The Syllable in Chinese

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1. Introduction

Most analyses of the Chinese syllable assume that it has a variable length, ranging from one segment (C or V) to four (CGVC or CGVG). This chapter argues that while the input segments to a syllable can range from one to four, there are only two syllable structures, the heavy syllable CVX and the light syllable CV.

Section 2 compares the traditional representation of the Chinese syllable with the present one. Section 3 presents evidence for the present analysis. Section 4 gives conclusions.

2. Two analysis of the Chinese syllable

2.1. The traditional analysis

In the traditional analysis (e.g. Chao 1968, Yuan 1989, Beijing University 1989), the Chinese syllable has a variable length, ranging from one segment, C or V, to a maximum of four, CGVC or CGVG, where C is a consonant, V a vowel, and G a glide or a high vowel. Since there is no contrast between the glides [j, w, ɥ] and the high vowels [i u y] in Chinese, a glide will be used in the prenuclear position and a high vowel will be used in the nuclear or the coda position. (1) shows some examples in Standard Chinese (hereafter Mandarin), transcribed in phonetic symbols without tone, and (2) shows some examples in Mainstream Shanghai (e.g. Xu et al 1988, hereafter Shanghai), where * indicates a missing form.

(1) Mandarin syllable types

C	V	GV	VC	CV	VG
m	ɤ	wa	an	ta	ai
'yes?'	'goose'	'frog'	'peace'	'big'	'love'
CVG	GVG	CVC	CGV	CGVC	CGVG
fei	wai	t^hoŋ	kwa	hwaŋ	k^hwai
'fly'	'outside'	'pain'	'melon'	'yellow'	'fast'

(2) Shanghai syllable types

C	V	GV	VC	CV	*VG
ŋ	a	ja	aʔ	du	
'fish'	'short'	'wild'	'duck'	'big'	
*CVG	*GVG	CVC	CGV	CGVC	*CGVG
		t^hoŋ	k^hwa	kwaʔ	
		'pain'	'fast'	'scrape'	

In both dialects V can be followed by C. However, G can follow V in Mandarin but not in Shanghai. Syllables without an initial C or G usually have some consonant articulation at the beginning, to be discussed below. In some dialects VGC rimes can be found in final position, such as [p^heiŋ] 'invite' in Fuzhou. However, in non-final positions VGC rimes become VC rimes; thus there is no need to consider VGC a new rime type (Tao 1930, Chao 1931, Duanmu 1990: 42-47).

2.2. The present analysis

The present analysis follows the proposal of Duanmu (1993), according to which there are two kinds of Chinese dialects. In the first, represented by Mandarin, there is a distinction between full syllables and weak syllables. Most lexical words are full syllables, such as those in (1). Weak syllables are usually function words, such as the aspect marker [lə]. Full syllables have stress and tone, and weak syllables have no stress or tone. Duanmu (1993) proposes the uniform structure (3a) for full syllables, which has two rime slots and is heavy. Weak syllables have the structure (3b), which has one rime slot and is light. In the second kind of Chinese dialects, represented by Shanghai, all syllables have the structure (3b) underlyingly. (A moraic representation of (3a) and (3b) is of no consequence for the present discussion.)

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(3)   a.   S          b.   S          Syllable
          /\              /\
         O R             O R          Onset/Rime
         | /\            | |
         X XX            X X          timing slots

         CVX             CV
```

For convenience, (3a) will be called CVX, where C is the onset, V is the nucleus, and X is the coda, and (3b) will be called CV. A full Mandarin syllable is CVX both underlyingly and at surface. A Shanghai syllable is CV both underlyingly and at surfaces except when it occurs in isolation or in initial position, where it is lengthened under stress (cf. Zhu 1995). According to (3), (1) and (2) should be analyzed as (4) and (5) respectively, where the symbol [ø] represents a zero onset and V' represents a laryngealized vowel.

(4) Mandarin (full syllables): CVX

ømm	øɤɤ	waa	øan	taa	øai
‘yes?’	'goose'	'frog'	'peace'	'big'	'love
fei	wai	t^hoŋ	k^waa	h^waŋ	k^{hw}ai
‘fly’	'outside'	'pain'	'melon'	'yellow'	'fast'

(5) Shanghai (non-initial positions): CV

øŋ	øa	ja	øa'	du
‘fish’	'short'	'wild'	'duck'	'big'

t^hõ	k^{hw}a	k^wa'
'pain'	'fast'	'scrape'

The zero onset is has several manifestations (cf. Chao 1948, 1968, Li 1966). When there is no vowel, it is usually the same as a syllabic consonant. When V is a high vowel, the zero onset is often realized as the corresponding glide. When V is a mid or low vowel, the zero onset is usually one of [ɣ, ʔ, ŋ, ɦ] in Mandarin, depending on speakers (Chao 1968). (6) shows four alternative forms of the same word in Mandarin.

(6) ɣaw / ʔaw / ŋaw / ɦaw

'concave'

In Shanghai, when V is a mid or low vowel, the zero onset is [ʔ] if the syllable has an upper register tone (fall or high rise) and [ɦ] if the syllable has a lower register tone (low rise).

There are two major differences between the traditional analysis and the present one. First, in the traditional analysis the prenuclear G is an independent sound. In the present analysis, the prenuclear G is an independent sound only when there is no initial C. When there is an initial C, CG together forms a single sound, where G is the secondary articulation of C (see below). Second, in the traditional analysis full syllables have different rime lengths. In the present analysis, full syllables are all heavy (bimoraic), and all Shanghai syllables are light (monomoraic) (except in initial position or in isolation).

3. Argument for the present analysis

This section presents evidence for the present analysis (cf. also Woo 1969, Duanmu 1990, 1993, Ao 1992, Yip 1992, 1994, Wang 1993, 1995). The argument will again be focused on two representative dialects: Mandarin and Shanghai.

3.1. Mandarin

The argument in Mandarin consists of six parts. First, there is an obligatory onset.

Second, the prenuclear G is in the onset, and there is only one onset slot. Thus, when there is no initial C, G is an onset segment by itself, but when there is an initial C, CG together forms a single segment. Third, the present analysis gives a better account of CG combinations. Fourth, the present analysis gives a better account of palatals. Fifth, an open full syllable has a long vowel and a closed full syllable has a short vowel. Finally, weak syllables have CV only.

3.1.1. The obligatory onset

The idea that there is an obligatory onset in all full Mandarin syllables is shared by some traditional analyses. For example, both Chao (1968) and Beijing University (1995) include the 'zero consonant' in their phonemic inventory. In addition, the phonetic realizations of the zero consonant have been carefully discussed in such works as Chao (1948, 1968) and Li (1966). But the status of the zero consonant is somewhat problematic in traditional analyses. If it is a phoneme, then all full Mandarin syllables have an onset. But then there is the question of why the distribution of the zero onset is defective and predictable, namely, it occurs only in the onset and it occurs only if there is no other onset or a prenuclear glide. In particular, in the traditional analysis, the prenuclear glide is in the rime, so there is no explanation why the zero onset does not occur with a prenuclear glide (see below). If the zero onset is not a phoneme, and if the Mandarin syllable does not require an onset, then there is the question of why the zero onset is there. The only good solution is to say that the zero onset is not a phoneme but required by syllable structure, namely, all full Mandarin syllables have an obligatory onset slot. This is what the present analysis assumes.

3.1.2. Prenuclear G is in the onset

The traditional analysis assumes that the prenuclear G in Mandarin is a separate sound and that it is in the rime. However, there is both phonological and phonetic evidence that suggests the opposite, namely, the prenuclear G is in the onset and that CG form a single sound. Let us look at the evidence. First, for two syllables to rime in Chinese, what matters is the nuclear V and the coda (if any), and not the prenuclear G (cf. Chao 1927, Wang 1957). If the prenuclear G is in the rime, one must explain why part of the rime is ignored in riming. Second, the zero onset cannot be used with a prenuclear glide. This is shown in (7).

(7)	waa	(*ɦwaa	*ɣwaa	*ʔwaa	*ŋwaa)	'frog'
	jaa	(*ɦjaa	*ɣjaa	*ʔjaa	*ŋjaa)	'crow'

Here, none of the phonetic realizations of the zero onset can be used with the prenuclear glide. In the traditional analysis, the prenuclear glide is in the rime and the zero consonant is in the onset, so the lack of their combination is unexpected. In the present analysis, the prenuclear glide is in the onset. In addition, the zero consonant is not an independent phoneme; it is called for only when the onset slot is empty. It is expected, therefore, that when the onset is filled by a glide, no zero consonant will occur.

With regard to phonetics, Chao (1934) observed that the Mandarin syllable [swei] 'age' is pronounced differently from the English syllable [swei] 'sway'. In English, [s] and [w] sound like separate segments, but in Mandarin [sw] sound like a single segment.

The above facts are known to the traditional approach. Still, the prenuclear G is analyzed as a separate sound and as part of the rime. The reason, according to Chao (1934), is phonemic economy. If CG is a single sound, one would have to assume many more consonants, as well as more onset types. On the other hand, if G is a separate sound (which has to be assumed anyway), the consonant inventory can be reduced, with no increase in the glide inventory. In addition, if G is in the rime, one can reduce the number of onset types with only a small increase in the number of rime types.

The economy based on the total number of onset and rime types is not obvious. For example, in the present analysis there is just one onset type C and one rime type VX, whereas in the traditional analysis there is one onset type C (or zero) but four rime types, V, GV, VX, and GVX. In this regard, the traditional analysis is more complicated. The argument based on phonemic economy is addressed in the next section.

3.1.3. Distribution of CG and the consonant inventory

Let us now consider what additional consonants need to be assumed if CG is a single sound. According to Beijing University (1995:6), Mandarin has twenty-one Cs (ignoring the zero consonant) and three glides. Chao (1968) gives a similar inventory. The list is shown in (8). The voiced retroflex is transcribed as [r], although [▏ ♦] have also been used by others.

(8) Mandarin consonants and glides

Labial	p	p^h	m	f			
Dental	t	t^h	n	l	ts	ts^h	s
Palatal	tç	$tç^h$	ç				
Velar	k	k^h	x				
Retroflex	ʈʂ	$ʈʂ^h$	ʂ	ʐ			
Glides		j	w	ɥ			

As Chao (1934) points out, the palatal series are not independent phonemes but can be derived from another series (dentals [ts, ts^h, s], velars [k, k^h, x], or retroflexes [ʈʂ, $ʈʂ^h$, ʂ]) when they occur before [i, y] or [j, ɥ] (see below). For the remaining eighteen Cs, if CG is a single sound (where G is the secondary articulation of C), there are potentially 54 additional consonants. Of the 54, only 29 are found. This is shown in (9), where a minus sign indicates a missing CG. (10) gives examples of good CG combinations, where tones are omitted.

(9) Mandarin CG combinations[i]

		j	w	ɥ
labial	p	p^j	-	-
	p^h	p^{hj}	-	-
	m	m^j	-	-
	f	-	-	-

dental	t	t^{j}	t^{w}	-
	t^{h}	t^{hj}	t^{hw}	-
	n	n^{j}	n^{w}	n^{ɥ}
	l	l^{j}	l^{w}	l^{ɥ}
	ts	tç	ts^{w}	tç^{w}
	ts^{h}	tç^{h}	ts^{hw}	tç^{hw}
	s	ç	s^{w}	ç^{w}
velar	k	-	k^{w}	-
	k^{h}	-	k^{hw}	-
	x	-	x^{w}	-
retroflex	ʈʂ	-	ʈʂ^{w}	-
	ʈʂ^{h}	-	ʈʂ^{hw}	-
	ʂ	-	ʂ^{w}	-
	ʐ	-	ʐ^{w}	-

(10) Examples of Mandarin CG combinations

		j	w	ɥ
labial	p	p^{j}an 'change'	-	-
	p^{h}	p^{hj}an 'cheat'	-	-
	m	m^{j}an 'noodles'	-	-
	f	-	-	-

dental	t	t^{j}an	t^{w}an	-
		'store'	'broken'	
	t^{h}	t^{hj}an	t^{hw}an	-
		'sky'	'roll'	
	n	n^{j}an	n^{w}an	n^{ɥ}ee
		'year'	'warm'	‘cruel’
	l	l^{j}an	l^{w}an	l^{ɥ}ee
		'link'	'disorder'	‘omit’
	ts	tçan	ts^{w}an	tç^{w}an
		'sharp'	'drill'	'donate'
	ts^{h}	tç^{h}an	ts^{hw}an	tç^{hw}an
		'owe'	'usurp'	'persuade'
	s	çan	s^{w}an	ç^{w}an
		'thread'	'garlic'	'select'
velar	k	-	k^{w}an	-
			'close'	
	k^{h}	-	k^{hw}an	-
			'broad'	
	x	-	x^{w}an	-
			'joyful'	

retroflex	tʂ	-	tʂ^{w}an 'brick'	-
	tʂ^{h}	-	tʂ^{hw}an 'boat'	-
	ʂ	-	ʂ^{w}an 'bolt'	-
	ʐ	-	ʐ^{w}an 'soft'	-

The gaps call for an explanation, not just in the present analysis but in any other theory. Before a solution is discussed, several remarks are in order. First, the lack of [f^{j}] is probably accidental, since all other labials can combine with [j]. Second, where one expects palatalized dentals [ts^{j}, ts^{hj}, s^{j}], one finds palatals [tç, tç^{h}, ç]. It will be discussed below that the two series have identical articulators and that both series are found in real speech. Third, where one expects [ts^{ɥ}, ts^{hɥ}, s^{ɥ}], one finds [tç^{w}, tç^{hw}, ç^{w}]. In addition, the palatalized nasals [n^{j}, n^{ɥ}] can also occur as palatals [ɲ, ɲ^{w}]. It will be argued, again, that the two series have identical articulators. Finally, of the seven dentals, five combine with [ɥ] but two do not. It is more reasonable to assume that dentals can in principle combine with [ɥ] and that the lack of [t^{ɥ}, t^{hɥ}] are accidental gaps. If one assumes that dentals cannot in principle combine with [ɥ], then there is no explanation for the presence of [n^{ɥ}, l^{ɥ}, tç^{w}, tç^{hw}, ç^{w}].[ii] Under such considerations, (9) can be generalized in (11).

(11) Mandarin CG combinations (generalized)

	j	w	ɥ
Labial	+	-	-
Dental	+	+	+
Velar	-	+	-
Retroflex	-	+	-

To my knowledge, there has been no previous account of (11). In the present analysis, a solution is as follows. First, consider retroflex sounds. In a retroflex the tongue tip is curled back, which tends to push the tongue body back, yet [j] and [ɥ] require the tongue body to be fronted. The lack of retroflex-[j] and retroflex-[ɥ], therefore, is probably due to articulatory ease.[iii] The other cases can be explained in terms of articulators in feature geometry. Let us assume that Mandarin glides have the articulator structures in (12), where Dor means Dorsal, Cor means Coronal, and Lab means Labial.

(12) Articulators of Mandarin glides

```
     [j]            [w]              [ɥ]

   Dor-Cor        Dor-Lab        Dor-Cor-Lab
     |                |            |      |
  [-back]         [+round]      [-back] [+round]
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The Dor part of a palatal has been the standard assumption in feature theory (cf. Halle & Clements 1983). The representation of [w] is also standard. Arguments for a Cor part of a palatal can be found in Clements & Hume (1995). Finally, [ɥ] is a rounded [j], as traditionally assumed. Now when C and G have different articulators, such as in [p]+[j], all articulators can be kept, as shown in (13), where * indicates the major articulator (the one with greater constriction).

(13) [p] + [j] —> $[p^j]$

```
 *Lab    Dor-Cor       Dor-Cor-*Lab
            |             |
         [-back]       [-back]
```

When the articulator of C is the same as an articulator of G, such as in [t]+[j], the latter is replaced (because CG is primarily a consonant). This is shown in (14).

(14) [t] + [j] —> $[t^j]$

```
 *Cor    Dor-Cor       Dor-*Cor
            |             |
         [-back]       [-back]
```

However, since the Cors of [t] and [j] are the same, both being on the teeth in Mandarin, the replacement does not destroy the palatal elements, namely, Dor–[-back] and Cor. So the result is still a palatalized C. Now consider [p]+[w], shown in (15).

(16) [p] + [w] —> ?

[p]	[w]	?
*Lab	Dor-Lab	Dor-*Lab
	|	
	[+round]	

Because [p] is not [+round], when the *Lab of [p] replaces that of [w], the [+round] of [w] is lost. The result, therefore, is not [p^{W}] (it might be interpreted as [$p^{ɣ}$], but Mandarin does not have a glide phoneme [ɣ]). With this background, let us return to the CG distribution pattern, analyzed in (17), where lost features during articulator replacement are shown in parentheses.

(17) Articulator analysis of CG combinations

	[j]	[w]	[ɥ]
	Dor-Cor	Dor-Lab	Dor-Cor-Lab
	[-back]	[+round]	[-back] [+round]
*Lab	+	([+round])	([+round])
*Cor	+	+	+
*Dor	([-back])	+	([-back])

In this analysis, the four missing combinations correspond to those where a feature is lost. The rest five combinations are all found.

Let us now consider how CG can be analyzed in the traditional analysis, where CG is a cluster of two sounds. First, the lack of retroflex-[j] and retroflex-[ɥ] can be attributed to articulatory ease, similar to the present analysis. Second, the lack of other CG combinations can be attributed to articulator dissimilation. Specifically, one can assume that [j] is Dor, [w] is Lab, and [ɥ] is Lab-Dor, and that there is a constraint against a sequence of two identical articulators. The constraint is stated in (18) and illustrated in (19).

(18) Articulator dissimilation:

Identical articulators cannot occur in succession.

(19) Mandarin CG combinations (in terms of articulators)

	[j]	[w]	[ɥ]
	Dor	Lab	Lab-Dor
Lab	+	-	-
Cor (dental)	+	+	+
Dor (velar)	-	+	-

It can be seen that the bad combinations involve two identical articulators: Lab-[w] and Lab-[ɥ] involve two Labs, and velar-[j] and velar-[ɥ] involve two Dors.

Leaving aside the question of whether palatals also have Cor, there is still a problem. While (18) can account for CG combinations, it does not apply to CV, GV, or across syllables. This can be seen in (20).

(20)

Lab-Lab	Lab-Lab	Dor-Dor	Cor-Cor
CV	GV	CV	CVC.CV
muu	woo	kɤɤ	çan.tai
'female'	'me'	'song'	'present time'

Such cases are problematic if G is in the rime, as the traditional analysis assumes. The reason is that, for (18) to hold over CG, it must be able to apply across the onset-rime domain, but then one expects (18) to apply across CV, which it does not. In addition, if (18) can apply across the onset-rime domain, it perhaps ought to apply to a smaller domain GV, which, in the traditional analysis, is within the rime, yet (18) does not hold there either. Thus, compared with CV and GV, CG has a special status. In the traditional analysis this special status must be stipulated. In contrast, in the present analysis, there is no such problem. Since CG is a single sound, the CG combinations follow from feature geometry, according to which each articulator can only occur once in a CG. Since CV and GV are not single sounds, they are not subject to the same restriction.

A reviewer suggests that the lack of Lab-[w] or Lab-[ɥ] is due to perceptual reasons. There is not much of a transition of F2 and it is well known that salient transitions are important for perception. However, while phonetic salience may play a role, the lack of Lab-Lab over CG must also have a phonological motivation, namely, CG is a single sound, as the present analysis argues. The reason is that there is no Lab-Lab constraint against CV or GV, as seen in (20). If phonetic salience is the only factor, one would expect CV and GV to be subject to the Lab-Lab constraint, too.[iv]

Let us now consider the cost of the present analysis. If CG combinations are single sounds, it seems that 29 more phonemes must be added. But the cost is only apparent. Given an independent role of syllable structure, the additional sounds can be derived without an increase in the underlying consonant inventory. For illustration, consider the representation of the Mandarin syllable [s^wei] 'age' in (21).

(21)
```
  S     →     S
 /\          /\
O  R        O  R
|  /\       |  /\
X  XX       X  XX
            /\ ||
sw ei       sw ei
```
/swei/ [s^wei]

The syllable has four input segments /swei/. However, because there are only three slots in the syllable, [sw] must share the onset slot, giving three surface segments [s^wei].

In summary, the present analysis accounts for more phonetic and phonological facts, with no increase in underlying consonant inventory. There is, therefore, no motivation for considering the prenuclear G to be a separate surface segment or to be part of the nucleus.

3.1.4. The palatals

In the preceding discussion two proposals were made about palatals. First, [tç $tç^h$ ç] are derived by combining [ts, ts^h, s] with [j]. Second, [$tç^w$, $tç^{hw}$, $ç^w$] are derived by combining [ts, ts^h, s] with [ɥ]. The first case is shown in (22).

(22)

Places				Articulators
Dental	ts	ts^{h}	s	Cor
Dental-[j]	ts^{j}	ts^{hj}	s^{j}	Cor-Dor
Palatal	tç	tç^{h}	ç	Cor-Dor

The articulator of a dental is Cor, and those of [j] are Cor-Dor. The combination of the two is still Cor-Dor (see (14)). The palatals [tç, tç^{h}, ç] are Cor-Dor because there is both a dental contact (by the tongue tip) and a palatal contact (by the tongue body) at the same time. Since both [ts^{j}, ts^{hj}, s^{j}] and [tç, tç^{h}, ç] are Cor-Dor, both series are expected as far as articulators are concerned. In fact, there are two varieties of pronunciations. Variety A uses palatalized dentals, and variety B uses palatals. This is exemplified in (23).

(23)

C+G	Variety A	Variety B	
[ts]+[j]	[ts^{hj}an]	[tçan]	'sharp'
[ts^{h}]+[j]	[ts^{hj}an]	[tç^{h}an]	'owe'
[s]+[j]	[s^{j}an]	[çan]	'thread'
[ts]+[ɥ]	[ts$^{\text{ɥ}}$an]	[tç^{w}an]	'donate'
[ts^{h}]+[ɥ]	[ts$^{h\text{ɥ}}$an]	[tç^{hw}an]	'persuade'
[s]+[ɥ]	[s$^{\text{ɥ}}$an]	[ç^{w}an]	'select'

Variety A has been known for a long time. It is common among children and female speakers, as well as among some males (cf. Xu 1957, Cao 1987, Hu 1991). According to Cao (1987), in a 1986 survey of 200 speakers, 85% females and 29% males used variety A at various degrees. The presence of the two varieties suggests a phonological link between dentals and palatals. The link can be shown in terms of articulators. In feature geometry, every sound has at least one major articulator (indicated with *). A sound can also have one or more minor articulators. The major articulator assumes the given stricture of the sound, and the minor articulator typically assumes the default stricture of [+continuant]. The stricture of affricates is [-continuant] (cf. Steriade 1989). In palatalized dental affricates, such as [ts^{j}], there is complete closure (i.e. [-continuant]) at the dental place (for Cor), but no closure (i.e. [+continuant]) at the palatal place (for Dor). Thus, palatalized dentals are *Cor-Dor. In palatal affricates, such as [tç], there is complete closure at both the dental place and the palatal place. Thus, palatals are *Cor-*Dor. This is shown in (24).

(24) Articulator analysis of palatalized dentals vs. palatals

	Variety A	Variety B
[ts, ts^h, s]+[j]	[ts^j, ts^{hj}, s^j]	[tç, $tç^h$, ç]
	Dor-*Cor	*Dor-*Cor

The difference between the two varieties of speech therefore lies in whether the newly incorporated Dor (from [j]) acts as a major or a minor articulator. The alternation between [n^j, $n^ɥ$] vs. [ɲ, $ɲ^w$], also noted above, can be explained in the same way. Next, consider [$tç^w$, $tç^{hw}$, $ç^w$], which are shown in (25).

(25)

Places				Articulators
Dental	ts	ts^h	s	Cor
Dental-[ɥ]	$ts^ɥ$	$ts^{hɥ}$	$s^ɥ$	Cor-Dor-Lab
Palatal-[w]	$tç^w$	$tç^{hw}$	$ç^W$	Cor-Dor-Lab

When dentals combine with [ɥ], one expects dental-[ɥ], but palatal-[w] is also found. The difference between them, once again, lies in the role of the articulators. This is shown in (26).

(26) Articulator analysis of palatalized dentals vs. palatals

	Variety A	Variety B
[ts, ts^h, s]+[ɥ]	[$ts^ɥ$, $ts^{hɥ}$, $s^ɥ$]	[$tç^w$, $tç^{hw}$, $ç^w$]
	Dor-*Cor-Lab	*Dor-*Cor-Lab

In variety A, the newly incorporated Dor (from [ɥ]) is a minor articulator, whereas in variety B it is a major articulator.

Chao (1934) uses Mandarin palatals to argue that there is sometimes indeterminacy in phonemic analysis. In the present analysis, Mandarin does not have phonemic indeterminacy.

3.1.5. An open full syllable has a long vowel

Most Mandarin syllables are full syllables. In the traditional analysis, there are three rime types (excluding the prenuclear G), V, VC, and VG, as seen in (1). Compared with weak syllables, all full syllables are long and carry stress. Phonologically, full syllables show no difference in their stress or tone bearing abilities. With regard to the weight of full syllables, there are three possibilities. First, all full syllables are light. Second, V is light and VC and VG are heavy. Third, all full syllables are heavy.

If full syllables are light, one cannot explain why they all have greater stress and longer duration than weak syllables. For the second possibility, it is relevant to note that in languages like English, VC and VG are heavy and V is light. However, one cannot explain why the full V patterns with full VC and VG and not with weak rimes. For the third possibility, not only are VC and VG heavy, but V is a long vowel [V:] (assuming that a heavy syllable has two moras, or two timing slots in the rime). And if full Mandarin rimes are heavy, it is natural they are all stressed, either because Mandarin has moraic feet, or because of the Weight-to-Stress Principle (Prince 1990). The fact that all full Mandarin syllables are stressed have been pointed out by many people (e.g. Luo & Wang 1957, Chao 1968). Similarly, the fact that full syllables are longer than weak syllables is well known (cf. Woo 1969, Howie 1976, Lin et al 1984, Lin & Yan 1988). For example, Howie (1976) found that, when read in a carrier sentence, full Mandarin V, VG, and VN rimes are all about 200 ms in duration. In view of such facts, one would wonder why the open rime has traditionally been written as [V] instead of [V:]. The reason is phonemic economy. Since vowel length is predictable, namely, short in closed rimes and long in open rimes, there is no need to mark it. However, while the traditional transcription is economical, the fact that full syllables are heavy is often passed in silence. In contrast, in a multi-tiered analysis, both phonemic economy and syllable structure can be represented. This is shown in (27).

```
(27)      S     →      S          Syllable
         / \          / \
        O R          O R          Onset/Rime
        | / \        | / \
        XXX          XXX          timing slots
                     | \ /
        m a          m a

        /ma/         [maa]
```

Underlyingly there is no long vowel. However, because a full syllable has two rime slots, a vowel will fill both of them if there is no other coda, giving a surface long vowel.

3.1.6. Weak syllables are CV

Besides full syllables, Mandarin has a small number of weak syllables. The V in a weak syllable is usually a schwa, but it can also be other vowels (see below). Weak syllables are unstressed, do not carry underlying tones, and do not occur in phrase or foot initial positions. According to Lin & Yan (1988), the average rime duration of a weak syllable is about 50% that of a full syllable. Similar results were found by Woo (1969). There is little doubt that weak CV syllables are light. But it is less clear how to analyze weak syllables that are traditionally written as CVC and CVG, such as [t^hou] (literally 'head') in [muu t^hou] 'wood'. In particular, if weight is related to the number of timing slots in the rime, as the present analysis assumes, CVC and CVG should be heavy.

A solution to the dilemma comes from the phonetic study of Lin & Yan (1988). What they found was that when CVC or CVG was unstressed, it either dropped its coda or shortened its vowel. This fact was observed in other works. For example, Gao & Shi (1963: 84-85) gave the examples in (28).[v]

(28) Rime reduction in weak Mandarin syllables

muu t^hou --> muu t^ho	'wood'
nau tai --> nau te	'head'

When the second syllable in each expression is unstressed, its rime is shortened accordingly. Such evidence suggests that the weak syllable has just one rime slot and is metrically light.

3.1.7. Summary

To summarize, there are two kinds of syllables in Mandarin. All full syllables are heavy (CVX) and all weak syllables are light (CV).

3.2. Shanghai

As in Mandarin, the prenuclear G in Shanghai is also in the onset and CG is a single sound. However, Shanghai differs from Mandarin in two ways. First, unlike Mandarin, Shanghai does not show a distinction between full and weak syllables.[vi] For example, while full Mandarin syllables are considerably longer than weak syllables, such a contrast is not found in Shanghai. This can be seen in (29) and (30) (V' = laryngealized V, to be explained below).

(29) Mandarin

k^{hw}ai lɤɤ	k^{hw}ai lə
fast happy	fast ASP
'joyful'	'(have become) fast'

(30) Shanghai

k^{hw}a lo'	k^{hw}a lə'
fast happy	fast ASP
'joyful'	'(have become) fast'

In Mandarin, the full syllable [lɤɤ] 'happy' is considerably longer than the weak syllable [lə], but in Shanghai, the contrast is absent.

Second, while Mandarin has diphthongs and maintains a contrast between [n ŋ] in the coda, Shanghai has neither diphthongs nor coda contrasts. The rime inventories of Mandarin and Shanghai are shown in (31) and (32). There is some variation across different transcriptions, such as whether the Mandarin retroflex rime is [r] or [|], but the variation should not affect the present discussion. Prenuclear glides are not shown, since they are in the onset.

(31) Mandarin rimes

a. z r i u y a e ɤ

b. ai ei au ou in an ən yn iŋ aŋ uŋ əŋ er

(32) Shanghai rimes

a. m ŋ z i u y r a o ɔ e ö ɤ ã

b. ən in yn oŋ aʔ oʔ iʔ

Shanghai lacks all diphthongs and several VN rimes. The cognate words in (33) shows this difference.

(33)

	Mandarin	Shanghai	Gloss
a.	[ai]	[e]	
	lai	le	'come'
	ts^hai	ts^he	'guess'
b.	[an]	[e]	
	lan	le	'blue'
	fan	ve	'rice'
c.	[aŋ]	[ã]	
	laŋ	lã	'wolf'
	t^haŋ	tã	'sugar'
d.	[ou]	[ɤ]	
	lou	lɤ	'floor'
	tsou	tsɤ	'walk'
e.	[au]	[ɔ]	
	lau	lɔ	'old'
	t^hau	tɔ	'peach'
f.	[ei]	[e]	
	mei	me	'coal'
	pei	pe	'cup'

With regard to the weight of Shanghai rimes, there are again three possibilities. First, all Shanghai rimes are heavy. Second, those in (32a) are light and those in (32b) heavy. Third, all Shanghai rimes are light.

The first hypothesis predicts that rimes in (32a) are long and that the codas in (32b) are moraic. This hypothesis has three difficulties. First, it cannot explain why Shanghai lacks weak syllables. Second, it cannot explain why Shanghai has no diphthongs and few nasal codas, even though all its rimes are supposed to be heavy. Third, there is no phonological evidence that all rimes in Shanghai are heavy. The second hypothesis is based on the transcription in (32), with the assumption that VC is heavy. However, it predicts a weight contrast between (32a) and (32b), which is not found. The third hypothesis claims that the VC rimes are light. However, there is the question of why VC rimes are heavy in Mandarin but light in Shanghai. If the rimes in (32b) are light, they should ideally be V instead of VC. It will be argued they are indeed V.

To begin, consider the glottal coda [ʔ]. First, it should be noted that the nuclear vowel is always laryngealized in such syllables. Second, as Xu et al (1988:8) point out, the glottal coda in Shanghai is present only if the syllable is in final position; in non-final positions, [ʔ] is dropped, while the vowel stays laryngealized. This is generally true of other Wu dialects, of which Shanghai is a member (Chao 1967). Third, when [ʔ] is dropped, there is no lengthening of the vowel in Shanghai, in contrast to Taiwanese (Southern Min), where [ʔ] deletion leads to compensatory lengthening (Chiu 1931, Tsay 1990). For these reasons, it is more appropriate to analyze [Vʔ] as underlyingly a laryngealized vowel (written as [V']).

Next consider the remaining VC rimes [ən in yn oŋ], which all end in a nasal. First, it is relevant to note that the rime [ã] is written as a nasalized vowel and not [a] with a nasal coda. The nasal coda is used only for non-low vowels, where [ŋ] is used with the back [o], and [n] is used with the non-back [ə i y].[vii] Phonemically, then, [ən in yn oŋ] can be analyzed as nasalized vowels [ə̃, ĩ, ỹ, õ]. This analysis also agrees with the phonetic fact that [ən in yn oŋ] are often pronounced as [ə̃, ĩ, ỹ, õ] (Xu et al 1988: 73).

If Shanghai has nasalized vowels, one may wonder why there are just [ã, ə̃, ĩ, ỹ, õ], instead of a full set (one for every oral vowel). The answer is that the nasalized vowels derive from historical VN rimes, but not all historical VN rimes gave rise to a nasal vowel. For example, the Shanghai cognate for the Mandarin [lan] 'blue' is not [lã] but [le], and the Shanghai cognate for the Mandarin [man] 'full' is not [mã] but [mö].

In summary, all Shanghai syllables can be analyzed as underlyingly simple, namely, no diphthongs or codas. This is shown in (34), where [a', o', i'] are laryngealized vowels.

(34) Shanghai rimes (present analysis)

a. m n z i u y r a o ɔ e ö ɤ ã

b. ə̃ ĩ ỹ õ a' o' i'

Since all rimes are simple, it is natural to say that they are all underlyingly light. This agrees with the fact that Shanghai rimes do not bear inherent stress that is expected of a heavy rime, such as a full Mandarin rime (cf. the Weight-to-Stress Principle of Prince 1990; see Duanmu 1995 for stress assignment in Shanghai). A Shanghai rime is stressed only in initial position (including in isolation), where it will also be lengthened.

3.3. Further evidence for the proposed syllable structures

The claim that all full Mandarin syllables are heavy and that all syllables in Shanghai are light leads to a rather unusual prediction: under similar conditions, Shanghai speakers speak faster than Mandarin speakers, in terms of syllables per unit time. The stereotypical Shanghai speaker is indeed often said to speak fast. The phonetic study by Duanmu (1994) confirms the prediction (and the popular observation). In the study, four Mandarin speakers and five Shanghai speakers read five nearly identical sentences, written in Chinese characters. A significant difference was found between the average syllable duration of Mandarin speakers, which was 215 ms, and that of Shanghai speakers, which was 162 ms. This result offers further support for the proposed syllabic analysis.

4. Conclusions

It has been argued that there are two kinds of syllables in Chinese, the heavy syllable CVX and the light syllable CV. In Chinese dialects like Mandarin, both types are present. In particular, all full syllables are CVX and all weak syllables are CV. In Chinese dialects like Shanghai, all syllables are CV (except when stressed, in which case they become heavy). This analysis differs from the traditional view that the syllable in both Mandarin and Shanghai are flexible, ranging from a minimal of C or V to a maximal CGVX. The present analysis accounts for more facts both phonologically and phonetically.

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Notes

[i]Although [p^{w}, p^{hw}, m^{w}, f^{w}] are generally missing, there is one special exception. For many Mandarin speakers, [poo, p^{h}oo, moo, foo] are pronounced as [p^{w}oo, p^{hw}oo, m^{w}oo, f^{w}oo]. A solution is as follows. First, the constraint against [p^{w}, p^{hw}, m^{w}, f^{w}] can be stated in (i), namely, Mandarin avoids the structure in which the articulator Labial dominates the feature [+round].

```
(i)      *C    (i.e. *[pʷ], *[pʰʷ], *[mʷ], *[fʷ])
          |
        Labial
          |
       [+round]
```

The Labial part of [p^{w}oo, p^{hw}oo, m^{w}oo, f^{w}oo] is shown in (ii).

```
(ii)     xxx
         |\/
         C V
          \/
        Labial
          |
       [+round]
```

It can be argued that (ii) need not be a violation of (i). The reason is that in (i) Lab is linked to C alone, whereas in (ii) it is linked to both C and V. In other words, (i) can be seen as a constraint against a short feature, namely, one that occurs on one segment slot, but not against a long feature, namely, one that occurs on more than one segment slot.

[ii] A reviewer suggests that it would have been of interest to conduct some psycholinguistic experiments to see which of these gaps reflect real constraints for the speaker and which are simply accidental gaps. In English, for example, accidental gaps such as [blɪk] still sound good but real gaps such as [ŋlɪk] sound outright bad. However, there is a possible complication. English has tens of thousands of possible syllables (about 8,000 by counting CVC alone). In contrast, Mandarin has only about 400 syllables (excluding tone). Thus, while no English speaker will perhaps have heard all the possible syllables, any gap in Mandarin is immediately identified as non-existent. As a result, the difference between accidental and real gaps is likely to be less obvious in Mandarin.

[iii]This is not to say that retroflex-[j] is impossible, but that it is hard. Retroflex-[j] does occur in Russian, for example. In addition, some languages of the Indian Subcontinent have palatalized t-retroflex, as a reviewer points out.

[iv] The reviewer also suggests that the absence of Dor (velar) plus [j] is due to diachronic factors, since these velars changed to palatals. At one stage in the history of Chinese, then, Dor + [j] was possible. In the present analysis, a Dor-[j] like [k^{j}] has the articulators *Dor-Cor (where * indicates a major articulator), and a palatal has the articulators *Dor-*****Cor. Thus, the change from a palatalized Dor to a palatal is a change of Cor from a minor articulator to a major articulator (see section 3.1.4 below).

[v]The process shown here, where an originally full syllable loses stress and reduces to a weak one, is not productive in Mandarin. This process is more common with idiomatic or frequent usage. When an emphasis (such as a contrastive stress) is put on a reduced syllable, it will be restored to a full syllable.

[vi]Thanks to an anonymous reviewer for this point. However, Selkirk & Shen (1990) noted that Shanghai pronouns are more likely to lose underlying tones than other words. This suggests that even among light syllables, a difference may exists in their ability to retain stress.

[vii]There is some phonetic reason for why [ã] is transcribed as a nasalized vowel but [ən, in, yn, oŋ] are transcribed as vowels followed by a nasal coda. According to Whalen & Beddor (1989), lower vowels are more likely to be perceived as nasalized than higher vowels.

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