for each speaker in order to obtain his/her anatomical features for division of articulatory target regions (Figure 1). An alginate impression was taken to ascertain the shape of the upper articulator, and a plaster cast was then fabricated to create a permanent record of the palate and upper teeth. The contour line was drawn from the mid-point of the two frontal incisors to the palate, after the cast was cut in half (see also Anderson 2008; Ladefoged 1957).

The "place of articulation" includes not merely the precise target location on the upper articulator, but also the contact area on the lower articulator (Ladefoged and Maddieson 1996; Lee and Zee 2010). Descriptions of the contact patterns on the upper and lower articulators were extracted from palatograms and linguograms, respectively. Six articulatory zones are defined based on the individual anatomical features in the

[7] Palatography and linguagraphy are especially applicable to the field situation because of the following advantages: availability, portability and low cost in comparison with electronic devices such as Electropalatography (EPG), ultrasound, Electromagnetic Articulography (EMA) and real time MRI, and the information the techniques yield regarding both the tongue and the palate. Moreover, the data accuracy level has never been questioned in the literature (see Anderson 2008; Ladefoged 2003: 36-37 for more details).

sagittal plane (see also Catford 1977, 1988/2001; Jones 1972; Lee 1999a). As shown in Figure 1, the *dental zone* (1) begins at the apex of the front incisors and ends at the tip of the rim between incisor and gum at the mid-line. The *dentialveolar zone* (2) is the area between the end of zone 1 and the end of the frontal incisors. The *alveolar zone* (3) reaches back to the most prominent point on the alveolar ridge. The *postalveolar zone* (4) projects to the end of the alveolar ridge. The *prepalatal zone* (5) ranges from the end of zone 4 to the point at which the contour begins its downward slant. The *palatal zone* (6) proceeds to the end of the hard palate. Following Lee and Zee (2010) and subsequent work, a hyphen indicates contact involving more than one articulatory zone, which is meaningful in accounting for various characteristics of sounds. For example*, alveolar-postalveolar* refers to a contact extending from the alveolar zone to the postalveolar zone.

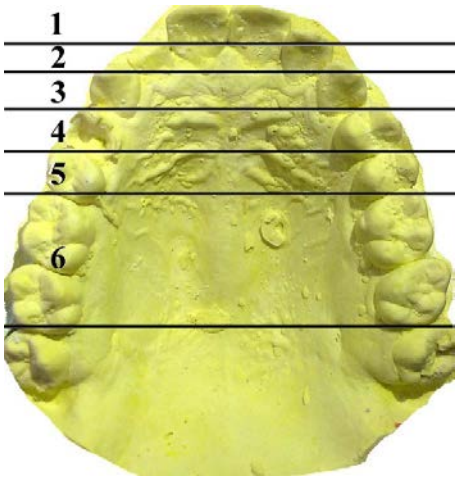


Figure 1: The articulatory zones of the upper articulator on a dental cast (Subject: M04)

To interpret the linguograms, the tongue can be roughly divided into four sections: rim, apex (tongue tip), lamina (tongue blade), and dorsum. Similar to Dart (1998), the present study divides the area of lingual contact into three: (i) *apical* where lingual contact is made on the very tip and/or rim of the tongue; (ii) *laminal* where the tongue blade is involved; (iii) *anterodorsal* where the tongue body is raised to cause a wider palatolingual contact. Once again, a hyphen is used when the lingual contact involves two parts of the articulator. For example, in Figure 2, *apicolaminal* (or *apical-laminal*) refers to an extended contact area covering both the apex and the blade.

apical apicolaminal laminal

Figure 2: The linguographic classifications

3. Results

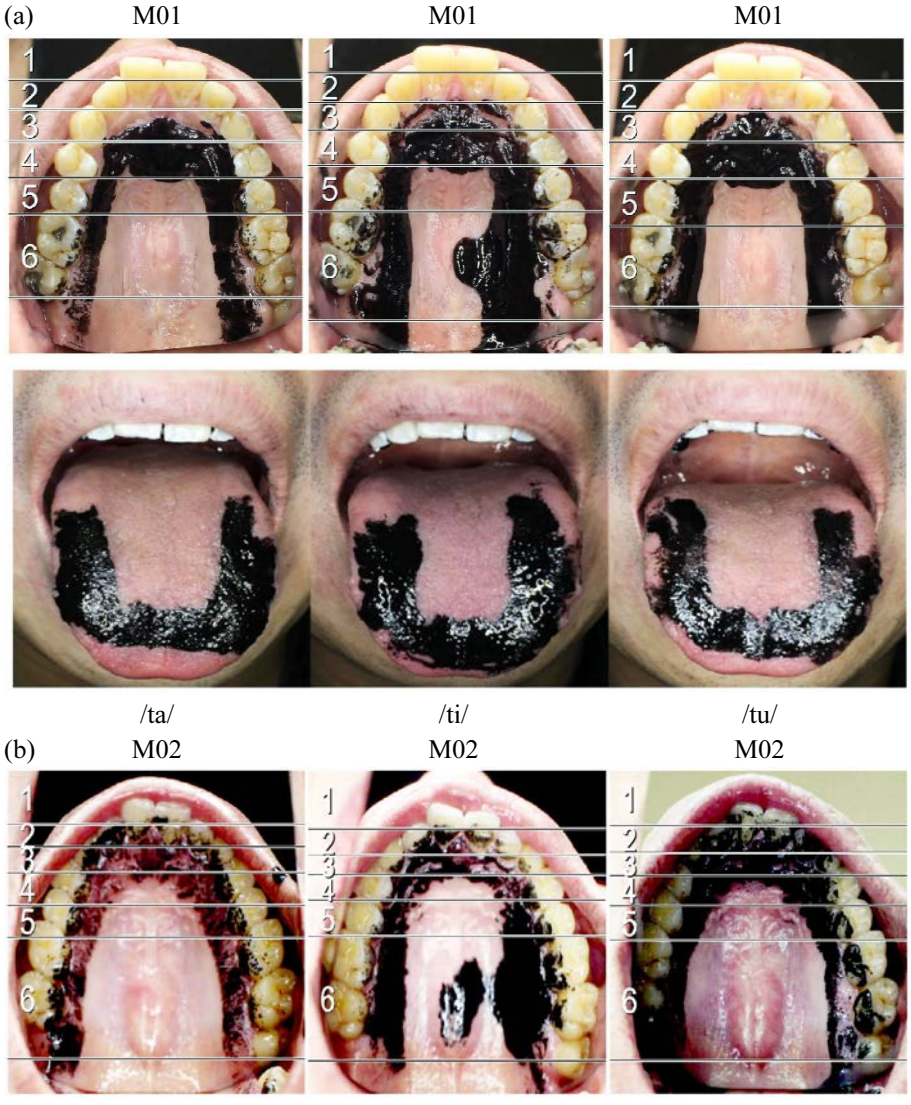
3.1 Linguopalatal Contacts

3.1.1 Stop *d*

Figure 3 demonstrates the palatograms and linguograms of the syllable-initial stop *d* for the test words [ta$^{33\uparrow}$] 'pimple', [ti$^{33\uparrow}$] 'low' and [tu$^{33\uparrow}$] 'to supervise' from the four participants. As shown in the palatograms, for all the speakers except M01, the contact on the palate involves two articulatory regions, i.e., *dentialveolar* and *alveolar* (zones 2-3). The constriction starts at the halfway of the upper frontal incisors, extending to the alveolar ridge. The contact patterns are similar across the three vowel contexts of [a, i, u]. For M03, the contact on the palate is broader in the context of [u], with a closure involving three areas: *dental*, *dentialveolar* and *alveolar* (zones 1-3). For M01, the foremost constriction point is farther back, behind the upper central incisors, extending to the rear part of the alveolar ridge (zones 3-4). Thus, we can characterize the coronal stop *d* of MM as primarily *dentialveolo-alveolar*.

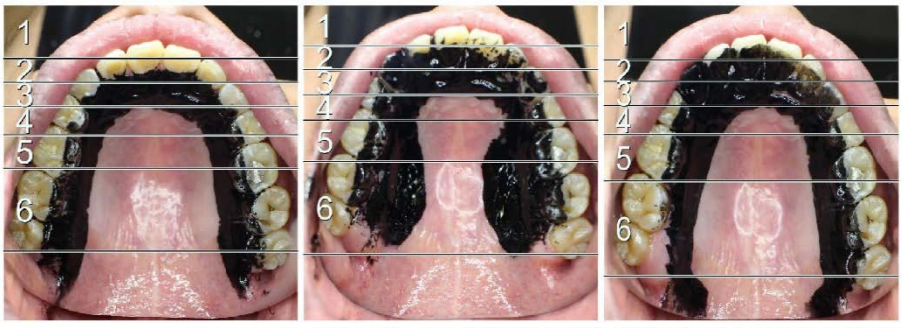
The linguograms of the syllable-initial stop *d* show similar broad contact patterns. The lingual contact is made mostly with the tip and the blade of the tongue, producing an extensive contact on the palate in at least two articulatory regions. In this case, *d* is *apico-laminal*. A few cases show individual differences. The contact is made chiefly on the blade during [t] of [ta$^{33\uparrow}$] and [tu$^{33\uparrow}$] for M01 (Figure 3(a)), and noticeably the contact

occurs further backward on the palate than it does for the other speakers. The lingual contact for M02 is slightly shorter, mainly on the upper surface of the tip. While the location of *d* in the midsagittal plane remains consistent across different vowels, the width of the lateral contact in the palatal region is noticeably increased in [ti], due to the raising of the tongue body. This is not unexpected, as (alveolo-)palatalization frequently occurs before high front vowels. In sum, the coronal stop *d* is best described as an *apico-laminal dentialveolo-alveolar* [t] for most of the cases.



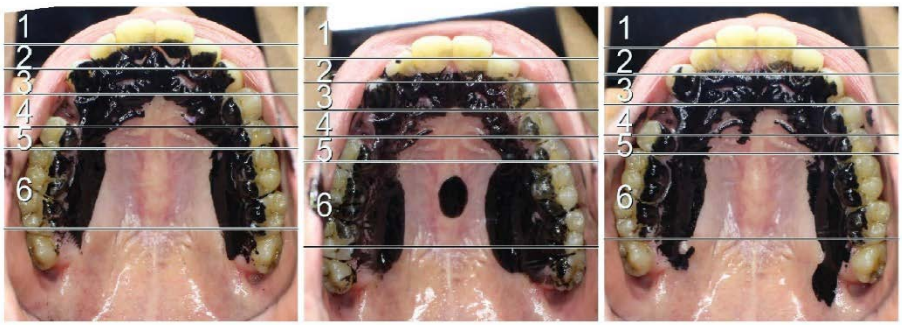
/ta/ /ti/ /tu/

(c) M03 M03 M03



/ta/ /ti/ /tu/

(d) M04 M04 M04



/ta/ /ti/ /tu/

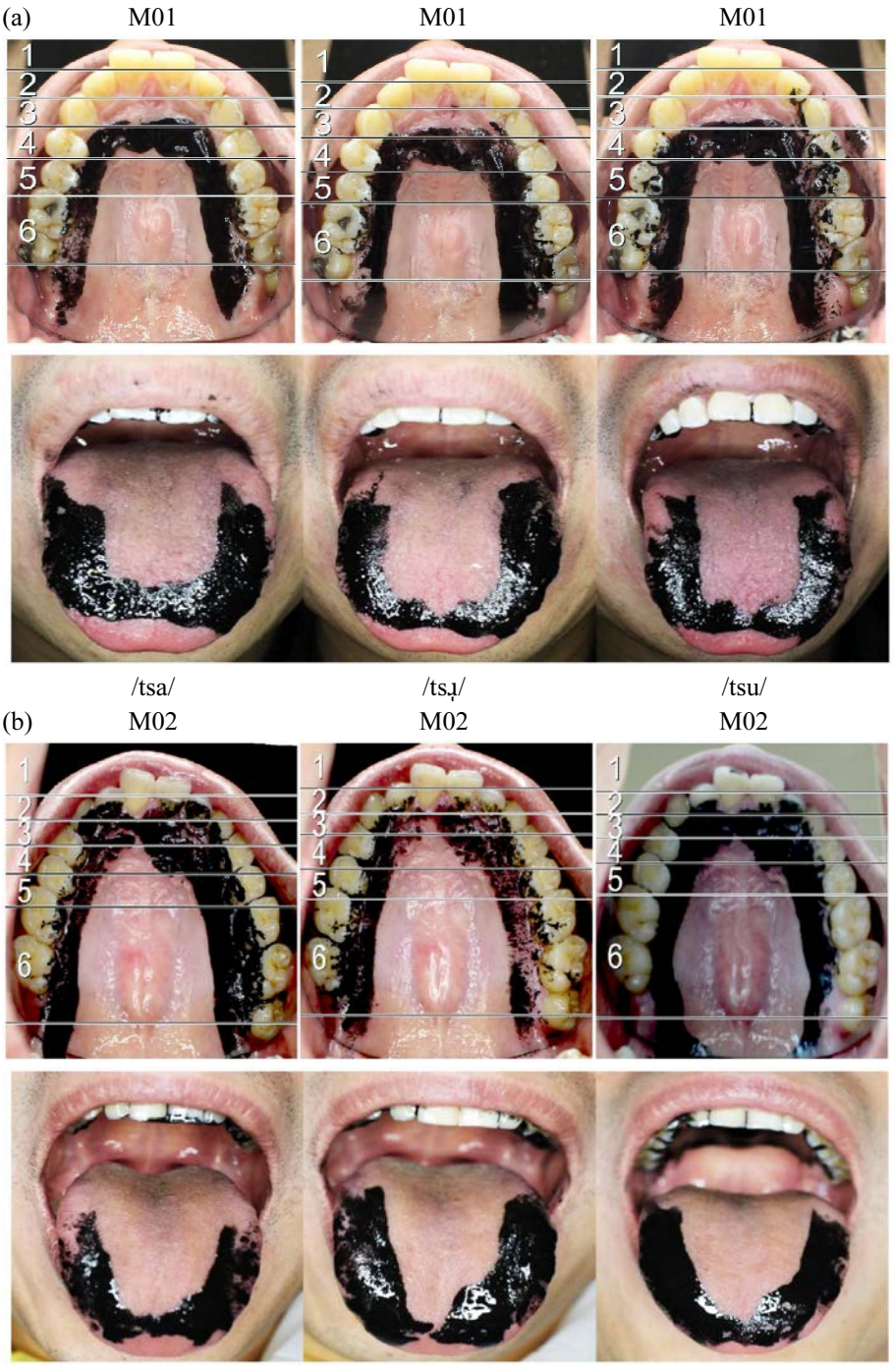
Figure 3: Palatograms (upper) and linguograms (lower) of the stop *d* of [ta$^{33\uparrow}$] 'pimple', [ti$^{33\uparrow}$] 'low', and [tu$^{33\uparrow}$] 'to supervise' across the four speakers

3.1.2 Affricates *z, zh, j*

Figures 4-6 illustrate the linguopalatal contact patterns for the affricates *z* [ts], *zh* [tʂ] and *j* [tɕ]. In Figure 4, the syllable-initial affricate *z* [ts] is shown in the vowel contexts of [a, ɻ, u], i.e., [tsa$^{33\uparrow}$] 'to tie up', [tsɻ$^{33\uparrow}$] 'source', and [tsu$^{33\uparrow}$] 'to rent'. The closure of [ts] occurs mainly at the front part of the alveolar ridge, i.e., it is *alveolar* (zone 3) (for all the speakers except M01). For M01, the contact is farther back, mainly in the *postalveolar* region (zone 4). In a few cases, the contact is extended forward to *dentialveolar* during [ts] of [tsɻ$^{33\uparrow}$] for M03, of [tsa$^{33\uparrow}$] for M04, and to *dental* during [ts] of [tsɻ$^{33\uparrow}$] for M04. The articulatory region of [ts] is affected little by the different vowels.

The linguograms for the most of the speakers show that [ts] involves only a single part of the tongue, i.e., the blade, making contact on the upper palate. This is consistent with the observation that [ts] has a shorter contact length[8] than [t]'s (38% versus 42%). There is only a single case ([ts] of [tsa$^{33\uparrow}$] for M03), where the lingual contact is *apicolaminal* and is therefore broader than that produced by the others. To summarize, the affricate *z* is characterized mainly as *laminal alveolar* [t̪s̪].

[8] One of the means quantifying "the length of central constriction" is to obtain the ratio of a central contact length (L1) over a baseline (L2). L1 represents the absolute contact measurement (in mm) in the sagittal plane; L2 indicates the length from the tip of the upper frontal incisors to the zone 5 line (cf. Lee and Zee 2010). The central contact length reported in this study is L% = L1/L2 * 100%.


(a)
M01
M01
M01
1
2
3
4
5
6
/tsa/
/tsɻ/
/tsu/
(b)
M02
M02
M02
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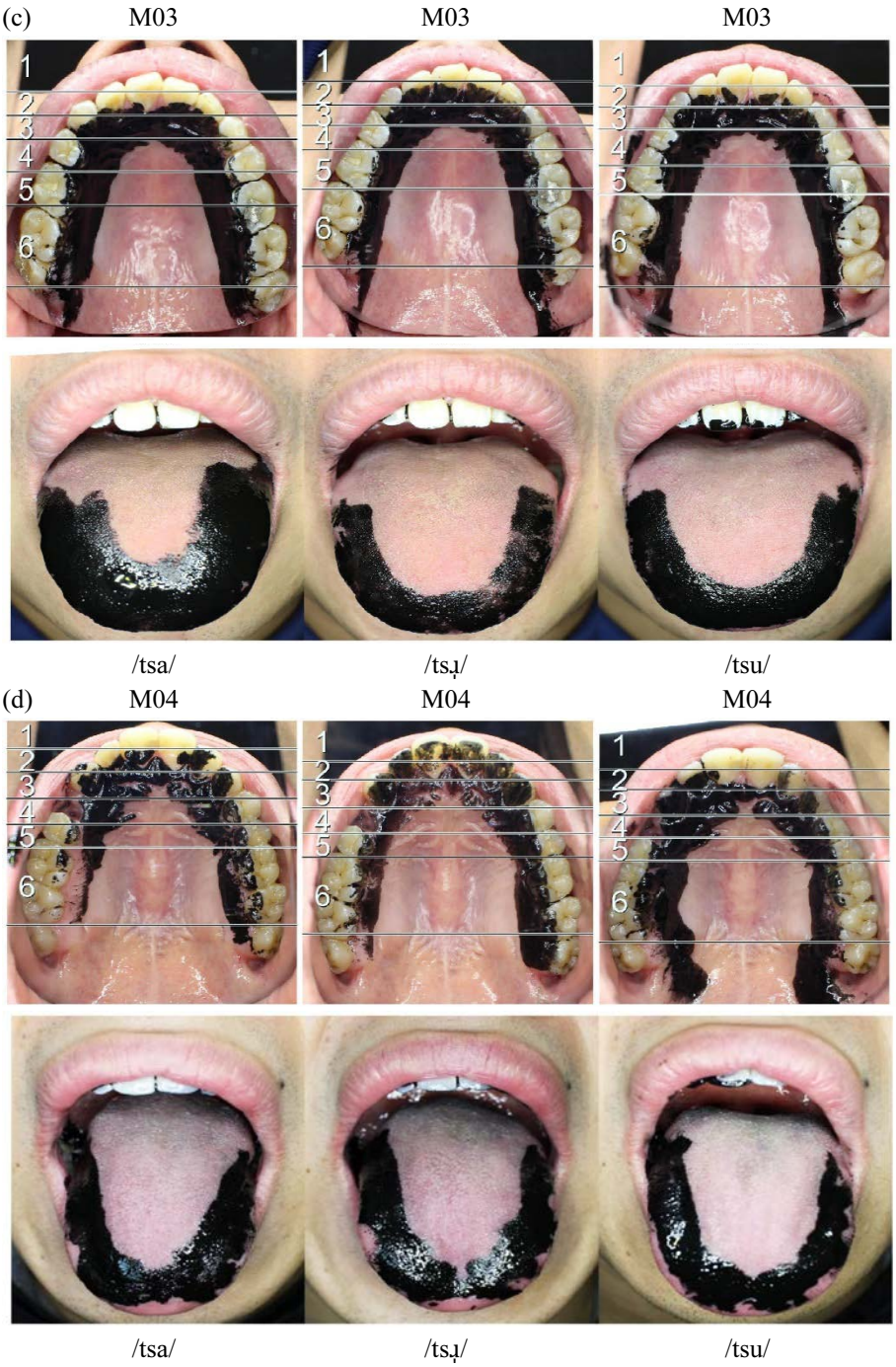
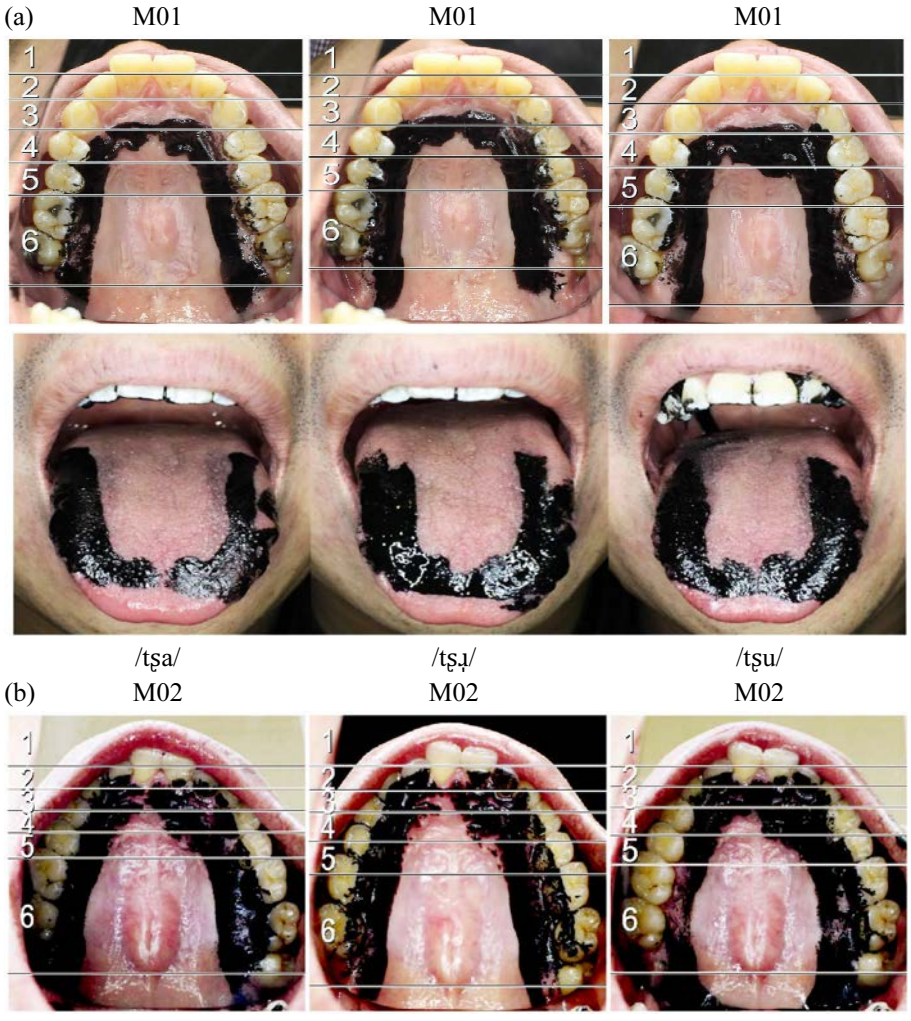


Figure 4: Palatograms (upper) and linguograms (lower) of MM affricates [ts] of [tsa$^{33\uparrow}$] 'to tie up', [tsɻ$^{33\uparrow}$] 'source', and [tsu$^{33\uparrow}$] 'to rent' across the four speakers

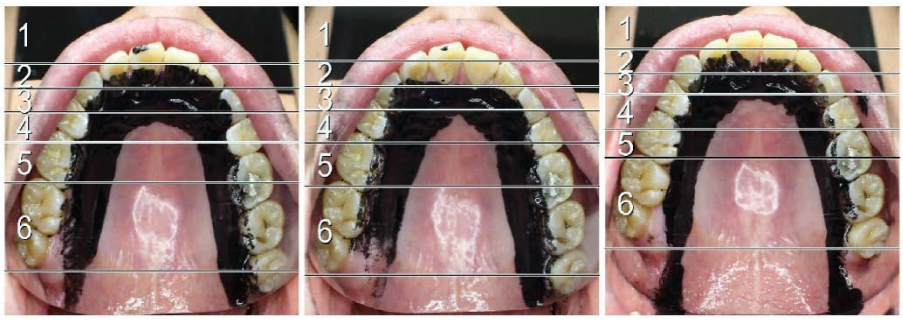
Figure 5 presents the linguopalatal contact patterns for *zh* [tʂ] for the test words [tʂa$^{33\uparrow}$] 'dregs', [tʂɻ$^{33\uparrow}$] 'to know', and [tʂu$^{33\uparrow}$] 'pig'. The palatograms show that (i) similar to [ts], [tʂ] is produced with a *postalveolar* articulation (zone 4) for M01, and an *alveolar* articulation (zone 3) for the other speakers; (ii) the central contact mainly occurs within a single region; and (iii) there is little coarticulation to affect the location of central contact. The obtained data reveal that M03 has an extended forward contact when producing *zh* before the vowel [a] (Figure 5(c)).

In the linguograms, [tʂ] is produced with the blade of the tongue. M03 differs from the other speakers in producing a broader contact on the lamina and/or the upper surface of the apex. In sum, the "retroflex" affricate *zh* is primarily a *laminal alveolar* articulation [tʂ̻].



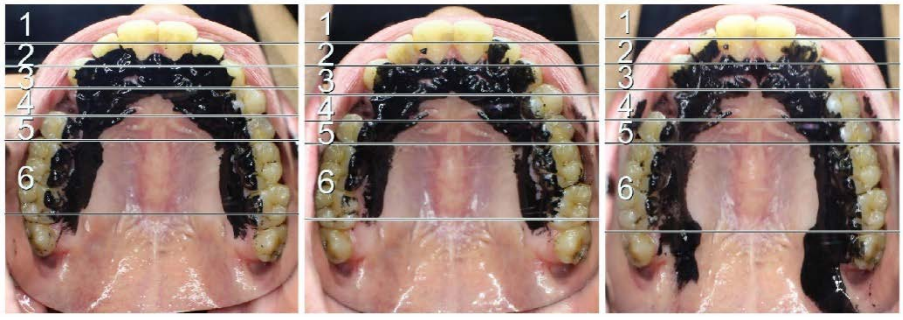
/tʂa/ /tʂɻ/ /tʂu/

(c) M03 M03 M03



/tʂa/ /tʂɻ/ /tʂu/

(d) M04 M04 M04



/tʂa/ /tʂɻ/ /tʂu/

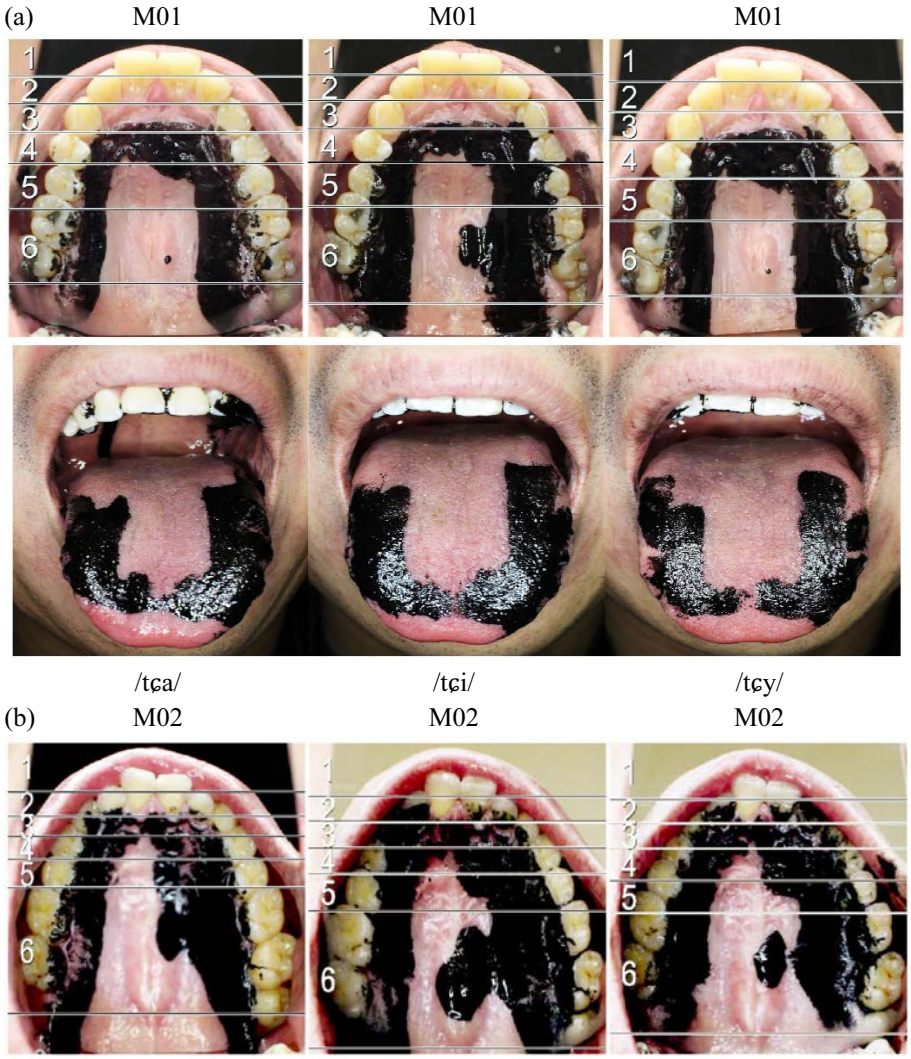
Figure 5: Palatograms (upper) and linguograms (lower) of the affricates [tʂ] of [tʂa$^{33\uparrow}$] 'dregs', [tʂɻ$^{33\uparrow}$] 'to know', and [tʂu$^{33\uparrow}$] 'pig' across the four speakers

Figure 6 presents the linguopalatal contact patterns for the syllable-initial *j* [tɕ] for the test words [tɕa$^{33\uparrow}$] 'home', [tɕi$^{33\uparrow}$] 'foundation', and [tɕy$^{33\uparrow}$] 'to live'. There is a discrepancy in contact patterns between the elder speakers (M01, M02) and the younger speakers (M03, M04). For the elder speakers, a closure of [tɕ] is formed in the *postalveolar* (zone 4) for M01 and in the *alveolar* region (zone 3) for M02. In the linguograms, [tɕ] for both of the speakers involves an articulation produced by the tongue blade. [tɕ] is different from [ts] and [tʂ] in two respects: (i) the contact is slight broader in the sagittal plane, and (ii) the lateral width behind the prepalatal zones is increased, indicating that [tɕ] undergoes a large degree of (alveolo-)palatalization.

On the other hand, the contact area is "more extensive" for the younger speakers (M03, M04). In the majority of the cases, the palatographic contact is extended form the *dentialveolar* region to the *alveolar* region (zones 2-3); the lingual contact is mainly on the upper surface of the apex. This observed contact pattern is true not only for the two younger speakers reported here, but also for the other two younger speakers (one male, one female; not included in this paper due to a data quality issue). There is a noticeable coarticulatory effect: the central contact is smaller (i.e., not extended forward) before [y] than [a] and [i]. The contact may span over three articulatory zones—*dental*, *dentialveolar*, *alveolar*, especially for [tɕ] of [tɕa] for M04. This conforms to Dart's (1991) observation that "upperapical" (i.e., the upper surface of the apex) articulation could involve more contact on the inner surface of the frontal incisors, producing an extended contact. Similarly, the width of the lateral contact in the palate region is broader

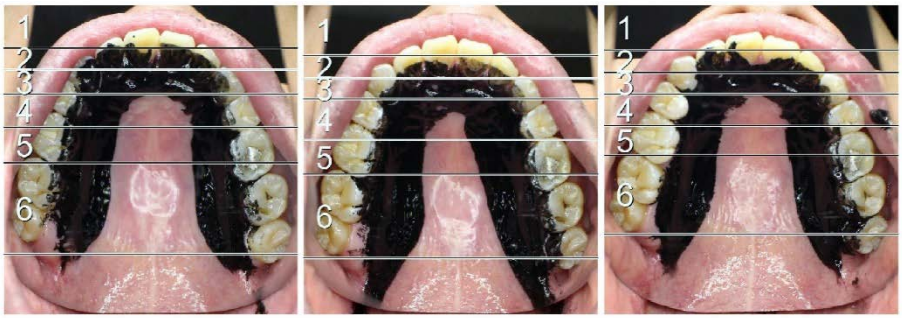
than those for [ts] and [tʂ] across the younger speakers, suggesting a large degree of (alveolo-) palatalization.

In sum, the MM affricate *j* is mainly characterized as *laminal alveolar* [tɕ̻] for the elder speakers (M01, M02), and *apical dentialveolo-alveolar* [tɕ̺] for the younger speakers (M03, M04).



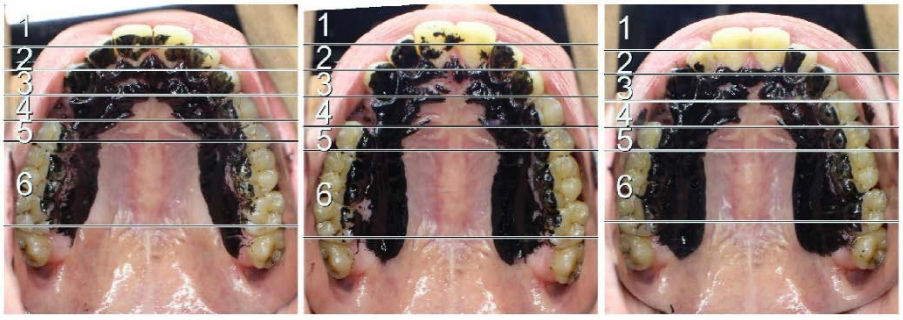
/tɕa/ /tɕi/ /tɕy/

(c) M03 M03 M03



/tɕa/ /tɕi/ /tɕy/

(d) M04 M04 M04



/tɕa/ /tɕi/ /tɕy/

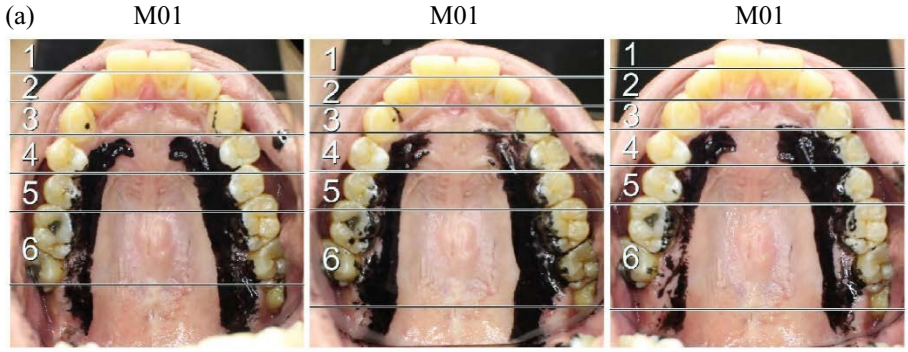
Figure 6: Palatograms (upper) and linguograms (lower) of the affricates [tɕ] of [tɕa$^{33\uparrow}$] 'home', [tɕi$^{33\uparrow}$] 'foundation', and [tɕy$^{33\uparrow}$] 'to live' across the four speakers

3.1.3 Fricatives *s, sh, x*

Figure 7 presents the linguopalatal contact patterns for the syllable-initial *s* [s] for the test words [sa$^{33\uparrow}$] 'to cast', [s̪ɻ$^{33\uparrow}$] 'to manage', and [su$^{33\uparrow}$] 'Christ'. In a majority of the cases (M02~M04), the maximal constriction point is at the front of the alveolar ridge (zone 3). In contrast, for M01, the foremost constriction point for [s] is at the back part of the alveolar ridge (zone 4), right beside the first premolars.

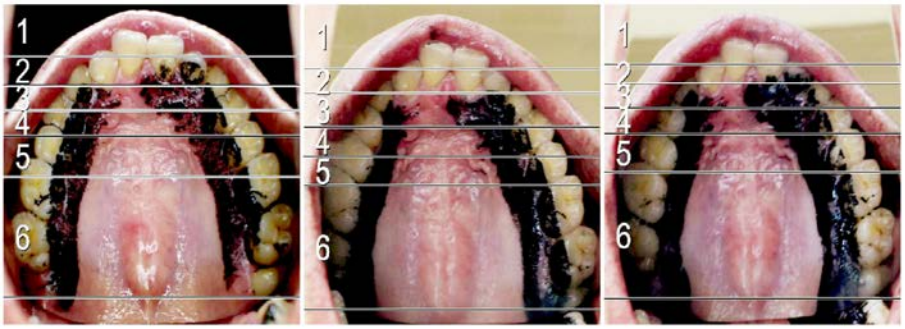
A comparison of the articulatory target regions reveals two principal findings: (i) [s] patterns with [ts], but not with [t]. Specifically, [s] is articulated in the same area as [ts], and both onsets have the contact mainly in a single region; (ii) there is no influence on the precise contact location from the various vowels.

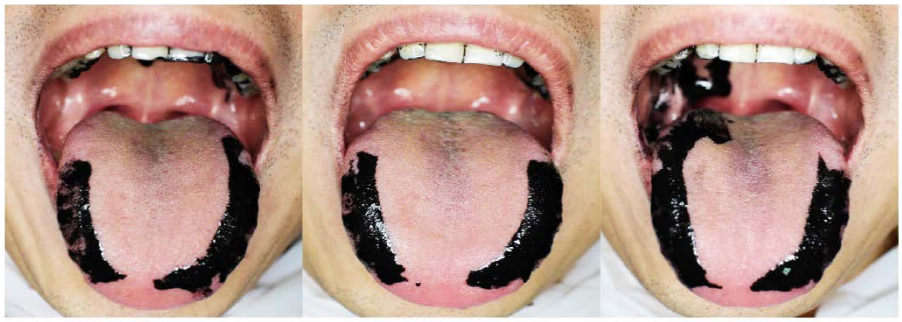
The corresponding linguograms indicate that the tongue blade is the major active articulator during the production of [s]. Accordingly, the MM fricative *s* in a majority of the cases is *laminal alveolar* [s̪].



/sa/ /s̩ɹ/ /su/

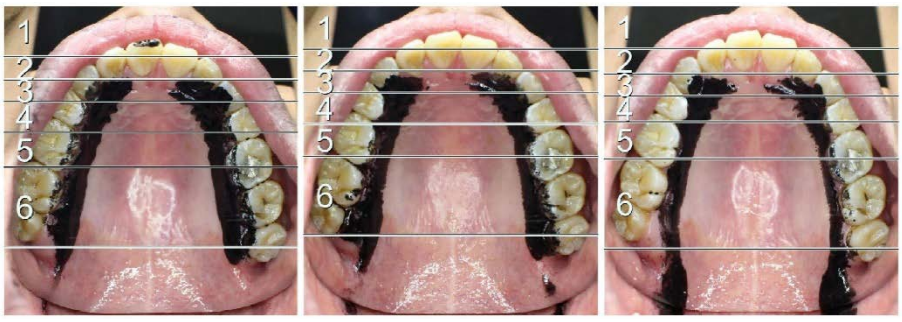
(b) M02 M02 M02





/sa/ /s̩ɹ/ /su/

(c) M03 M03 M03



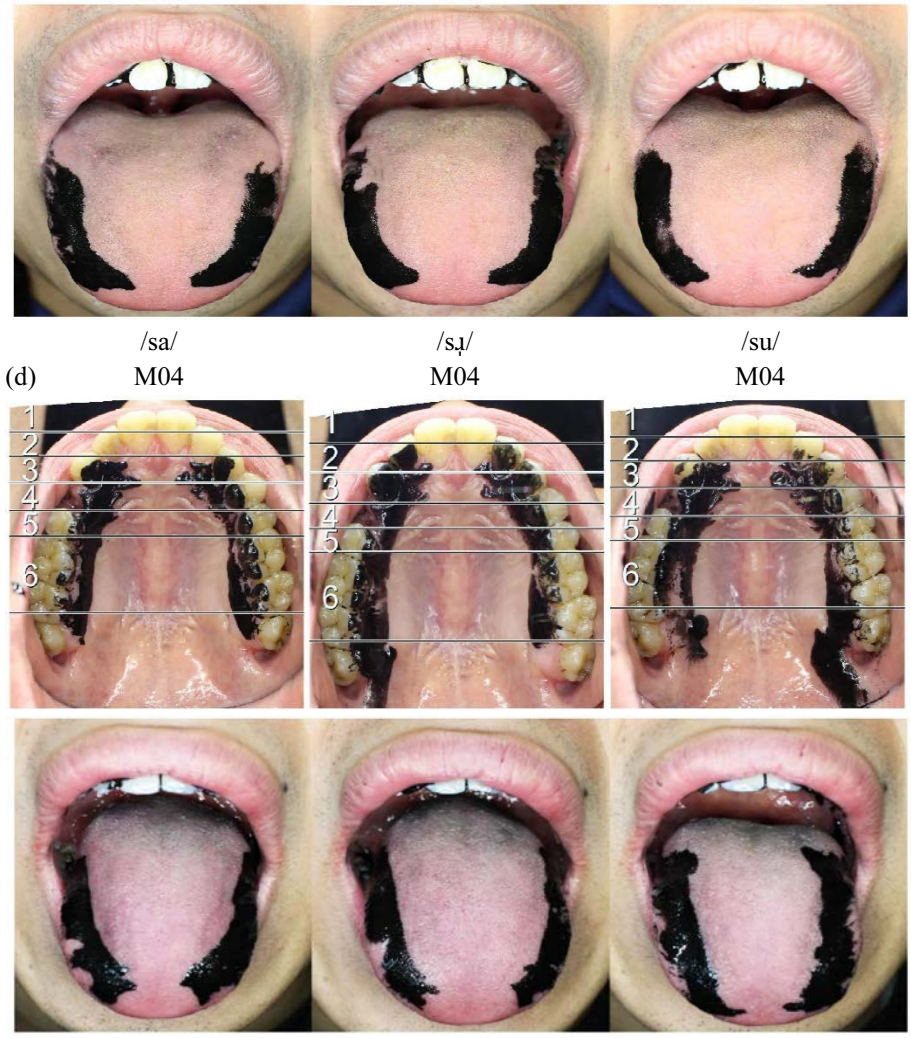
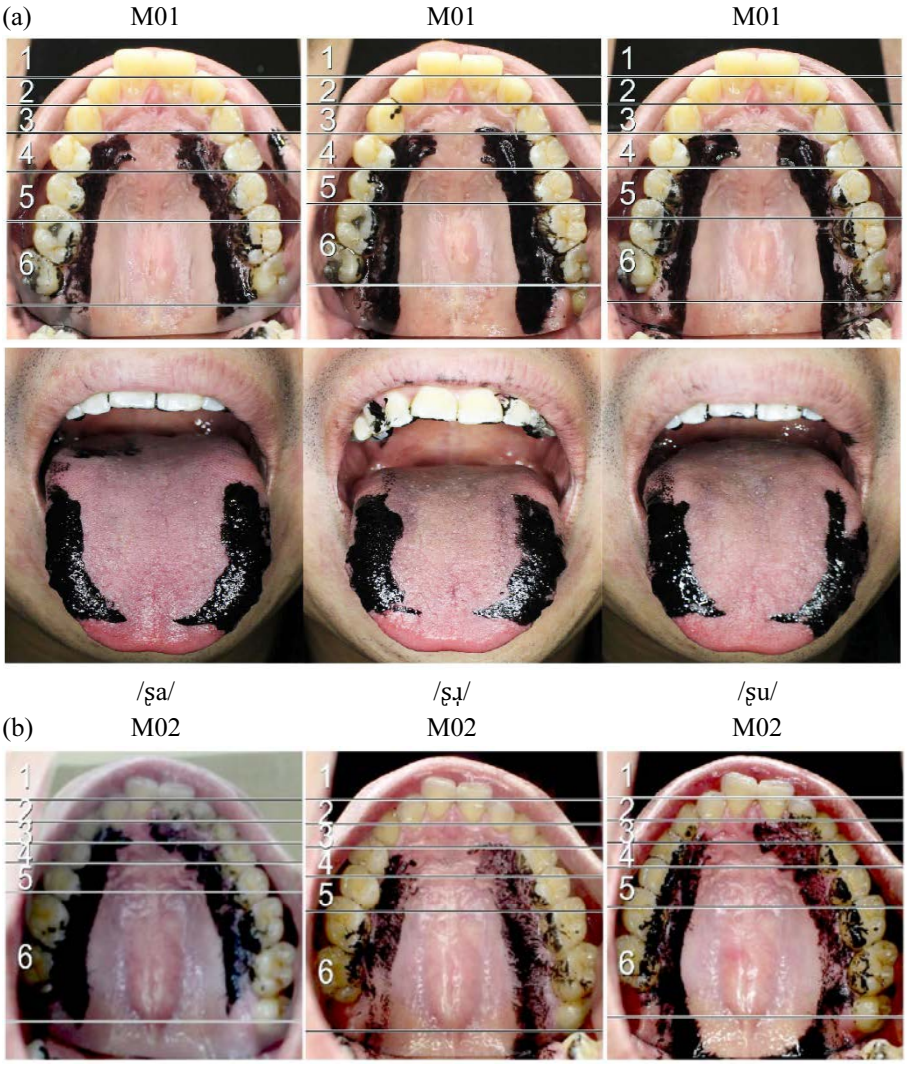


Figure 7: Palatograms (upper) and linguograms (lower) of the fricative [s] of [sa$^{33\uparrow}$] 'to cast', [sɻ$^{33\uparrow}$] 'to manage', and [su$^{33\uparrow}$] 'Christ' across the four speakers

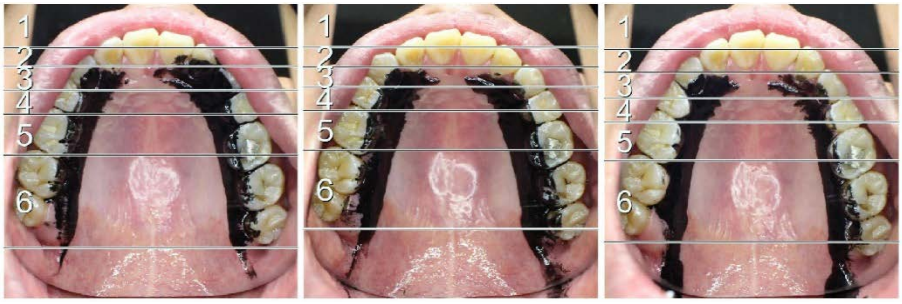
Figure 8 demonstrates the linguopalatal contact patterns for the syllable-initial *sh* [ʂ] for the test words [ʂa$^{33\uparrow}$] 'to kill', [ʂɻ$^{33\uparrow}$] 'teacher', and [ʂu$^{33\uparrow}$] 'book'. Like the articulation of [s], the maximal constriction of [ʂ] occurs primarily in the *postalveolar* region (zone 4) (M01) or the *alveolar* region (zone 3) (the other three speakers). There is a noticeable variation in the production of [ʂ] among speakers: in a single case (M02), [ʂ] has a posterior contact when followed by the vocalic segment [ɻ]. In the linguograms, [ʂ]

shows a laminal articulation. For M03, the contact on the lamina is much more significant in the context of [ɻ̩] than [a, u]. The wider contact implies that the tongue root is advanced during production of the "retroflex" *sh*, making the tongue front "bunched up lengthwise" (Ladefoged and Wu 1984: 271). Taking the data together, the fricative *sh* has a *laminal alveolar* articulation.



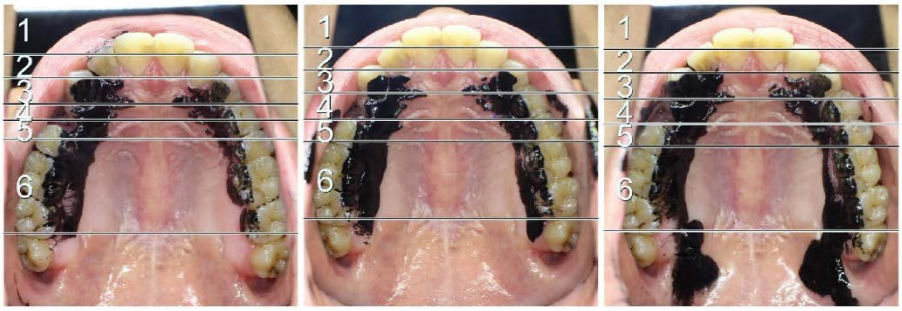
/ʂa/ /ʂɻ/ /ʂu/

(c) M03 M03 M03



/ʂa/ /ʂɻ/ /ʂu/

(d) M04 M04 M04

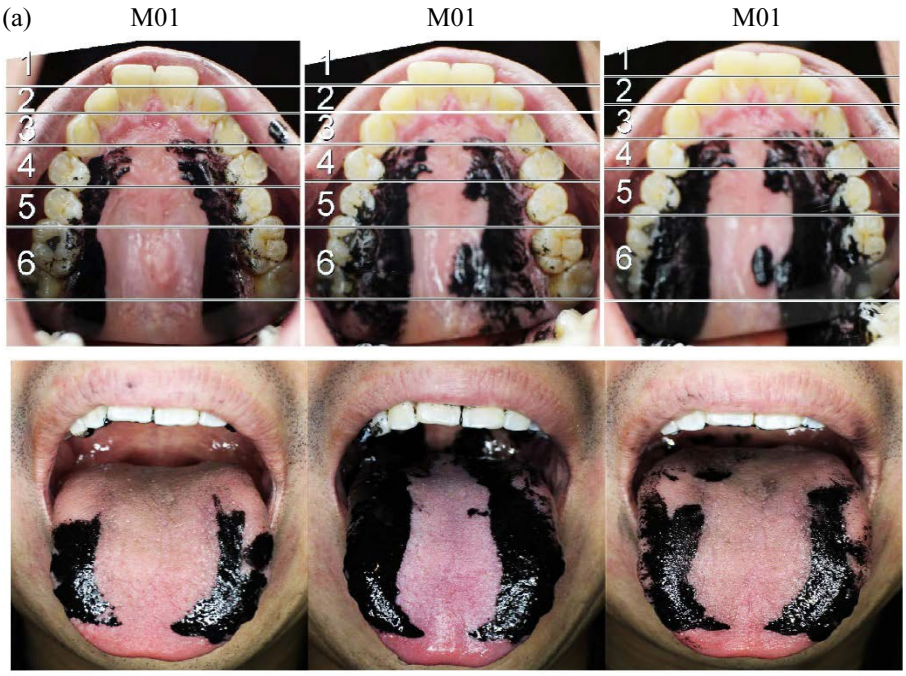


/ʂa/ /ʂɻ̩/ /ʂu/

Figure 8: Palatograms (upper) and linguograms (lower) of MM fricative [ʂ] of [ʂa$^{33\uparrow}$] 'to kill', [ʂɻ̩$^{33\uparrow}$] 'teacher', and [ʂu$^{33\uparrow}$] 'book' across the four speakers

Figure 9 demonstrates the linguopalatal contact patterns for the syllable-initial *x* [ɕ] for the test words [ɕa$^{33\uparrow}$] 'shrimp', [ɕi$^{33\uparrow}$] 'west', and [ɕu$^{33\uparrow}$] 'rest'. The contact for [ɕ] is primarily made in the *alveolar* regions (zone 3), but slightly backward in the *postalveolar* region (zone 4) for M01. The lingual contact for [ɕ] is *laminal*; as compared to [s], the lateral contact in the palatal region is much wider. Therefore, *x* is characterized chiefly as *laminal alveolar* [ɕ].

However, with careful examination, we noticed that [ɕ] displays much more variation in its contact pattern between the generations and across the vowel contexts. For the "elder" speakers in their 30s (M01, M02), the foremost contact point falls in the alveolar region (zone 3), with a stretch that is absent in [s] extending to the palatal zone (zone 5). In contrast, for the "younger" speakers in their 20s (M03, M04), there is no such contact extension. Note also that the contact point is pulled forward to the *dentialveolar* zone (zone 2) when [ɕ] is followed by [i], and in the *alveolar* zone (zone 3) when followed by [u]. For the "younger" speakers (M03, M04), *x* is not a "canonical" [ɕ]; perceptually and articulatorily, *x* is more "anterior", and may be characterized as *laminal (denti-)alveolar* [ʆ] (see more discussion in §3.2).


(a)
M01
M01
M01
1
2
3
4
5
6
/ɕa/
/ɕi/
/ɕu/
(b)
M02
M02
M02
/ɕa/
/ɕi/
/ɕu/

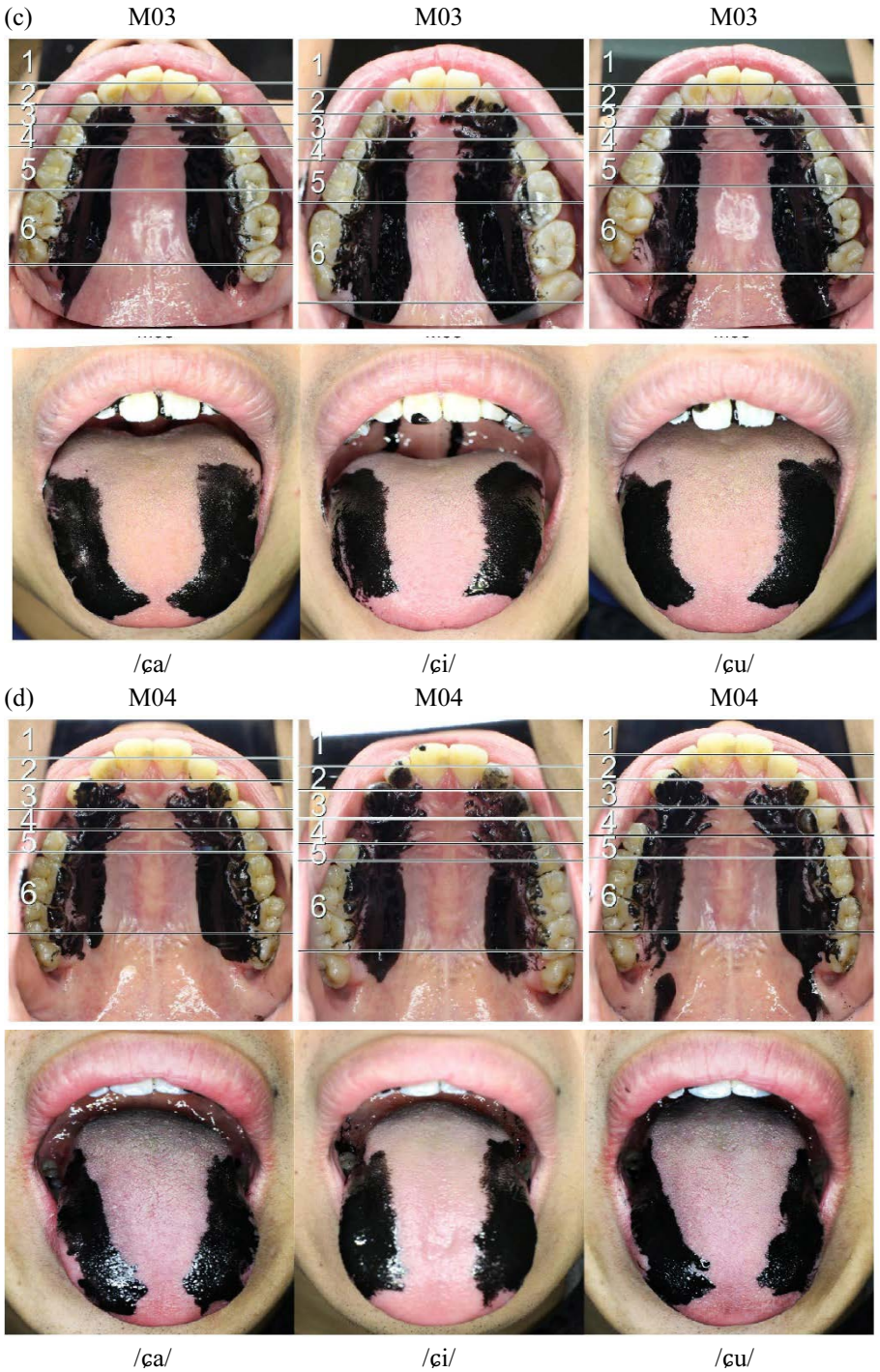


Figure 9: Palatograms (upper) and linguograms (lower) of the fricative [ɕ] of [ɕa$^{33\uparrow}$] ‘shrimp’, [ɕi$^{33\uparrow}$] ‘west’, and [ɕu$^{33\uparrow}$] ‘rest’ across the four speakers

3.2 Articulatory Characteristics of the Sibilant *x*

Let us now turn to the surface variants of the sibilant *x*. Recall from (2) that when preceding the high front vowel [i] and/or the palatal glide [j], this "palatal" fricative may be optionally "fronted", resulting in a more anterior sound (see (2)).[9] As shown in the previous section, the variability of *x* is significant, i.e., fronted [ɕ̟] versus non-fronted, canonical [ɕ]. In this sense, the present study replicates Chen's (1986) results: we found that (some of) our Malaysian Mandarin speakers do not consistently pronounce *x* as [ɕ] in certain environments (e.g., before [i, j]). To fully understand the characteristics of the fronted [ɕ̟], an articulatory analysis of the two variants is presented in this section.

Figure 10 shows a comparison of the linguopalatal contact patterns of *s* and *x*, where *s* is followed by the approximant [ɹ̟] and *x* is followed by the high front vowel [i]. We noted an apparent age effect on the place of articulation of *x*. For the "younger" speakers in their 20s (M03, M04), the predominant contact of *s* and *x* both occurred in the *alveolar* zone (or even slightly forward of there) (Figures 10(a)-(b)). Linguographically, *s* and *x* both involve the blade of tongue. The lateral contact of *x* is wider than that of *s*, probably because *x* must be followed by a high front vowel or palatal glide, both of which necessitate the raising of the tongue body. In contrast, for the "elder" speakers in their 30s (M01, M02), the principal contact made during the production of *x* was broader. For illustration, M02's *x* displays a contact in the *alveolar* zone, extending to the *postalveolar* zone (Figure 10(c)). Linguographically, the lateral contact produced in the palatal zone by the "elder" speakers is much wider (i.e., with a remarkable contact in the palatal zone) than that produced by the "younger" speakers. Therefore, we may conclude from the present experimental results that *x* is a canonical [ɕ] for the elder speakers (M01 and M02), whereas it is a fronted [ɕ̟] for the younger speakers (M03 and M04).

[9] Recall from (2) that the "palatal" affricates are rarely fronted (cf. Chen 1986). See section 4.2 for more discussion.

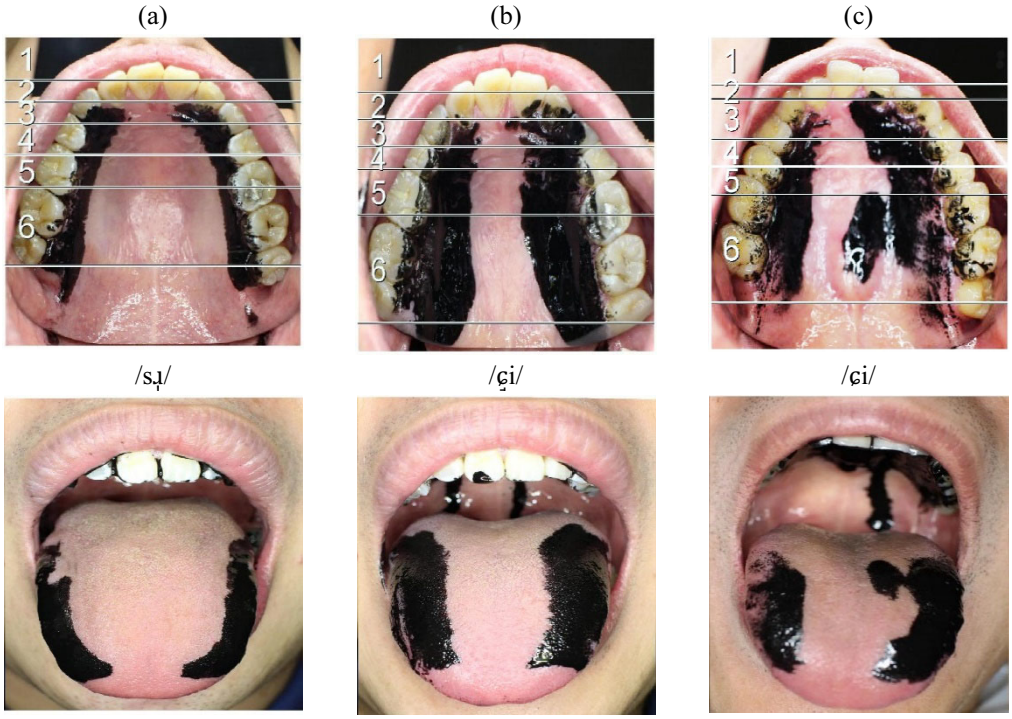


Figure 10: The articulatory contact patterns for [s], [ɕ̻] and [ɕ][10]

To recapitulate, [ɕ] is distinct from [s] in three respects: (i) the foremost contact in front-back dimension is broader; the foremost contact extends to the palatal region for the "elder" speakers, but not for the "younger" speakers; (ii) the front part of the dorsum may be raised to a variable height, causing different degrees of (alveolo-)palatalization; the increased width of lateral contact on sides of the palatal region is much more significant for the "elder" speakers than for the "younger" speakers; (iii) a noticeable coarticulatory effect is observed among the "younger" speakers; the constriction point is anterior before [i], and posterior before [u]; (iv) *x* is *laminal alveolar* [ɕ] for the "elder" speakers, and *laminal (denti-)alveolar* [ɕ̻] for the "younger" speakers.

All in all, it appears that the three-way contrast among the sibilants is undergoing reduction in Malaysian Mandarin. For the "dental" versus "retroflex" contrast, no difference was observed in the contact on the palate and on the tongue. For the "dental" versus "palatal" contrast, we observed a generational discrepancy. Specifically, the speakers in the 30s (M01 and M02) tend to produce an alveolo-palatal variant of *x*, while

[10] The representative examples are taken from (a) [sɻ] 'to think' produced by M03 (the younger speaker), (b) [ɕ̻i] 'west' by M03 (the younger speaker), and (c) [ɕi] 'west' by M02 (the elder speaker).

the speakers in their 20s (M03 and M04) tend to produce a more fronted, "non-palatal" version. Note that the conclusion reported here is primarily drawn from the male speakers. Some articulatory and acoustic difference may be found across gender. We leave this issue in the future study.

3.3 Summary

Table 2 summarizes the articulatory characterization of the coronal sounds in the variety of Malaysian Mandarin spoken in Penang. As has been reported in many other studies, we too found interspeaker variation in the articulation of these sounds. However, some generalizations can be drawn across the four speakers. More specifically, the stop *d* has the largest contact, made by the apex and blade of tongue (i.e., *apicolaminal*). For the coronal fricatives and affricates, we found that *s*, *z* are not substantially different from *sh*, *zh* with respect to the contact on the upper palate and the tongue. For the "palatal" sounds, we found some variations in *x* and *j*. For the "elder" speakers in their 30s, *j* is a *laminal alveolar* articulation, and it is *apical dentialveolo-alveolar* for the "younger" speakers in their 20s. *x* also displays larger articulatory variation across speakers, surfacing as (i) *laminal alveolar* [ɕ] for the "elder" speakers in their 30s and (ii) *laminal (denti-)alveolar* [ɕ̪] for the "younger" speakers in their 20s.

Table 2: Places of articulation for the coronal sounds in Malaysian Mandarin

		M01	M02	M03	M04
stop	*d*	laminal alveolo-postalveolar [t̻]	apical dentialveolo-alveolar [t̪]	apico-laminal dentialveolo-alveolar [t]	apico-laminal dentialveolo-alveolar [t]
fricative	*s*	laminal postalveolar [ʃ̻]	laminal alveolar [s̻]	laminal alveolar [s̻]	laminal alveolar [s̻]
	sh	laminal postalveolar [ʃ̻]	laminal alveolar [s̻]	laminal alveolar [s̻]	laminal alveolar [s̻]
	x	laminal postalveolar [ɕ]	laminal alveolar [ɕ]	laminal (denti-)alveolar [ɕ̪]	laminal (denti-)alveolar [ɕ̪]
affricate	*z*	laminal postalveolar [t̻ʃ̻]	laminal alveolar [t̻s̻]	apical alveolar [t̺s̺]	laminal alveolar [t̻s̻]
	zh	laminal postalveolar [t̻ʃ̻]	laminal alveolar [t̻s̻]	apical alveolar [t̺s̺]	laminal alveolar [t̻s̻]
	j	laminal postalveolar [tɕ]	laminal alveolar [tɕ]	apical dentialveolo-alveolar [tɕ]	apical dentialveolo-alveolar [tɕ]

(The hyphen "-" is used to denote the extension of contact area (see Lee and Zee 2010).)

4. Discussion

4.1 Places of Articulation: Linguographic and Palatographic Perspectives

In the literature, *s*, *z* were impressionistically transcribed as *dental*, *sh*, *zh* *retroflex*, and *x*, *j* *palatal* in Beijing Mandarin (Chao 1968; Duanmu 2000/2007; Karlgren 1915-1926; Ladefoged and Wu 1984; Lin 2007; among many others). Instrumentally speaking, nevertheless, Ladefoged and Wu (1984) suggested that there is no simple way to specify the three types of sibilants with a discrete set of places of articulation, as their data of palatography and X-rays from three speakers revealed substantial variations in articulatory target regions. Specifically, the position of *s* at the maximal constriction can vary from *dental* to *alveolar*; *x* is somewhere between *s* and *sh* and is not a "palatalized" version of either one.[11] More recently, Lee (1999a) and Lee (2008) analyzed the palatography and linguography of the coronal consonants from the younger and the older generations of Mandarin Chinese speakers in Beijing. The results show that the two generations show slight difference in the contact on the tongue, but no difference on the palate. For instance, *s* is *laminal* for the older (Pekingese) speakers, but *apical* or *laminal* for the younger (Beijing Mandarin) speakers. A comparison of the articulatory data between Malaysian Mandarin and Beijing Mandarin (Lee 1999a; Lee and Zee 2003), both obtained from the younger speakers (below 30 years old), is itemized in Table 3.

There are several points to note about Table 3. In both Mandarin varieties, *d* has a wide contact (*dentialveolo-alveolar*), produced by the tongue tip and blade. Next, the sibilants are produced very differently in the two language variants. In Beijing Mandarin, *s* and *sh* contrast in anteriority: *s* is *denti-alveolar* or *alveolar*, whereas *sh* and *x* are both *postalveolar*, but differ in apicality; more precisely, *sh* involves the tongue tip (i.e., *apical*), making contact on the posterior zone of the alveolar ridge, whereas *x* involves the simultaneous raising of the blade and the front portion of the dorsum to the alveolo-palatal region, as reported in previous X-ray studies (Ladefoged and Wu 1984) and real-time MRI studies (Proctor et al. 2012).

[11] Note that Ladefoged and Wu's (1984) observations were not made on the anatomically defined regions (e.g., Lee 1999b) and no linguography data were available for cross-comparison (see, for example, Dart (1991) for more disucssion).

Table 3: Patterns of linguopalatal contact for the coronal consonants in Beijing Mandarin and Malaysian Mandarin (Based on the data from younger speakers)

		Beijing Mandarin	Malaysian Mandarin
stop	*d*	apico-laminal dentialveolo-alveolar [t]	apico-laminal dentialveolo-alveolar [t]
fricative	*s*	apico-laminal or laminal denti-alveolar or alveolar [s]	laminal alveolar [s̻]
	sh	apical postalveolar [ʃ̺]	laminal alveolar [s̻]
	x	lamino-anterodorsal postalveolar or prepalatal [ɕ]	laminal (denti-)alveolar [ɕ̻]
affricate	*z*	apical-laminal or laminal dentialveolar or alveolar [ts]	laminal alveolar [ts̻]
	zh	apical postalveolar [ʃ̺]	laminal alveolar [ts̻]
	j	apico-anterodorsal or lamino-anterodorsal alveolo-palatal [tɕ]	apical dentialveolo-alveolar [tɕ]

(The hyphen "-" is used to denote the extension of contact area (see Lee and Zee 2010).)

In contrast, this distinction is not attested in Malaysian Mandarin. Palatographically, the primary point of contact for *s*, *sh*, *x* is almost the same in MM, i.e., *alveolar*. *x* is realized as a more "anterior" variant: (*denti-)alveolar* [ɕ̻]. Based on these findings, we suggest that the three-way sibilant contrast, still observable in Beijing Mandarin, has not been maintained in Malaysian Mandarin. Linguographically, all three sounds are *laminal* in MM, while the lateral contact is wider in production of *x*. *sh* displays no contact on the tip or the upper surface of the apex, suggesting that it deviates from its Beijing Mandarin counterpart in terms of *apicality*. As for *x*, the MM data show three major differences in the articulation of the segment compared to Beijing Mandarin: (i) the location of the principal contact on the palate is more anterior (i.e., in the *(denti-)alveolar* zone); (ii) the contact location varies with vowel contexts: *x* is significantly more "fronted" before high front vowel [i]; (iii) there is no obvious central anterodorsal contact, which leads to a minor increase in the lateral contact.

Lastly, it is also remarkable that the articulatory patterns of *z* and *zh* are similar to those found in the corresponding fricatives (i.e., *s* and *sh*),[12] while this observation does

[12] The contact difference between *s* and *sh* or *z* and *zh* is not significant, at least for the male speakers in

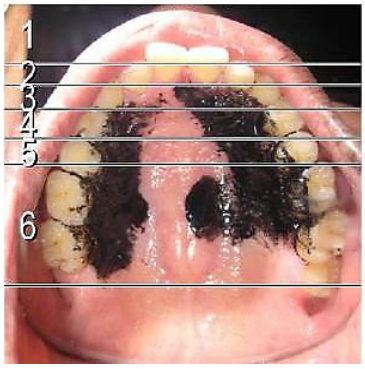
not hold true for *j*. Specifically, the principal point of contact for *j* is more forward and extensive than for the corresponding fricative *x*, as we have already discussed above.

4.2 Language Contact-induced Sound Change

One point on which we are silent is how the fronting of [ɕ] to [ʨ] is motivated in Malaysian Mandarin. It seems reasonable to attribute this phenomenon in question to the effect of L1 transfer — especially considering that Penang Hokkien, the local dominant language of the Malaysian Chinese community, has only two sibilants, /s/ and /ts/, like most (sub-)dialects of Southern Min. If Penang Hokkien shows no Front Vowel Palatalization (hereafter FVP; e.g., /si/ → [ɕi]), there would be no reason for palatalization to occur in L2 acquisition (i.e., of Malaysian Mandarin). While it is safe to say that L1 interference serves as an explanation for non-"canonical" forms and structures in other regional varieties of Mandarin Chinese, we believe that cannot be entire story for the "fronting" of [ɕ] to [ʨ] in MM. Some discussion is in order. First, the "canonical" sibilant *x* is not unattested before [i, j], albeit less frequently (i.e., 37.8% out of 270 tokens; see also (2)). In other words, there is indisputably some substantial degree of gradience, which cannot be entirely captured by the effect of L1 interference. Second and more importantly, a pilot study of Front Vowel Palatalization in Penang Hokkien confirms that FVP is not impossible in Penang Hokkien. Figure 11 presents a comparison of the palatograms for the syllable /si/ in Penang Hokkien between an "elder" speaker (M02) and a "younger" speaker (M03). As we can see, /s/ may have different contact patterns when preceded by [i]. For the elder speaker (11 (a)), the contact extends from the alveolar zone to the postalveolar zone; for the younger speaker (11 (b)), the contact area is solely in the alveolar region. These findings suggest that FVP is absent in the younger speaker, whereas the elder speaker showed the "expected" FVP pattern /si/ → [ɕi]. Incidentally, FVP of this sort is also attested in other dialects of Southern Min Chinese, such as Taiwanese Southern Min and Xiamen Chinese.

this study (compare Figures 4 and 5, 7 and 8). Specifically, the experimental results showed that *sh* and *zh* are not produced at a more *posterior* contact point than *s* and *z*, as Beijing Mandarin does (Lee 1999a; Lee and Zee 2003). It is concluded that both of the categories are not (at least) articulatorily distinguishable.

(a) Elder speaker (M02)



(b) Younger speaker (M03)

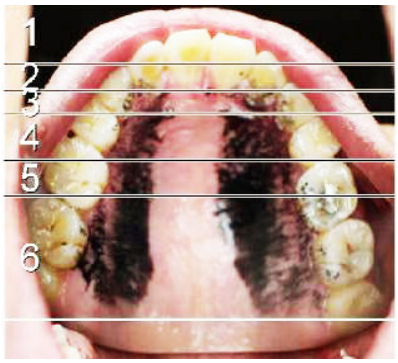


Figure 11: Distinct contact patterns of [si] in Penang Hokkien for an elder speaker (a) and a younger speaker (b)

These pilot study findings are thus consistent with the results of the linguographic and palatographic study presented above: recall that the fronting of the sibilant *x* in Malaysian Mandarin is mostly found among the "younger" speakers of both Malaysian Mandarin and Penang Hokkien. So the next question is: "how and why has the fronting of the sibilant *x* taken place (mostly) among the younger speakers in this region?" We may entertain the possibility of a contact-induced sound change. Education is primarily given in Malay (and English) after the independence of Malaysia, even for ethnic Chinese people. Given that neither Malay nor English exhibits FVP (at least non-postlexically), it is reasonable to posit that younger speakers, who have been much more exposed to Malay and English in school, tend not to produce an alveolo-palatal sibilant before a high front vowel/palatal glide. Consider (3): English contrasts [s] and [ʃ], and Malay has [s], along with a small number of [ʃ] from Arabic loanwords. Note further that the alveolo-palatal fricatives in English are labialized (a classic enhancement effect; cf. Stevens et al. 1986), making English [ʃ^{w}i] perceptually dissimilar to Mandarin [ɕi]. As for Malay, /ʃ/ (represented as "sy" in orthography) is mostly found in Arabic loanwords. So the speakers are exposed to many more exemplars of [si]. Taking these pieces of evidence together, it is tempting to postulate that [si], but not [ɕi], may be favored under "cross-linguistic (paradigmatic) uniformity". Elder speakers, however, may not be frequently exposed to tokens such as [si] in school (or elsewhere), with the result that fronting of the sibilant *x* is not (or less frequently) found in their speech.

(3) Fricatives in the four major languages in Penang, Malaysia

English	Malay	Penang Hokkien	Malaysian Mandarin
[si]	[si]	/si/→ [si] (younger speakers)	[si] (younger speakers)
[ʃʷ]/[ʒʷ]	[ʃi]$_{\text{Loanword}}$	/si/→ [ɕi] (elder speakers)	[ɕi] (elder speakers)

Another welcome result of the contact-based account of the fronting of [ɕ] to [ʨ] is the explanation it provides for the paucity of "fronted" *ji/qi* ([tsi/ts^{h}i], [tʨi/tʨ^{h}i]) uncovered in this study. As we have seen in section 3.1, both elder and younger speakers often, if not always, produce the canonical [tɕi] only. A similar finding was reported in Chen's (1986) study on the "substitution" of sibilants in Singaporean Mandarin, according to which 29.3% of instances of [tɕ] were "replaced" with a dental [ts], 23.2% of [tɕ^{h}] were replaced with a dental [ts^{h}], and 86.5% of [ɕ] with a dental [s]. From a purely phonological perspective, it is puzzling why affricates should prove more resistant to fronting than fricatives — since, all else being equal, [ɕ] and [tɕ] are not indistinguishable in terms of place features. We believe that this problem dissolves, however, if language contact is taken into consideration. More specifically, neither English nor Malay has [ts] in its phoneme inventory (see (4)). As a result, Mandarin speakers in Penang have no access to tokens such as [tsi]; furthermore, they *do* have supporting evidence for FVP in this context, since the affricate /ts/ undergoes (alveolo-)palatalization in Penang Hokkien (i.e., /tsi/ → [tɕi]; see Figure 12). It therefore follows that the fronting of the affricates is not attested for syllables such as [tɕi] in MM.

(a) Elder speaker (M02) (b) Younger speaker (M03)

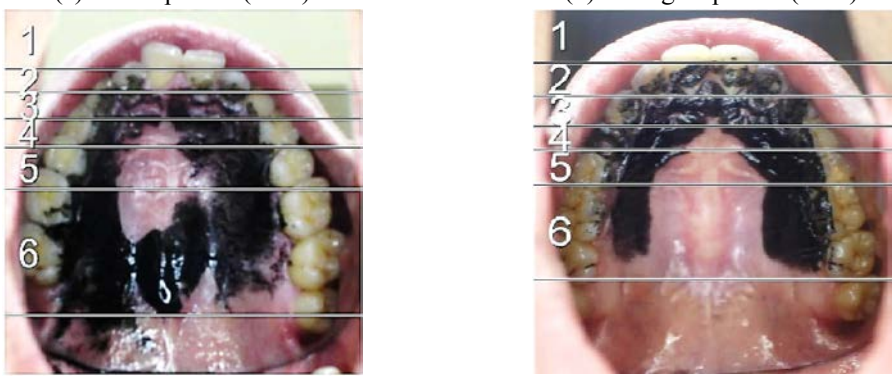


Figure 12: Distinct contact patterns of [tsi] in Penang Hokkien for an elder speaker (a) and a younger speaker (b)

(4) Affricates in the four major languages in Penang, Malaysia

English	Malay	Penang Hokkien	Malaysian Mandarin
*[tsi]	*[tsi]	/tsi/→ [tɕi] (younger speakers)	[tɕi] (younger speakers)
[tʃi/dʒi]	[tʃi/dʒi]	/tsi/→ [tɕi] (elder speakers)	[tɕi] (elder speakers)

Finally, an anonymous reviewer pointed out that the fronting phenomenon might be due to "a relic of earlier contact" probably before the First World War, although according to Tan (2000), Mandarin was adopted as the common medium of instruction *only* in the 1920s, while "the early Chinese schools had taught in the dialects as they were set up to meet the needs of the children of Cantonese, Hokkiens and Hakkas" (See 2013). At any rate, indeed, it is worth mentioning that the phenomenon observed here is reminiscent of the so-called "feminine speech"[13] reported in the city of Beijing, where some young female speakers of Beijing Mandarin tend to produce more fronted palatal sibilants preceding a high front vowel/palatal glide (Cao 1987; Chao 1968; Hu 1991; among others). However, it is highly unlikely that the feminine speech in Beijing has any bearing on the fronting of the fricative *x* in Malaysian Mandarin because the fronted sibilants are not a widespread phenomenon and, more importantly, have never been recognized as "standard" pronunciation in school education. Finally, this "earlier contact" account based on feminine speech still cannot accommodate the asymmetry in (3) and (4), namely that the affricates *j* and *q* are *not* subject to fronting in MM (cf. Chen's (1986) study of Singaporean Mandarin), even though *j*, *q*, *x* are essentially homorganic (Table 3). It is important to reiterate that no such asymmetry has ever been reported for feminine

[13] Cao (1987) made a survey of 200 Beijing speakers, and found that 85 percent of females and 29 percent of males do not have the true "palatals". The sibilants *j*, *q*, *x* are pronounced as the postalveolars [tʃ, tʃʰ, ʃ] at a point between the true dentals and palatals (see also Xu 1957). More recently, Beckman et al. (2014) reported that fronted sibilants of this sort are also produced by some younger speakers of Songyuan Chinese, a Mandarin dialect spoken in the Northeastern Chinese province of Jilin. From a socio-phonetic perspective, Beckman et al. (2014) treat the emergence of the fronted sibilants in Songyuan Chinese as dialect borrowing for the sake of social status. Incidentally, it has been convincingly shown in Hu (1991) that the feminine speech does not really reflect the so-called "sharp and round" (i.e., palatal vs. non-palatal) distinction in early Mandarin. Neither does the fronting of the sibilants, because, for example, *xi* 'hope', historically with a palatal/ "round" sibilant onset is mostly pronounced [si] ([ɕi]) in this study.

speech or any other varieties of Mandarin Chinese, to the best of our knowledge. The same reviewer further questioned if the "source" could be a southern variety of Mandarin Chinese so that the fronting phenomenon is motivated. Again, on the one hand, the paucity of the fronted affricates as in MM has never been reported elsewhere in the literature. On the other hand, our field experience is that the Chinese education (after the independence of Malaysia) had long been based on teachers and textbooks from Taiwan until recently. It is uncontroversial that the fronted fricatives and affricates are not found in Taiwanese Mandarin (and Taiwanese Southern Min), while in recent years, there is no denying that the Chinese education in Malaysia has been heavily influenced by China. Once again, as mentioned earlier, the fronted sibilants have never been recognized as "standard" in China as well. All in all, we suggest that the fronted fricative be more likely to be an innovative, contact-induced sound change on its own right.

5. Conclusion

This work is a palatographic and linguographic study of the coronal sounds of Malaysian Mandarin spoken in Penang. The principal findings are: (i) *d* is *apico-laminal dentialveolo-alveolar* [t]; (ii) *s* and *sh* are mostly *laminal alveolar* [s̻] (compare: *sh* of Beijing Mandarin is *apical postalveolar* [ʂ̺]); (iii) *x* has two phonetic variants, i.e., *laminal alveolar* [ɕ] (canonical) and *laminal dentialveolar* [ɕ̻] (fronted); and (iv) the contact patterns of affricates *z*, *zh* are the same as those of the "homorganic" fricatives, whereas *j*, as compared to *x*, has a wider contact, i.e., *apical dentialveolo-alveolar* [tɕ]. Finally, another important new finding in this study is that [ɕ] and [ɕ̻] are not in free variation. The non-"canonical", fronted [ɕ̻] mostly co-occurs with the high front vowel [i] and the palatal glide [j], while the "canonical" alveolo-palatal [ɕ] is found elsewhere. Phonologically speaking, this contextual variation is problematic because the high front vowel and the palatal glide share a *bona fide* distinctive feature for (alveolo-) palatalization. Therefore, our conclusion is that the fronting of the sibilants is very likely due to an intensive language contact with the other non-Chinese languages, i.e., Malay and English. In this regard, this study also contributes to a growing body of work on the phonetic and phonological characteristics of regional varieties of Mandarin Chinese. Needless to say, a glaring limitation of this study is the small number of the participants

so that the current observations may be, to some extent, inconclusive. Also, there may well be regional differences in the varieties of Mandarin Chinese spoken in Malaysia. We acknowledge these problems, with the hope that more intensive, large-scale studies could be conducted for a more comprehensive understanding of the phenomena in question.

(Proofreader: Li Qi-hong)

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馬來西亞華語舌冠音的構音研究：特究其「非典型」嘶擦音的可能來源

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摘　要

本研究旨在調查馬來西亞（檳城）華語舌冠音的構音特徵，特別著眼於嘶擦音的「非典型」發音性質。主要研究結果臚列於下：（一）塞音 *d* 的顎位遍及齒齦 (dentialveolar) 和齒槽 (alveolar) 兩區，舌位則包括舌尖和舌葉；（二）擦音 *s*、*sh* 和塞擦音 *z*、*zh* 發音部位大致相同，皆為舌葉齒槽音；（三）擦音 *x* 有兩個語音變體，分別為典型的齒槽音 [ɕ] 和位置偏前的齒齦舌音[ɕ̟]；（四）塞擦音 *j* 的接觸面積較大，為一舌尖面音，碰觸齒齦及齒槽兩區。本研究另外發現 *x* 的語音變體基本上由環境制約：在馬來西亞（檳城）華語中，引發顎化現象的前高母音及介音 [i, j] 常與非典型、偏前變體 [ɕ̟] 相拼，而典型變體 [ɕ] 則多出現於其它環境。本文認為該現象很有可能是語言接觸後的音變結果。

關鍵詞：馬來西亞華語，舌冠音，嘶擦音，假顎圖，舌面圖，語言接觸

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