Chinese Syllable Structure

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1. Introduction

The title of this chapter may seem both too broad and too narrow. On the one hand, Chinese dialects are probably as diverse as Romance languages. Should one not treat them separately? However, I shall show that there are considerable similarities among them and a single treatment is still useful. On the other hand, the study of syllables is closely related to the studies of phonemes, stress, and tone. Therefore, the discussion cannot be limited to syllable structure alone but will cover some of its relations to other areas as well.

The Chinese writing system is not alphabetic, but Chinese scholars have studied syllables for a long time. For example, SUN Yan of the Three Kingdoms period (about 200-280) invented a method, known as Fanqie 'reverse cut', to indicate the pronunciation of written graphs (characters), each of which represents a monosyllabic word. The method uses two familiar graphs, where the first has the same onset as the target graph and the second has the same rime as the target. Similarly, there were riming books that grouped Chinese graphs into different sets based on their initial consonants and whether they rime with each other.

Despite the traditional scholarship, and the fact that Chinese syllables seem less complicated than those in English, disagreements exist over most major issues. For example, what is the maximal size of the Chinese syllable? Does every syllable have a vowel? How does the analysis of syllables interact with the analysis of phonemes? What is the interaction between syllable weight, stress, and tone? What are major phonotactic restrictions that rule out non-occurring syllables? What is the cause of the massive loss of syllable types in Chinese? In this chapter I address such questions. Following the editors' guidelines, I shall focus on major empirical facts, rather than arguing for my own analysis.

However, the distinction between facts and theories is not always clear. For example, the word 'outside' in Standard Chinese, which sounds the same as the English word *why*, has been transcribed as [waj] (Hartman 1944), [uai] (Cheng 1966) , and [ua^{i}] (You *et al*. 1980). For Hartman (1944) the syllable has two glide phonemes and a vowel phoneme, for Cheng (1966) it has three vowels phonemes, and for You *et al*. (1980) it has two vowel phonemes. Accordingly, the syllable analyses are GVG (or CVC), VVV, and VV respectively. One could see that even basic terms like glides, diphthongs, and triphthongs are not always transparent or meaningful. Such problems exist in English and other languages, too. Therefore, our discussion is, inevitably, also of general theoretical interest.

2. The maximal syllable structure

A maximal Chinese syllable, regardless of the dialect, is often thought to contain four positions, or CGVX, where C is a consonant, G a glide, V a vowel, and X either a consonant or the second part of a long vowel or diphthong. Syllables with a syllabic consonant will be discussed later, as will syllables whose rime seems to be longer than VX. In CGVX, a diphthong takes two positions and cannot be followed by a consonant coda. Some examples are shown in (1) from Standard Chinese. For simplicity, I enclose phonetic transcription in square brackets, regardless of the level of analysis. As noted above, some analyses would transcribe a pre-nuclear glide as a high vowel (e.g. Cheng 1966, Lin & Wang 1992).

(1) The CGVX analysis of the maximal syllable in Standard Chinese

[kʰwai]	[kwa:]	[tʰjan]	[kwaŋ]	[tswan]
'fast'	'melon'	'day'	'light'	'diamond'

Different Chinese dialects can use different phonemes to fill the four slots of a syllable. Three dialects, Standard Chinese (S.C.), Cantonese, and Shanghai, are shown in (2).

(2) Dialect variation: phonemes to fill each position in CGVX

	C	G	V	X
S. C.	most Cs	[j, w, ɥ]	any V	[i, u, n, ŋ, ɚ]
Cantonese	any C	[w]	any V	[i, u, n, m, ŋ, p, t, k]
Shanghai	any C	[j, w, ɥ]	any V	([ʔ, ŋ])

In all dialects, the C position can be filled by almost any consonant, with occasional exceptions; for example, similar to English, [ŋ] is not used in the C position in Standard Chinese. The G position can be filled by one of three glides in Standard Chinese and Shanghai. In Cantonese, there are two glides [w, j], which can occur without C, but when the C is filled, only [w] can be used. The V position can be filled by any V (and sometimes by a syllabic consonant, such as [n] 'fish' in Shanghai, to be discussed later). For the X position, Cantonese is among the most conservative dialects, which has kept a full set of nasals and a full set of unreleased stops. In contrast, Shanghai is among the most advanced dialects with regard to the X position, which only allows a glottal stop or a nasal; in addition, these two sounds often combine with the preceding vowel to form a single sound, a glottalized V or a nasalized V. Therefore, all syllables in Shanghai behave like open syllables. I shall return to this issue below.

There is a fair amount of disagreement on the analysis of CGVX, especially with regard to the affiliation of G. Three proposals are shown in (3).

(3) Proposals for the affiliation of G in CGVX

a. [C [GVX]] Xu (1980: 80)

b. [C [G [VX]] Cheng (1966: 136)

c. [[CG][VX]] Bao *et al*. (1997: 87)

In (3a) GVX form a flat structure. Since VX is the basis for riming, to the exclusion of G (e.g. [ljan] 'practice' rimes with [lwan] 'disorderly'), (3a) does not seem optimal. (3b) and (3c) recognize VX as a unit but differ in the treatment of G. In (3b) G is affiliated with VX, whereas in (3c) G is affiliated with C.

A simpler proposal is also available, in which the maximal Chinese syllable has three positions, or CVX (Ao 1992, 1993; Duanmu 1990, 2007). The initial C can be a complex sound C^G, which is a consonant with a glide as secondary articulation (see CHAPTER 27: SECONDARY ARTICULATION AND DOUBLY ARTICULATED CONSONANTS). The analysis of Standard Chinese is shown in (4). Strictly speaking, since VX is a unit for riming, the full structure of CVX is [C[VX]].

(4) The CVX analysis of the maximal syllable in Standard Chinese

[k^{hw}ai]	[k^{w}a:]	[t^{hj}an]	[k^{w}aŋ]	[ts^{w}an]
'fast'	'melon'	'day'	'light'	'diamond'

The CVX analysis seems to assume more consonant phonemes than the CGVX analysis. For example, in Ao (1992, 1993) [k^{hw}, k^{w}, t^{hj}, ts^{w}] are separate phonemes, but in the CGVX analysis they are clusters of two phonemes each [k^{h}w, kw, t^{h}j, tsw]. I return to this issue below.

Besides phonemic economy, arguments for various proposals have been drawn from cooccurrence restrictions, language games, and phonetic measurements. With slightly different assumptions, most of the proposals can account for all the evidence (for a review, see Duanmu 1990, 2007). Since there is no compelling evidence for the more complicated proposals, in what follows I shall use the CVX representation.

3. Heavy and light syllables

In Standard Chinese, most syllables have a full or VX rime, which can be VC, a diphthong, a long vowel, or occasionally a long syllabic consonant. Some examples are shown in (5), where the onset can be absent. Such syllables typically also bear a lexical tone.

(5) Syllables with VX rimes in Standard Chinese

[n^{j}au]	[wa:]	[mau]	[ai]	[ɤ:]	[m:]
'bird'	'frog'	'cat'	'love'	'goose'	'yes?'

In contrast, other syllables have a reduced rime, where the consonant coda is deleted or the vowel is shortened, and they do not carry (or hold onto) a lexical tone. Such syllables are often function words or the second part of a compound, both being prosodically weak. When such syllables are pronounced with stress, their rime becomes VX (and their lexical tones are retained; see the Weight-Stress Principle and the Tone-Stress Principle below). Some examples are shown in (6).

(6) Rime reduction in unstressed syllables in Standard Chinese

Stressed	Unstressed	Example
[kɤ:]	[kə]	a classifier, as in [ʈʂei.kə] ‘this (one)’
[ma:]	[mə]	a question marker, as in [t^{w}ei.mə] ‘right?’
[faŋ]	[fə̃]	[ti:.fə̃] ‘land-direction (place)’
[t^{h}ou]	[t^{h}o]	[mu:.t^{h}o] ‘wood-head (wood)’
[tai]	[te]	[nau.te] ‘head-bag (head)’

If we compare the two kinds of syllables, then those with full rimes are stressed and those with reduced rimes are unstressed. Native judgment on the stress difference between full and reduced syllables is quite clear and is consistently reported (e.g. Chao 1968: 38, Wang & Feng 2006), even though native judgment on relative stress between full syllables is less so. Phonetic studies also show that the coda of unstressed syllables is dropped and the rime duration is reduced by about 50 per cent (Woo 1969, Lin & Yan 1988). We can refer to the two kinds of syllables are heavy and light. Their differences are summarized in (7).

(7)

	Rime	Duration	Reduction	Lexical tone
Heavy syllable	VX	long	no	yes
Light syllable	V	short	yes	no

There is a lack of studies on the phonetic differences between heavy and light syllables in other Chinese dialects. My own sense is that a similar contrast exists in them, too. VX rimes that end in [p, t, k], which are found in dialects like Cantonese, may sound shorter than those that are made of vowels or end in sonorants. However, if we include the duration of [p, t, k], then all VX rimes should have comparable durations.

Given the two rime types, segment length is predictable: in a heavy syllable, a vowel (or syllabic consonant) is long when there is no coda and short when there is. In what follows, predictable length mark is often omitted.

4. Superheavy rimes

Rimes that are longer than VX have been reported. Let us call them superheavy rimes. Some examples are shown in (8), where [a::] is an extra long [a].

(8) Superheavy rimes

Standard Chinese	[ma::]	'horse'
Cantonese	[sa:m]	'shirt' (vs. [sam] 'heart')

However, such rimes are found in restricted environments. In Standard Chinese, the superheavy rime is found only when a syllable is before a pause and carries an extra tone. For example, in nonfinal positions ‘horse’ is [ma:] and has the tone L, but in final position it has an extra H, so that the entire contour is low and then H, which Woo (1969) represents as LLH on a three-mora syllable. Therefore, its extra duration can be attributed to the complexity of the tone and final lengthening. In addition, as Chao (1933: 132) points out, such a syllable ‘often breaks into two syllables’, e.g. [ma::] → [ma:.ʔa]. In Cantonese, the vowel length contrast can be attributed to one of vowel quality. For example, Huang (1970) represents the [sam]-[sa:m] contrast in Cantonese as [sʌm]-[sam] instead.

A more dramatic case of superheavy rimes is found in Fuzhou. According to Feng (1996), Fuzhou has six superheavy rimes in nonfinal positions, shown in (9).

(9) Superheavy rimes in Fuzhou

[pɛiŋ]	[pouŋ]	[pøyŋ]	[pɛiʔ]	[pouʔ]	[pøyʔ]
‘class’	‘help’	‘hut’	‘eight’	‘broad’	‘north’

Some linguists, such as Lin & Wang (1992: 105), believe that while the maximal rime is VX in most Chinese dialects, it can be larger in others, such as VVC Fuzhou. However, there are other facts to consider. In particular, the only consonant codas in Fuzhou are [ŋ, ʔ]. Therefore, one could analyze the superheavy rimes as [ɛ̃ĩ, õũ, ø̃ỹ, ɛiˀ, ouˀ, øyˀ], where [ɛ̃ĩ, õũ, ø̃ỹ] are nasalized diphthongs and [ɛiˀ, ouˀ, øyˀ] are glottalized diphthongs, all of which are VX (see CHAPTER 119: POLISH SYLLABLE STRUCTURE on the representation of nasalized vowels in Polish).

According to Feng (1996: 84), excluding the prenuclear glide and a syllabic nasal, there are twenty-eight rimes in Fuzhou. Most rimes except [ɛʔ, œʔ] have a 'tense' and a 'lax' form. The lax form is used only when a syllable is in final position and its tone starts out low; the tense form is used in nonfinal positions, or in final position with one of four higher tones. The twenty-eight rimes are shown in (10), where a slash separates the tense form (on the left) and the lax form (on the right).

(10) Rime inventory in Fuzhou (Feng 1996)

a/ɑ	ɛ/ɑ	œ/ɔ	o/ɔ	i/ɛi	u/ou	y/øy
aŋ/ɑŋ	ɛiŋ/ɑiŋ	øyŋ/ɔyŋ	ouŋ/ɔuŋ	iŋ/ɛiŋ	uŋ/ouŋ	yŋ/øyŋ
au/ɑu	ɛu/ɑu					
		øy/ɔy				
ai/ɑi						
	ɛiʔ/ɑiʔ	øyʔ/ɔyʔ	ouʔ/ɔuʔ			
aʔ/ɑʔ	ɛʔ	œʔ	oʔ/ɔʔ	iʔ/ɛiʔ	uʔ/ouʔ	yʔ/øyʔ

Several observations can be made. First, there are twelve lax VVC rimes but just six tense (or nonfinal) ones. Second, there are more contrasts in the nonfinal rimes, as can be seen in [a/ɑ, ɛ/ɑ], [œ/ɔ, o/ɔ], and [au/ɑu, ɛu/ɑu]. Third, there is no [ɛŋ], [øŋ], or [oŋ], and so one could treat tense [ɛiŋ, øyŋ, ouŋ] as [ɛŋ, øŋ, oŋ] (or as [ɛ̃ĩ, ø̃ỹ, õũ] as suggested above). Therefore, we do not need to assume any VVC rime in nonfinal positions.

Phonetically, rimes are shorter in non-final positions in Standard Chinese (Woo 1969), Cantonese (Wang 1999), and Fuzhou (Wright 1983). The same seems to be the case in Thai (Leben 1971). In summary, while superheavy pre-pause rimes are common in various Chinese dialects, evidence for superheavy nonfinal rimes is not compelling, regardless of the dialect. This result is similar to what is found in English and German, where nonfinal rimes are limited to VX (e.g. Borowsky 1989, Hall 2001, 2002, Duanmu 2008).

5. Syllabic consonants

Many Chinese dialects have syllabic consonants. Some examples are shown in (11), where length is not indicated.

(11) Syllabic consonants

Shanghai	[n]	'fish'
Cantonese	[m]	'not'

Such words are full lexical items. Since they are pronounced without opening of the mouth and it is hard to claim that they contain a vowel.

Some phonologists believe that every syllable must have a vowel and that there are no syllabic consonants (e.g. Luo & Wang 1957, Cheung 1986, and Coleman 2001). For them, the words in (11) should have a hidden vowel. For example, Cheung (1986: 150) proposes that the

Cantonese word [m] is underlyingly [mi:m], where the hidden vowel [i:] is not pronounced. Since such proposals lack phonetic predictions, they are hard to justify.

Different views on syllabic consonants can also affect the analysis of several other syllables in Standard Chinese. Consider the examples in (12). The transcription is based on many analyses, such as Dong (1958: 37), Chao (1968: 24), Ramsey (1987), Wiese (1997), and Duanmu (2007).

(12) Syllabic [z] and [ʐ] in Standard Chinese

[z]:	tsz	ts^{h}z	sz	
	'self'	'time'	'four'	
[ʐ]:	ʈʂʐ	ʈʂ^{h}ʐ	ʂʐ	ʐʐ
	'paper'	'tooth'	'history'	'sun'

For those who do not assume syllabic consonants, the rimes in the above words are not [z] and [ʐ] but two special 'apical vowels' (Karlgren 1915-1926, Zee & Lee 2007). Interestingly, Lee & Zee (2003) seem to alternate between the terms 'syllabic consonant' and 'apical vowels'. Similarly, Ao (1993: 59) uses 'fricative vowels' to refer to such sounds in Nantong Chinese, although he transcribes them as syllabic fricatives, such as [z̩, β̩].

6. Casual speech: new syllables and voiceless syllables

In casual speech, new syllables can be created owing to sound deletion or change (see CHAPTER 82: REDUCTION). For example, in careful speech no syllable in Standard Chinese ends in [m], but in casual speech such syllables are found, such as [wom], shown in (13).

(13) New syllable created by syllable merger

wo mən → wom

'I plural (we)'

Similarly, devoicing of non-low vowels often happens for syllables that have an aspirated onset (including voiceless fricatives) and a low tone. Some examples are shown in (14). The transcription is based on Duanmu (2007). HL, H, LH, and L are four lexical tones in Standard Chinese. When a sound is devoiced, the tone cannot be heard, which is indicated by Ø.

(14) Devoicing of non-low vowel with a low tone in Standard Chinese

	L-LH	Ø-HL	
[ɤ]→[x]	kʰɤ-nəŋ →	kʰx-nəŋ	'possible'
	HL-L	HL-Ø	
[i]→[ɕ]	ji-tɕʰi →	ji-tɕʰɕ	'together'
	H-L	H-Ø	
[y]→[ɕʷ]	ʈʂəŋ-tɕʰʷy →	ʈʂəŋ-tɕʰʷɕʷ	'strive for'
	L-H	Ø-H	
[y]→[ɕʷ]	ɕʷy-tʷo →	ɕʷɕʷ-tʷo	'many'
	L-HL	Ø-HL	
[u]→[xʷ]	ʂʷu-tɕa →	ʂʷxʷ-tɕa	'summer vacation'

	H-L	H-Ø	
[u]→[xʷ]	ɕin-kʰʷu →	ɕin-kʰʷxʷ	‘working hard’
	L-HL	Ø-HL	
[u]→[xʷ]	tʰʷu-tʲi →	tʰʷxʷ-tʲi	‘land’

Devoicing can happen to syllables in any position (initial, medial, or final). Devoiced [i, ɤ, u, y] sound like [ɕ, x, xʷ, ɕʷ] respectively. (The IPA diacritic [ʷ] in [ɕʷ] simply means ‘labialized’, without implying velar or [+back]).

Devoiced syllables have durations similar to the originals (although rime length is not indicated in the above transcription), and therefore they still sound like separate syllables. If one assumes that every syllable must have a vowel, one would propose devoiced vowels [i̥, ɤ̥, u̥, y̥]. Syllabic consonants can be devoiced, too. Some examples are shown in (15).

(15) Devoicing of syllabic consonants in Standard Chinese

	HL-L	HL-Ø	
[ʋ]→[f]	təu-fʋ →	tou-ff	‘tofu’
	HL-L	HL-Ø	
[z]→[s]	ʂaŋ-tsʰz →	ʂaŋ-tsʰs	‘last time’
	HL-L	HL-Ø	
[ʐ]→[ʂ]	li-ʂʐ →	li-ʂʂ	‘history’

Again, if one does not recognize syllabic consonants, one has to propose special devoiced vowels, instead of [f, s, ʂ].

Casual speech forms, if used frequently, can become new words in a language. For example, in English *an apron* comes from *a napron*, apparently owing to casual speech. In Standard Chinese, the word [pəŋ] comes from [pu juŋ] ‘no need’, and the word [nei] comes from [na ji] ‘that one’.

7. Syllables and phonemes

We have seen that, depending on one’s view of whether every syllable needs a vowel, the rimes in words like [tsz] ‘self’ and [ʈʂʐ] ‘paper’ in Standard Chinese have been treated as ‘syllabic consonants’ or ‘apical vowels’, which could lead to different phonemic analyses.

In view of such ambiguities, Chao (1934) suggests that there is often no best way to analyze the phonemes of a language. Instead, competing solutions may coexist. I have mentioned three different analyses of the word ‘outside’ in Standard Chinese, repeated in (16), which differ in the number of phonemes in the syllable, the kind of phonemes in the syllable, and the size of the syllable.

(16) Influence of phonemic analysis on syllable analysis

[waj] GVG or CVC (Hartman 1944)

[uai] VVV (Cheng 1966)

[ua^{i}] VV (You *et al*. 1980)

Li (1983) proposes that we should consider both the economy of phonemic inventory and the economy of syllable types (CHAPTER 24: INVENTORIES). He suggests that CG should be treated as two sounds in Standard Chinese but one in Cantonese. The reason is that Standard Chinese has about twenty CG pairs, whereas Cantonese has two, which are [kw, k^hw]. If we treat CG as one sound in Cantonese, we increase the consonant inventory by two but can simplify the syllable structure to CVC. In contrast, if we treat CG as one sound in Standard Chinese, we would have to double the consonant inventory.

You *et al*. (1980) go still further and propose that not only can diphthongs be treated as single phonemes (CHAPTER 21: DIPHTHONGS), but VC rimes can as well, such as [an] and [aŋ] in Standard Chinese. They call such VC units 'rime phonemes'. The advantage, they argue, is that the syllable can be simplified even more, where all rimes are V.

Ao (1992, 1993) argues that the maximal Chinese syllable is CVX, where C corresponds to the traditional CG. His analysis would usually double the inventory of consonants. For example, in the traditional analysis there are two velar stops [k, k^h] in Standard Chinese, and [kw] and [k^hw] are clusters of two sounds each. In contrast, in Ao's analysis [k, k^h, k^w, k^{hw}] are four separate phonemes. Ao argues that simplifying the statements of phonotactic restrictions, and the syllable structure, is more important than minimizing the phonemic inventory.

Duanmu (1990, 2007) proposes an analysis that maintains both a small syllable size and a small phoneme inventory. The maximal syllable is CVX, similar to that in Ao (1992, 1993). However, unlike Ao, who assumes that C is filled by a single phoneme, Duanmu assumes that C can be filled by two phonemes, a consonant and a glide, which will merge into a complex sound. In Duanmu's analysis of Standard Chinese, the phoneme inventory is slightly smaller than that of traditional analyses, and about half the size of Ao (1992).

Hartman (1944) proposes to minimize the phoneme inventory even further. For example, while Ao (1992) assumes [k, k^h, k^w, k^{hw}] to be four phonemes in Standard Chinese, Hartman assumes the representation [k, kh, kw, khw], in which there is only one velar stop [k], and [kh, khw, kw] are cluster of two or three phonemes each, where [w] and [h] are independently needed anyway. The cost, of course, is a more complicated syllable structure, which has three positions before the vowel, and it vastly over predicts possible syllables in Chinese.

In (17) I compare the analyses of some syllable-initial units in Standard Chinese by Hartman (1944), Cheng (1966), Ao (1992), and Duanmu (2007), where 'Onset' refers to the maximal size of the given units and 'Stops' refers to the number of velar stop phonemes.

(17) Analyses of four syllable-initial units in Standard Chinese

Author	Underlying	Surface	Onset	Stops
Hartman	[k, kh, kw, khw]	[k, kh, kw, khw]	CCC	1
Cheng	[k, k^h, ku, k^hu]	[k, k^h, kw, k^hw]	CG	2
Ao	[k, k^h, k^w, k^{hw}]	[k, k^h, k^w, k^{hw}]	C	4
Duanmu	[k, k^h, ku, k^hu]	[k, k^h, k^w, k^{hw}]	C	2

Hartman (1944) represents an extreme position in which phonemic economy overrides syllable structure. On the opposite extreme, there is Ladefoged (2001: 170), who believes that phonemes have no place at all. Instead, he suggests that syllables are the basic units of analysis and that 'consonants and vowels are largely figments of our good scientific imaginations'.

8. Missing syllables

I use missing syllables to refer to those that do not occur in the language, although their structure fit the maximal size. In Chinese, the majority of conceivable syllables are missing. Consider an example from Nantong Chinese, which allows CVC syllables. According to Ao (1993), Nantong has fifteen vowels and thirty-eight consonants. Given that the initial or final C can be absent, there are thirty-nine choices for the initial C and thirty-nine for the final C, and the total number of possible syllables is 39 x 15 x 39 = 22,815, of which only about 400 occur in Nantong, or hardly 2%. Ao's illustration is perhaps intended to be dramatic. Given the fact that the final C in Nantong can only be [k] or [ŋ], a more reasonable estimate is 39 x 15 x 3 = 1,755 possible syllables, of which 23% occur. Still, most conceivably syllables are missing, and an explanation is needed.

Let us consider Standard Chinese in some detail. The phonemes of Standard Chinese are shown in (18) and (19), based on Duanmu (2007).

(18) Consonants in Standard Chinese

Initial: p, pʰ, t, tʰ, k, kʰ, ts, tsʰ, ʈʂ, ʈʂʰ, f, s, ʂ, ʐ, x, m, n, l

Final: n, ŋ

(19) Vowels in Standard Chinese

i, y, u, a (ɑ), ə (ɤ, e, o), (ɚ)

(ai, au, əi, əu)

Most consonants can occur in syllable initial position but only two can occur in syllable final position. The palatals [tɕ, tɕʰ, ɕ] are not included, because they can be represented as combinations of [tsj, tsʰj, sj] underlyingly. The high vowels [i, u, y] can occur before a nuclear vowel, in which case they are represented as glides. The vowel [ɑ] is an allophone of [a] and [ɤ, e, o] are allophones of [ə]. The vowel [ɚ] is in parentheses because it has limited distribution. Diphthongs are also in parentheses because they can be seen as two-vowel combinations.

A syllable in Standard Chinese can have up to four underlying phonemes CGVX (although CG is realized as a complex sound). In addition, each syllable can carry one of four tones. In principle, there are 1,900 possible full syllables without tonal contrasts, or 7,600 including tonal contrasts. The calculation is shown in (20). Since [y] does not occur in the coda, and [ɚ] is mostly limited to suffixed words, they are not included in the choices for X. I have also excluded unstressed syllables and consider there to be four possible tones per syllable.

(20) Possible combinations of syllables in Standard Chinese

Position	Choices	Notes
C	19	One of 18 Cs, or no C
G	4	One of [j, w, ɥ], or no G
V	5	One of five vowels
X	5	One of [i, u, n, ŋ] or no X
Total:	1,900	without tonal contrasts
	7,600	with tonal contrasts (four tones per syllable)

The actual number of syllables is much smaller, shown in (21). As can be seen, with or without tonal contrasts, just one fifth of the possible syllables are used.

(21) Actual and predicted numbers of full syllables in Standard Chinese

	Actual	Possible	% missing
Without tonal contrast:	404	1,900	79%
With tonal contrast:	1,297	7,200	82%

The data raise an interesting question: Why are so many possible syllables missing? The question is especially puzzling because it is often thought that Chinese has such a shortage of syllabic contrasts that it has created many disyllabic words (Wang 1944, Karlgren 1949, Lü 1963, Li & Thompson 1981, Chen 2000a).

Let us consider the missing forms in two ways. First, let us consider CG combinations. If each initial C can combine with any of the three glides, there should be 18 x 3 = 54 CG combinations. However, only twenty-nine (54%) are found. The restrictions turn out to be quite systematic: labial Cs do not combine with [w, ɥ] and velar and retroflex Cs do not combine with [j, ɥ]. In traditional feature terms, the former shows a restriction against two labials, and the latter shows a restriction against [+back, -back] or [-palatal, +palatal]. The details are shown in (22). Given the restrictions, we expect thirty-two CG forms, of which just three are missing.

(22) Expected CG forms in Standard Chinese (missing numbers in negative)

	j	w	ɥ
Labials (3): [p, p^h, f, m]	4 (-1)	-	-
Dentals (7): [t, t^h, ts, ts^h, s, n, l]	7	7	7 (-2)
Velars (3): [k, k^h, x]	-	3	-
Retroflexes (4): [ʈʂ, $ʈʂ^h$, ʂ, ʐ]	-	4	-

Expected:	32
Occurring:	29
Missing:	[fj, tɥ, t^hɥ]

Next, let us consider GVX combinations. In Standard Chinese there are 100 possible GVX forms, calculated in (23). I have ignored tonal contrasts. In addition, I have omitted the vowel [ɚ] and syllabic consonants.

(23)	Position	Choices	Notes
	G	4	One of [j, u, ɥ], or no G
	V	5	One of five vowels
	X	5	One of [i, u, n, ŋ] or no X
	Total:	100	

The 100 possible GVX forms are shown in (24). The first column indicates choices for X, the top row indicates choices for G, and 0 indicates lack of G or X. High vowels are written as glides before the nuclear vowel.

(24)

		0-	j-	w-	ɥ-	
[-0]	i	+	(+)	-	-	ji = i
	u	+	-	(+)	-	wu = u
	y	+	-	-	(+)	ɥy = y
	ə	+	+	+	+	
	a	+	+	+	-	
[-n]	in	+	(+)	-	-	jin = in
	un	-	-	-	-	
	yn	+	-	-	(+)	ɥyn = yn
	ən	+	-	+	-	
	an	+	+	+	+	
[-ŋ]	iŋ	-	-	-	-	
	uŋ	+	+	(+)	-	wuŋ = uŋ
	yŋ	-	-	-	-	
	əŋ	+	+	+	-	
	aŋ	+	+	+	-	
[-i]	ii	(+)	(+)	-	-	ii = i, jii = ji
	ui	-	-	-	-	
	yi	-	-	-	-	
	əi	+	-	+	-	
	ai	+	+	+	-	

[-u]	iu	-	-	-	-	
	uu	(+)	-	(+)	-	uu = u, wuu = wu
	yu	-	-	-	-	
	əu	+	+	-	-	
	au	+	+	-	-	

Actual +:	35
Missing - or (+):	65
Total:	100

The symbol (+) indicates a missing form that one might expect. For example, if we assume that a high vowel will automatically spread to the onset, then there is no contrast between [ji] and [i], because [i] will become [ji]. Similarly, because vowel length is predictable (long in open syllables and short in closed syllables), there is no contrast between [uu] and [u]. Even so, many GVX forms are missing.

Some attempts have been made to explain the missing forms in terms of phonological constraints. For example, Wiese (1997) proposes that many of them can be ruled out by the Obligatory Contour Principle. Similarly, Duanmu (2007) proposes that many missing forms have opposite values of the same feature. For example, [yi] is a bad combination because [y] is [+round] and [i] is [-round].

It seems that some missing forms are due to phonological restrictions. On the other hand, some missing forms seem to be accidental gaps. For example, in Standard Chinese [ma] and [mi] occur with four tones each, but [mai] and [mu] occurs with just three each; I am not aware of any reason that would rule out the missing tone in the latter. Similarly, it is unclear why [m^{j}an],

[p^jan], and [p^{hj}an] are used in Standard Chinese but [f^jan] is not. The distinction between ungrammatical forms (those ruled out by phonological restrictions) and accidental gaps (those that violate no restriction but happen not to be used) is not always easy to make. Indeed, whether such a distinction exists for every language is a matter of theoretical debate. For example, Halle (1962) and Coetzee (2006) believe that the distinction exists in a clear-cut way, while Frisch *et al*. (2000) and Boersma & Hayes (2001) argue that it is gradient. In addition, Duanmu (2008) suggests that, while there may be universally ungrammatical forms, grammaticality for a given language may not be well defined.

9. Syllable weight and tone split

When a Chinese syllable is pronounced alone, it has a tone, which is called the citation tone. A striking difference among Chinese dialects is that in many of them a citation tone stays the same whether a syllable is pronounced alone or with other syllables. In contrast, in some dialects citation tones often split into two parts, one of which is shifted to another syllable. A non-splitting dialect is Standard Chinese, illustrated in (25), and a splitting dialect is Shanghai, illustrated in (26).

(25) Stability of citation tones in Standard Chinese

Surface:	H	H	H	LH	HL	H	HL	LH
Citation:	H	H	H	LH	HL	H	HL	LH
	san	pei	san	p^han	sz	pei	sz	p^han
	‘three cups’		‘three plates’		‘four cups’		‘four plates’	

(26) Instability of citation tones in Shanghai Chinese

Surface:	H	L	H	L	L	H	L	H
Citation:	HL	HL	HL	LH	LH	HL	LH	LH
	se	pe	se	pø	sz	pe	sz	pø
	‘three cups’		‘three plates’		‘four cups’		‘four plates’	

It can be seen that while citation tones are stable in Standard Chinese, they all split in the Shanghai examples. A longer example is shown in (27), in fairly broad transcription, where | indicates a boundary between tonal domains in Shanghai.

(27) Tonal patterns in Shanghai and Standard Chinese

<table>
<tr><td>Shanghai</td><td>ku-po^{ʔ}</td><td>lu</td><td></td><td>la^{ʔ}-la^{ʔ}</td><td></td><td>t^{h}i-se</td><td>lu</td><td></td><td>pã-pi</td></tr>
<tr><td>Citation</td><td>LH-LH</td><td>LH</td><td></td><td>LH-LH</td><td></td><td>HL-HL</td><td>LH</td><td></td><td>LH-HL</td></tr>
<tr><td>Surface</td><td>L-H</td><td>0</td><td>|</td><td>L-H</td><td>|</td><td>H-L</td><td>0</td><td>|</td><td>L-H</td></tr>
<tr><td>Standard</td><td>ku-pei</td><td>lu</td><td></td><td>zai</td><td></td><td>t^{hj}an-ʂ̥an</td><td>lu</td><td></td><td>p^{h}aŋ-p^{j}an</td></tr>
<tr><td>Citation</td><td>L-L</td><td>HL</td><td></td><td>HL</td><td></td><td>H-H</td><td>HL</td><td></td><td>LH-H</td></tr>
<tr><td>Surface</td><td>LH-L</td><td>HL</td><td></td><td>HL</td><td></td><td>H-H</td><td>HL</td><td></td><td>LH-H</td></tr>
<tr><td>Gloss</td><td>Gubei</td><td>road</td><td></td><td>be-at</td><td></td><td>Tianshan</td><td>road</td><td></td><td>vicinity</td></tr>
</table>

‘Gubei Road is in the vicinity of Tianshan Road.’

We see again the stability of citation tones in Standard Chinese (except for one rule, which changes L to LH before L, as seen on the first syllable). In contrast, citation tones are lost in Shanghai unless they occur in the initial position of a domain; in addition, each surviving citation tone is split between the first two syllables of a domain.

There are two approaches to the difference between the dialects. The first is typological. For example, Yue-Hashimoto (1987) suggests that Shanghai has left-dominant tonal domains but Standard Chinese does not. Similarly, Chen (2000b) suggests that tonal domains in Shanghai are determined by left-headed stress whereas those in Standard Chinese are not. Moreover, Yip (1989) proposes that there are two kinds of tones: those in Standard Chinese are units that cannot be split, and those in Shanghai are clusters that can. However, the typological approach in effect restates the difference and offers no explanation why Shanghai behaves one way and Standard Chinese behaves another way.

In the second approach, proposed by Duanmu (1990, 1999), the difference in tonal behavior is related to an independent difference in rimes: Dialects that are like Shanghai in tonal behavior (with unstable citation tones) have no diphthongs or true codas, while dialects that are like Standard Chinese in tonal behavior (with stable citation tones) have diphthongs and/or true codas. In other words, Shanghai only has 'simple rimes' (V or C) while Standard Chinese has many 'complex rimes' (VC or VG). Consider the data in (28) and (29).

(28) Rime types in the basic vocabulary of 2,500 morphemes in Standard Chinese

VC or VG	1,519	61%	e.g. [man] 'slow', [mai] 'sell'
V or C	981	39%	e.g. [ma] 'scold', [sz] 'four'
Total	2,500	100%	

(29) Rimes in Shanghai Chinese (Duanmu 2008)

[m, n, ɚ, z, u, ø, ɔ, y, i, o, ɤ, e, a, ỹ, ĩ, õ, ɤ̃, ã, iˀ, aˀ, oˀ]

The nasal vowels in Shanghai can be represented as [Vŋ] underlyingly, and the glottalized vowels can be represented as [Vʔ] underlyingly. Both [Vŋ] and [Vʔ] can merge into a single sound without loss of underlying segmental features.

Given the difference in rime structure between Shanghai and Standard Chinese, it is possible to explain their difference in tonal behavior. First, most rimes in Standard Chinese are inherently heavy. In contrast, syllables in Shanghai have no inherent weight: they can be heavy or light, depending on the prosodic environment. They are long when spoken in isolation or in a stressed position, such as the first syllable of a disyllabic word or compound, which is a trochaic foot; otherwise the syllables are short. Phonetic studies confirm the predictions (Zhu 1995).

The relation between syllable structure and tone is mediated by stress: heavy syllables have stress and stressed syllables can carry tone (see CHAPTER 44: PITCH, DURATION, VOWEL QUALITY AND ACCENT). The principles are stated in (30) and (31).

(30) Weight-Stress Principle

a. Stressed syllables are heavy (or light syllables are unstressed).

b. Unstressed syllables are light (or heavy syllables are stressed).

(31) Tone-Stress Principle

a. Stressed syllables can be accompanied by a lexical tone (pitch accent).

b. Unstressed syllables are not accompanied by a lexical tone (pitch accent).

The Weight-Stress Principle has been proposed in various forms in the literature (e.g. Prokosch 1939, Kager 1989, Prince 1990, and Hammond 1999; CHAPTER 57: QUANTITY-SENSITIVITY). Kager (1999) refers to (30a) as the Stress-to-Weight principle, and Prince (1990) refers to (31b) as the Weight-to-Stress principle. The Weight-Stress Principle is a bidirectional requirement on the relation between weight and stress, regardless of which comes first.

The Tone-Stress Principle has also been proposed in various forms in the literature (e.g. Liberman 1975, Clements & Ford 1979, Pierrehumbert 1980, and Goldsmith 1981). In Chinese, the Tone-Stress Principle is evidenced by the fact that unstressed syllables lose their lexical tones. In English, it is evidenced by the fact that only stressed syllables are assigned a pitch accent.

If a language has many complex rimes, then many syllables will remain heavy and stressed. And because they are stressed, they will keep their lexical tones. The chances for tone split will be low, because most syllables have their own tones and cannot take those from others. In contrast, if a language has no complex rime, then many syllables can become light and unstressed (unless they occur in prosodically strong positions, which are initial positions in trochaic feet). And because they are unstressed, they will lose their lexical tones. The chances for tone split will be high then, because many syllables are toneless and can take a piece from another syllable. A detailed analysis is offered in Duanmu (2008: ch. 7).

Leben (1973) observes a similar pattern in the African language Mende. For example, in a compound made of two monosyllabic words, the second word will lose its underlying tone, and the tone of the first word will spread over both syllables. The Mende case would be expected if it lack CVX syllables and if its compounds form trochaic feet.

10. Suffixation and rime changes

Many Chinese dialects have suffixes that merge with the preceding syllable. The most common case is the diminutive suffix. In some dialects the rime change is quite simple, whereas in others it can be quite complicated. Let us begin with Chengdu, shown in (32). The process is quite straightforward: in the diminutive form, the rime is replaced by [ɚː].

(32) Diminutive suffix in Chengdu

Word	Diminutive	Gloss
[kən]	[kɚː]	‘root’
[kau]	[kɚː]	‘cake’
[kou]	[kɚː]	‘dog’
[p^jan]	[p^jɚː]	‘side’
[k^wan]	[k^wɚː]	‘hall’
[ja]	[jɚː]	‘bud’
[wan]	[wɚː]	‘bowl’
[yan]	[yɚː]	‘yard’

Next we consider diminutive forms in Standard Chinese, which are more complicated. Some examples are shown in (33).

(33) Diminutive forms in Standard Chinese

Word	Diminutive	Gloss
[pʰai]	[pʰaɚ]	‘plaque’
[pʰi:]	[pʰʲɚ:]	‘skin’
[pʰan]	[pʰaɚ]	‘dish’
[jaŋ]	[jãɚ̃]	‘lamb’
[nʲau]	[nʲauᵊ˞]	‘bird’
[tʰu:]	[tʰuᵊ˞:]	‘rabbit’

In the first three cases the suffix replaces [n] and [i], although in the third case [i] survives as a glide on the onset. In the fourth case the suffix replaces the coda, but part of the coda is preserved as nasalization on the rime. In the last two cases the suffix is realized as a retroflex color on the original vowel. A number of questions arise about the suffixation process. For example, is the suffix a syllable, a vowel, a consonant, or a just feature? Why is the coda or the vowel completely replaced in some case but partially retained in others? Can the suffixation process create syllables not found in unsuffixed words?

Suffixation in Standard Chinese has been analyzed by Lin (1989), Wang (1993), and Duanmu (1990, 2007), among others. The consensus is that, the suffix is a retroflex coronal sound or feature, which will replace a sound that has a non-retroflex coronal component (essentially [i] and [n]). Otherwise, the suffix is superimposed on the rime, but the rime structure remains the same, which is VX.

Finally, let us consider Yanggu, which is among the most complicated cases. The original data come from Dong (1985), who distinguishes four patterns, shown in (34), where the regular word precedes the diminutive form.

(34) Diminutive forms in Yanggu

a. […ɭ] when nucleus is [i, y, z]

[p^{h}i]	[p^{h}iɭ]	‘skin’
[ɕin]	[ɕiɭ]	‘heart’
[ti]	[tiɭ]	‘flute’
[tɕ^{h}y]	[tɕ^{h}yɭ]	‘tune’
[sz]	[sɭ]	‘silk’

b. […r] when nucleus is not [i, y, z] and initial C is not dental, without prenuclear [i, y]

[pao]	[paor]	‘bag’
[p^{h}ɛ]	[p^{h}ɛr]	‘plaque’
[xou]	[xour]	‘monkey’
[kən]	[kər]	‘root’
[ʂə]	[ʂər]	‘tongue’
[kua]	[kuar]	‘melon’

c. [l…r] when nucleus is not [i, y, z] and initial C is dental, , without prenuclear [i, y]

[tao]	[tlaor]	‘knife’
[tsuan]	[tsluɛr]	‘drill’
[na]	[nlar]	‘to press’
[tan]	[tlɛr]	‘single’
[tsuə]	[tsluər]	‘seat’
[tʰu]	[tʰlur]	‘rabbit’

d. Disyllabic with prenuclear [i, y] when nucleus is not [i, y]

[ɕiɛ]	[ɕilɛr]	‘shoe’
[ie]	[iler]	‘leaf’
[piao]	[pilaor]	‘mark’
[tɕiou]	[tɕilour]	‘wine’
[yə]	[ylər]	‘medicine’
[yan]	[ylɛr]	‘garden’
[pjan]	[pilɛr]	‘pony tail’

Three observations can be made. First, the diminutive form does not increase the rime size; in particular, [aor] is probably a retroflex [ao] (or [au]) and [our] is probably a retroflex [ou]. Second, there is a set of exceptions to (34a), not listed above, such as [tsʰuən]-[tsʰuəɭ] ‘village’ and [suəi]-[suəɭ] ‘ear of grain’. Dong (1985: 276) remarks that the exceptions ought to belong to

(34c), i.e. 'village' should be [ts^huən]-[ts^hluər] and 'ear of grain' should be [suəi]-[sluər], which would resolve the exceptions. Third, the four patterns are largely predictable, although we need to consider the initial C, the medial glide, and the nuclear vowel.

There are two approaches to the analysis of Yanggu. In the first, there is an infix and a suffix, which interact with the sounds in the host syllable (Lin 1989, Yip 1992). In the second approach, there is a retroflex suffix [r], which spreads the feature [+retroflex] leftward; the spreading interacts with [-retroflex] sounds in various ways (Duanmu 1990, Chen 1992). The medial [l] is not always a separate sound, but can be 'a transitional lateral release between two antagonistic articulatory gestures' (Chen 1992: 197), i.e. between [-retroflex] and [+retroflex]. The second approach is more consistent with diminutive forms in other Chinese dialects and the fact that the diminutive form originates from a (historical) suffix that originally means 'child' or 'son'.

11. Syllables and morphemes

Written Chinese is made of a sequence of graphs, each taking up a fixed amount of space. Each graph is called a *zi* (字) or character, which represents both a syllable and a morpheme. Exceptions exist but are not many. Consider the examples in (35) and (36). For clarity I use a hyphen to separate syllables in the Pinyin spelling system.

(35) Two syllables (morphemes) per graph

Pinyin	Character	Gloss
qian-wa	千瓦 or 瓩	'kilowatt'
ying-chi	英尺 or 呎	'English foot (unit of length)'

(36) Polysyllabic morphemes

Pinyin	Character	Gloss
ma-nao	玛瑙	‘amber’
bian-fu	蝙蝠	‘bat’
jia-na-da	加拿大	‘Canada’
jia-li-fu-ni-ya	加利福尼亚	‘California’

The compound ‘kilowatt’ can be written as two characters or as one, although the latter is still pronounced as two syllables. Similarly, the compound ‘English foot’ can be written as two characters or as one (where 呎 is created for the English foot, in contrast to the comparable Chinese unit, which is 尺), although the latter is still pronounced as two syllables. Such cases of two syllables per graph are rare and seem to be innovations in competition with the standard practice, which is one syllable per graph.

There are more examples of polysyllabic morphemes, especially translated names. However, polysyllabic morphemes can often be truncated to a monosyllable, typically in a compound. This is illustrated in (37).

(37) Truncation of polysyllabic morpheme to monosyllabic ones

Non-truncated	Truncated	Gloss
bian-fu chao	*bian chao*	‘bat nest’
蝙蝠 巢	蝙 巢	
jia-na-da yuan	*jia yuan*	‘Canadian dollar’
加拿大 元	加 元	

jia-li-fu-ni-ya zhou	*jia zhou*	'California State'
加利福尼亚 州	加 州	

The compound *bian-chao* 'bat nest' was made up by me but seems quite acceptable. The compounds *jia-zhou* 'California State' and *jia-yuan* 'Canadian dollar' are real ones.

Overall, it is fair to say that every syllable is a morpheme (or a perceived morpheme) in Chinese. In addition, since most morphemes are also words in Chinese, it is fair to say that most Chinese syllables are words, or that most Chinese words are monosyllabic.

The close relation between syllables and words in Chinese raises an interesting question. If we find a generalization for the Chinese syllable, how do we know whether it is indeed a generalization for syllables and not a generalization for words? For example, should we say that every syllable in Chinese has a tone, or should we say that every word in Chinese has a tone?

12. Statistic data on syllables in Standard Chinese

Compared to English, Standard Chinese has a fairly small inventory of syllables. Consider the data in (38) and (39). A simplex word is one that contains one morpheme.

(38) Monosyllabic simplex words in English (CELEX lexicon, Baayen *et al*. 1995)

(All simplex words:	7,401)
Monosyllabic simplex words:	3,834
Different pronunciations:	3,219

(39) Syllables in Standard Chinese

Vocabulary type:	All	Common
Characters:	12,041	2,500
Syllables (with tones):	1,334	1,001
Syllables (without tones):	413	386

English has over 3,000 monosyllables in simplex words. In contrast, Standard Chinese has about 1,000 syllables including tones, or 400 excluding tones.

Although Standard Chinese has just 1,334 syllables (including tones), only about 1,000 are commonly used. Therefore, up to 300 syllables are unfamiliar to the average speaker. This is confirmed by the study of Myers & Tsay (2005), who found that acceptability judgments on possible syllables in Standard Chinese are gradient and influenced by lexical frequency.

Next consider onset and rime frequencies. If we split each of the 2,500 common characters (morphemes) into an onset and a rime, we get 2,500 rime tokens and a slightly smaller number of onset tokens (some syllables do not have an onset). The onset frequencies are shown in parentheses in (40), based on Duanmu (2008), where CG is transcribed as a single sound. The symbol Ø indicates lack of an onset, which is found in thirty characters. It is interesting to see that the retroflex sounds [ʈʂ], [ʈʂ^{h}], and [ʂ] are among the most frequent onsets.

(40) Fifty-five onsets ranked by frequencies, in the basic lexicon of 2,500 characters in Standard Chinese.

ts^{j} (177)	j (143)	s^{j} (120)	ʈʂ (107)	ʂ (107)	ʈʂ^{h} (78)	w (77)
ts^{hj} (75)	p (75)	l^{j} (75)	x^{w} (72)	f (60)	k^{w} (58)	ɥ (54)

t (54)	k (54)	m (53)	t^{h} (49)	ʈʂ^{w} (46)	x (42)	ts (41)
l (41)	ts^{h} (40)	p^{j} (38)	t^{w} (36)	t^{j} (36)	ʈʂ^{hw} (34)	ʂ^{w} (34)
ts^{ɥ} (33)	p^{h} (33)	k^{hw} (33)	k^{h} (33)	s^{ɥ} (32)	t^{hw} (30)	f^{w} (30)
Ø (30)	t^{hj} (29)	s (29)	l^{w} (29)	s^{w} (28)	p^{hj} (27)	m^{j} (26)
ts^{w} (24)	ts^{hɥ} (24)	ʐ (23)	m^{w} (22)	n^{j} (18)	n (18)	ts^{hw} (17)
ʐ^{w} (15)	p^{hw} (14)	l^{ɥ} (10)	p^{w} (8)	n^{w} (8)	n^{ɥ} (1)	

The 2,500 rimes fall into twenty-one types. Their frequencies are shown in (41). The rimes [o, e, ɤ] are allophones of the phoneme [ə], where [o] occurs after [u] or a labial consonant, [e] occurs after [i] or [y], and [ɤ] occurs in other open heavy syllables.

(41) Twenty-one rimes ranked by frequencies, in the basic lexicon of 2,500 characters.

an (349)	u (206)	aŋ (194)	i (192)	au (189)	əŋ (178)	a (134)
əu (120)	əi (116)	ən (109)	uŋ (96)	o (96)	ai (93)	e (89)
ʐ (84)	ɤ (78)	y (74)	in (71)	z (27)	aɚ (4)	ə (1)

Type:	VC	VG	V or C	All
Count:	1,001	518	981	2,500

It is worth noting that 61% of the rimes are VC or VG (diphthongs), while just 39% of the rimes are V (realized a long vowel in a heavy rime) or C (syllabic [ʐ, z]).

Next consider tonal frequencies in Standard Chinese, shown in (42), from Duanmu (2008), where the values of T1-T4 are H, LH, L, and HL respectively, and T5 indicates the lack of a lexical tone in unstressed syllables.

(42) Tonal frequencies in the basic lexicon of 2,500 morphemes in Standard Chinese.

Tone type	T1	T2	T3	T4	T5	All
Tone values	H	LH	L	HL	Ø	
Count	587	627	444	837	5	2,500
	23.5%	25.1%	17.8%	33.5%	0.2%	100.0%

The T5 syllables include three interjections (*la*, *me*, and *ne*) and two grammatical particles (the aspect marker *le* and the nominal modification marker *de*). One might get the impressions that most words in Chinese are stressed. But my own examination of natural speech shows that about one third of all syllables are unstressed. This is because many full syllables can become unstressed in context (especially in compounds), in which case they lose their lexical tones and become T5. The data above do not reflect de-stressing in natural speech.

The 2,500 common morphemes are made of 385 different syllables. In principle, each full syllable can take four lexical tones. In fact, however, only a fifth of the syllables have four tones each. This is shown in (43).

(43) Tones per syllable in the 2,500 common morphemes.

1	2	3	4	5	All
19%	24%	35%	22%	0%	100.0%

Most syllables have three tones each and over 40% of the syllables have just one or two tones each. No syllable has all five tones, because only unstressed syllables have T5, and unstressed syllables may appear to have a different vowel. For example, the T5 syllable [mə] (an interjection) is spelled as *me*, instead of *ma*. If it is spelled as *ma*, then this syllable would have all five tones (ignoring vowel length).

Finally, let us consider how many morphemes a syllable can represent. For simplicity, let us assume that each written character represents a morpheme. If we include tones, there are 1,001 different syllables representing the 2,500 common morphemes. As shown in (44), the number of morphemes per syllable ranges from one to twenty (tones transcribed as 1-4). It can be seen that 43% of the syllables are unambiguous, representing just one morpheme each.

(44) Top five and bottom two numbers of morphemes per syllable, including tones, among the 2,500 common morphemes.

No. of morphemes	No. of such syllables	
20	1	[ʂʐ̩4]
15	1	[i4]
13	2	[fu4, tɕan4]
12	3	[tɕi2, tɕi4, y4]
11	2	[li4, ʈʂʐ̩1]
2	229	(23%)
1	432	(43%)

If we ignore tones, there are 385 different syllables. As shown in (45), the number of morphemes per syllable ranges from one to thirty-eight.

(45) Top six and bottom four numbers of morphemes per syllable, excluding tones, among the 2,500 common morphemes.

No. of morphemes	No. of such syllables	
38	1	[ʂʐ̩]
36	1	[tɕi]
33	1	[tʂʐ̩]
32	1	[i]
31	1	[tɕan]
29	1	[fu]
4	38	(10%)
3	46	(12%)
2	42	(11%)
1	47	(12%)

It can be seen that most of the syllables that represent the largest numbers of morphemes are not what are commonly found in other languages, such as English.

13. Shrinking syllable inventory

In the riming book *Guangyun*, written in 1008, Chinese had about 3,800 syllables. In contrast, modern Standard Chinese has about 1,300 syllables. Thus, in a matter of 1,000 years, Chinese lost over 60% of its syllables. Moreover, the syllable inventory of modern Chinese continues to shrink. For example, of the 1,300 syllables in Standard Chinese, only 1,000 are commonly used (which cover 99% of modern text corpora).

It is not obvious how one should interpret the massive loss of syllables, but here are some possibilities. First, *Guangyun* might not represent a single dialect, but a mixture of more than one dialect. In contrast, Standard Chinese is essentially a single dialect. Therefore, the loss of syllables may not be as dramatic as it seems. Second, modern Chinese has developed many disyllabic words, and so a reduction in syllable inventory is harmless (no danger of causing ambiguities). This interpretation raises new questions though. For example, did syllable loss come before or after the increase of disyllabic words? If before, why did syllable loss occur in the first place? If after, why was there an increase of disyllabic words? Would we expect similar syllable loss in English, which also has many polysyllabic words? A third interpretation is that, paradoxically, in a language with a small syllable inventory, syllable loss is expected to be fast. Studies on frequency effects suggest that frequent words are more likely to undergo reduction than infrequent words (e.g. Fidelholtz 1975, Bybee 2001). If so, Chinese syllables are more likely to undergo reduction, because Chinese has fewer syllables than English and so Chinese syllables are used much more frequently.

14. Final remark

I hope to have shown that, despite its apparently simple structure, there are many interesting questions about the Chinese syllable, and many interesting proposals to address them, even though a consensus or satisfactorily solutions are sometimes still to be reached.

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