Syllable Structure

San Duanmu

In *Encyclopedia of Chinese Language and Linguistics*,
Volume 4, ed. Rint Sybesma (general editor), 230-236. Leiden: Brill.

Summary
Despite its seemingly simple structure, there are many interesting questions about the Chinese syllable, such as its size, its structure, its interaction with stress and tone, and why the syllable inventory is so sparsely populated.

Keywords:
Weight-Stress Principle, Tone-Stress Principle, missing syllables, syllabic consonants

1. Introduction

In this article "Chinese" refers generally to all varieties and dialects. The boundaries of the syllable are fairly clear in Chinese. In most cases, each Chinese written graph, *zì* 字, represents a syllable and thus syllable boundaries are unambiguous in writing. In most cases, each morpheme also corresponds to a spoken syllable, which may help speakers judge syllable boundaries whether they are literate or not. Chinese scholars have studied syllables for a long time. For example, Sūn Yán 孫炎 of the Three Kingdoms period (about 200-280) used a method, known as *fǎnqiē* 反切 'reverse cut', to indicate pronunciation in his book *Ěryǎ Yīn Yì* 《爾雅音義》. Similarly, medieval Chinese rhyme books grouped written graphs into different sets based on their similarities in pronunciation. But some important questions were rarely discussed until modern times, such as the size and the structure of syllables, the relation between syllable structure, stress, and tone, and the compatibility of sounds within a syllable, which we address below.

2. Syllable size and syllable structure

The analysis of syllables depends on the analysis of what a sound unit, or phoneme, is (where a sound unit can be V (vowel), C (consonant), or G (glide)). For example, for Hartman (1944) the word *shǎo* 少 "less" in Beijing Chinese is CCVG and has four phonemes /sraw/, whereas for Yóu *et al*. (1980) the word is CV and has two phonemes /ʂa^{u}/, where /a^{u}/ is a single vowel. In what follows we assume the analysis of Duanmu (2007), according to which Standard Chinese has five vowel phonemes /i, u, y, ə, a/, nineteen consonant phonemes /p, t, k, p^{h}, t^{h}, k^{h}, m, n, ŋ, l, f, s, ʂ, z̩, ts, ts^{h}, ʈʂ, ʈʂ^{h}, x/, and a marginal vowel /ɚ/. The glides [j, w, ɥ] can be derived from /i, u, y/ and the consonants [tɕ, tɕ^{h}, ɕ] can be derived from /tsi, ts^{h}i, si/. Variations of the phonemes occur, such as consonant voicing, vowel nasalization, high vowel devoicing, retroflex colored vowels, the fronting of /a/, and the fronting or rounding of /ə/, as detailed in Duanmu 2007.

The largest Chinese syllable, regardless of the dialect, contains four phonemes, CGVX, where G is a pre-nuclear high vowel, transcribed as a glide, and VX can be VV (a diphthong or long vowel) or VC. Syllables larger than CGVX are sometimes found in limited environments, to be discussed below. Some examples of CGVX syllables are shown in (1) (tones omitted).

(1) The maximal syllable in Standard Chinese

[k^hwai]	[kwaː]	[t^hjan]	[kwaŋ]	[tswan]
快	瓜	天	光	鑽
‘fast’	‘melon’	‘day’	‘light’	‘diamond’

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

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

	C	G	V	X
S. C.	any C but /ŋ/	/i, u, y/	any V	/i, u, n, ŋ, ɚ/
Cantonese	any C	/u/	any V	/i, u, n, m, ŋ, p, t, k/
Shanghai	any C	/i, u, y/	any V	(/ʔ, ŋ/)

In Shanghai, only /ʔ, ŋ/ can occur in the X position; in addition, they often combine with the preceding vowel to form a glottalized V or a nasalized V. Therefore, all syllables in Shanghai behave like open syllables. There are a few dialects in which G can be [l] or [r]; for example, medial [l] occurs in some diminutive forms in *Yánggǔ* 陽谷 (Dǒng 1985, Lin 1989).

Rimes larger than VX have been reported, but they either occur in restricted positions, or can be analyzed in other ways. For example, in Beijing a syllable with full third tone is found in pre-pause position and is considerably longer than it is in other positions. Woo (1969) considers the lengthened syllable to have three moras, whereas regular syllables have two moras. Similarly, some rimes in Fuzhou show up as VVC in final position but VC otherwise. Moreover, there is a contrast between [sam] 心 ‘heart’ and [saːm] 衫 ‘shirt’ in Cantonese, where the rime of [saːm] seems to be VVC. However, the contrast does not lie in length alone but also in quality. For example, Huang (1970: xiii) transcribes the words as [səm] 心 ‘heart’ and [saːm] 衫 ‘shirt’. Once we recognize the quality difference, the length difference becomes redundant and both syllables can be treated as CVC.

It is less obvious how to analyze CGVX in terms of internal structure. Various views have been proposed, such as [C [GVX]] (Xǔ 1980: 80), [C [G [VX]] (Cheng 1966: 136), and [[CG][VX]] (Bāo *et al*. 1997: 87). The simplest proposal is [C^G[VX]], where C^G is a complex sound (Duanmu 1990, 2007). This proposal is called the CVX theory, illustrated in (3). It has been argued to apply to English and other languages, too (Duanmu 2008).

(3) The CVX analysis of the maximal Chinese syllable

[k^{hw}ai]	[k^waː]	[t^{hj}an]	[k^waŋ]	[ts^wan]
快	瓜	天	光	鑽
‘fast’	‘melon’	‘day’	‘light’	‘diamond’

Two other issues with regard to syllable structure merit attention. One is whether all syllables must have an onset, regardless of the language. Some scholars believe so and some do not (see Duanmu 2008 for a review of the arguments). Another issue is whether every syllable needs a vowel, regardless of the language. Phonetically, some Chinese syllables clearly have no vowel, such as /n/ 魚 ‘fish’ in Shanghai and /m/ 唔 ‘not’ in Cantonese, where the mouth is closed

throughout. For linguists who believe that every syllable must have a vowel (e.g. Luó and Wáng 1957, Cheung 1986), a hidden vowel must be proposed. For example, Cheung (1986: 150) proposes that the underlying form of [mː] 唔 'not' in Cantonese is not /m/ but /miːm/, where the hidden vowel [iː] is not pronounced. Such proposals remain to be justified.

Different views on syllabic consonants yield different transcriptions. For example, the transcription in (4) assumes syllabic consonants (e.g. Dǒng 1958: 37, Chao 1968: 24, Ramsey 1987, Wiese 1997, and Duanmu 2007).

(4) Syllabic [z] and [ʐ̩] in Standard Chinese

[z]:	tsz	tsʰz	sz	
	自	次	四	
	'self'	'time'	'four'	
[ʐ̩]:	ʈʂʐ̩	ʈʂʰʐ̩	ʂʐ̩	ʐʐ̩
	纸	齿	史	日
	'paper'	'tooth'	'history'	'sun'

In contrast, those who do not assume syllabic consonants would transcribe the above rimes with two special vowels [ɿ, ʅ], known as "apical vowels" (*shéjiān yuányīn* 舌尖元音; Karlgren 1915-1926, Zee and Lee 2007). Some linguists vacillate between the positions. For example, Lee and Zee (2003) use the terms "syllabic consonant" and "apical vowel" for the same sounds. Similarly, Ao (1993: 59) uses "fricative vowels" to refer to such sounds in Nántōng 南通 Chinese, although he transcribes them as syllabic fricatives, such as [z̩, β̩].

Many Chinese dialects have suffixes that merge with the preceding syllable. The process usually modifies the final consonant or the rime (e.g. Lin 1989 and Lin 1993), but the resulting syllable remains within the CGVX template (Duanmu 2007).

3. The Weight-Stress Principle and the Tone-Stress Principle

Syllables can be divided into two kinds depending on whether the rime is short or long. A long rime has two positions, which can be filled by one long sound (consonant or vowel) or two short ones. A short rime has one position. Syllables with a long rime are called "heavy" and those with a short rime are called "light". Some examples are shown in (5), where [mː] has a long consonant in the rime.

(5) Heavy syllables in Standard Chinese

[nʲau]	[waː]	[mau]	[ai]	[ɤː]	[mː]
鳥	蛙	貓	愛	鵝	呣
'bird'	'frog'	'cat'	'love'	'goose'	'yes?'

Light syllables in Standard Chinese

[lə]	了 (aspect marker)
[tə]	的 (possessive marker)

Light syllables are mostly function words, traditionally called *xūcí* 虛詞 'empty words'. Heavy and light syllables have different properties. In particular, heavy syllables are phonetically long and carry a lexical tone, whereas light syllables are short and do not carry a lexical tone (Lin and Yan 1988). The difference can be described by two phonological principles, the requirement of foot binarity, and the definition of stress, shown in (6)-(9). It can be seen that there is some overlap among (6), (8), and (9), but we shall not pursue how to eliminate the redundancy here.

(6) The Weight-Stress Principle (WSP):
A syllable is stressed if and only if it is heavy.

(7) The Tone-Stress Principle (TSP):
A stressed syllable can be assigned a lexical tone or pitch accent.
An unstressed syllable cannot be assigned a lexical tone or pitch accent.

(8) Foot Binarity (m = mora, s = syllable, underline = stress):
Moraic foot: (<u>m</u>m)
Syllabic foot: (<u>s</u>s)

(9) Metrical definition of stress: Stress is the head of a foot.
Implications: The presence of stress implies the existence of a foot and vice versa.

When a stressed syllable has several choices of tonal units that make lexical distinctions (as in Chinese), those units are called lexical tones. When a stressed syllable has just one or two choices of tonal units (as in Japanese or Swedish), they are often called pitch accents. When a stressed syllable has several choices of tonal units that distinguish contextual meanings but not lexical meanings (such as 'yes!' vs. 'yes?' in English), they are also called pitch accents.

The WSP, the TSP, and Foot Binarity have been proposed in various forms in the literature and are found to have cross-linguistic support. For example, the TSP has been proposed for Japanese and English, where pitch accents are assigned to (or aligned with) stressed syllables and not to unstressed ones (e.g. McCawley 1965, Liberman 1975, Pierrehumbert 1980, Goldsmith 1981). The definitions here are based on Duanmu (2007, 2008, 2011).

A mora is a rime unit. A heavy syllable has two moras, can form a moraic foot, and hence has stress. By the TSP, a heavy syllable can also keep its lexical tone. In contrast, a light syllable has one mora and cannot form a foot, and by the TSP it cannot keep a lexical tone. The principles also explain why, when a syllable loses stress, it loses its tone and undergoes rime reduction. Some examples are shown in (10), where tone is not transcribed. As can be seen, rime reduction shortens the rime, which causes the coda consonant to drop and the vowel to shorten or change quality.

(10) Rime reduction in unstressed syllables in Standard Chinese

(With tone) Stressed	(No tone) Unstressed	Example
[kɤː]	[kə]	[kɤːkə] 哥哥‘brother’
[maː]	[mə]	a question marker, as in [tʷei.mə] 對嗎 ‘right?’
[faŋ]	[fə̃]	[tiː.fə̃] 地方 ‘land-direction (place)’
[tʰou]	[tʰo]	[muː.tʰo] 木頭 ‘wood-head (wood)’
[tai]	[te]	[nau.te] 腦袋 ‘head-bag (head)’

The phonetic difference between heavy and light syllables is very clear to native speakers. Now, because the lack of stress co-occurs with the lack of a lexical tone, one might propose that it is sufficient to attribute the difference between the syllable types to tone alone, without assuming any stress distinction. However, this proposal has several shortcomings. First, the difference between heavy and light syllables remains even when pitch is factored out, as in whispered speech. Therefore, we need to explain differences such as duration, coda loss, and vowel quality, which are expected by the WSP, without reference to tone. Second, we need to assume stress anyway to account for differences among heavy syllables; for example, there is a general agreement that in Beijing Mandarin a common stress pattern for a three-syllable name or compound is 2-3-1, where 1 represents the greatest stress and 3 the weakest, as in *Jiānádà* 加拿大 ‘Canada’ and *jìsuànjī* 計算機 ‘computer’ (e.g. Chao 1968). Third, in some dialects, such as Shànghǎi 上海, there is extensive deletion of lexical tones, and this happens only if the dialect has no diphthongs or VC rimes (Duanmu 1999). The correlation between tone deletion and rime structure is hard to account for if we do not assume stress. Finally, while omitting stress may seem economical for the description of Chinese, we would lose considerable cross-linguistic generalizations with regard to the interaction among syllable structure, stress, and tone-bearing ability.

4. Careful vs. casual speech

Phonological studies of syllables often focus on careful speech. In casual speech, many more syllables can be found. Consider the example in (11) from Standard Chinese.

(11) [woː mən] → [wom]
我們 ‘first-person plural pronoun (we)’

The resulting syllable is new because Standard Chinese has no [wom] in careful speech. Similarly, devoicing of non-low vowels often happens for syllables that have an aspirated onset (including voiceless fricatives) and a low tone. Since devoiced vowels look like syllabic consonants, they raise the question of whether every syllable needs a vowel. Two examples are shown in (12), where H, LH, and L are feature representations of first, second, and third tones respectively in Standard Chinese. When a sound is devoiced, the tone cannot be heard, which is indicated by Ø.

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

	H-L	H-Ø	
[u]→[x^w]	ɕin-k^huː →	ɕin-$k^h x^w$ː	辛苦 ‘toil’
	L-LH	Ø-LH	
[ɤ]→[x]	k^hɤː-nəŋ →	k^hxː-nəŋ	可能 ‘possible’

Devoiced syllables are still perceived as separate syllables, in part because their duration is similar to that of the original syllable. If one insists that every syllable must have a vowel, one can transcribe the rimes with devoiced vowels like [i̥, ɤ̥]. Syllabic consonants can be devoiced, too. Some examples are shown in (13), where HL is a feature representation of fourth tone in Standard Chinese.

(13) Devoicing of syllabic consonants in Standard Chinese

	HL-L	HL-Ø	
[ʊ]→[f]	təu-fʊː →	təu-fː	豆腐 ‘tofu’
	HL-L	HL-Ø	
[z]→[s]	ʂaŋ-ts^hzː →	ʂaŋ-ts^hsː	上次 ‘last time’
	HL-L	HL-Ø	
[ʐ̩]→[ʂ]	liː-ʂʐ̩ →	liː-ʂː	曆史 ‘history’

Casual speech can also create syllables that already exist through contraction. Some examples in Standard Chinese are shown in (14) (transcription after Duanmu 2007).

(14)

HL-HL	HL	
[tɕəu-jau] →	[tɕau]	就要 ‘soon will’ (same as 叫 ‘shout’)
LH-HL	HL	
[ʂʐ̩-xəu] →	[ʂəu]	時候 ‘time’ (same as 瘦 ‘thin’)

Casual speech forms, if used frequently, can acquire the status of regular words and retain their monosyllabic form in careful speech. In Standard Chinese, [pəŋ] 甭 comes from [puː juŋ] 不用 ‘no need’, and [nei] 那 comes from [naː jiː] 那一 ‘that one’.

5. Syllable inventory

A phonological study of any variety of Chinese often includes a complete inventory of all its syllables. In contrast, I am not aware of any study of English that does so. The reason seems to be twofold. First, there are only several hundred syllables in any form of Chinese (ignoring tone) and listing a full inventory is feasible. In contrast, English syllables are at least in the thousands, too many to list. Second, it is not always clear what constitutes an English syllable. Some believe that it can be as large as CCCVCCCC, while others believe that it is much smaller (see Duanmu 2008 for various views). For example, some linguists analyze *text* as /tɛkst/, where all five sounds are part of the syllable, and some analyze it as /tɛk/<st>, where <st> is outside the

syllable. In Chinese, syllable boundaries are clear and there is no question of extra-syllabic sounds.

Once we know the syllable inventory, we can compare it with the general syllable structure and ask how many syllables are missing, whether accidentally or systematically. Let us consider Standard Chinese as an example. Given the template CGVX, there are at least 1,900 possible syllables (ignoring tonal contrasts). The calculation is shown in (15).

(15) Possible combinations of syllables in Standard Chinese (ignoring tone)

Position	Choices	Notes
C	19	one of 19 Cs except [ŋ], or no C
G	4	one of [j, w, ɥ], or no G
V	5	one of five vowels (ignoring the marginal vowel [ɚ])
X	5	one of [i, u, n, ŋ] or no X
Total:	1,900	

The number of occurring syllables is much smaller, shown in (16) (Duanmu 2007). As can be seen, just one fifth of the possible combinations are used.

(16) Possible and occurring syllables in Standard Chinese

Occurring	Possible	% missing
404	1,900	79%

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 an impermissible combination because [y] is [+round] and [i] is [-round]. On the other hand, some missing forms do not seem to violate any phonological constraint and appear to be accidental gaps. For example, Standard Chinese has [ʈʂuŋ] (e.g. *zhōng* 中), [ʈʂʰuŋ] (e.g. *chōng* 衝), and [ʐuŋ] (e.g. *róng* 榮) but no [ʂuŋ]. The distinction between ungrammatical forms (those ruled out by phonetic or phonological restrictions) and accidental gaps (those that violate no known restriction but happen not to occur) is, however, 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, but Frisch *et al*. (2000) and Boersma and Hayes (2001) argue that it does not (or that at least it is a gradient).

The high percentage of missing syllables in Chinese also raises another question: Is there more ambiguity in spoken Chinese than in spoken English? The answer seems to be yes, but there is no study to demonstrate it, in part because it is not easy to measure ambiguity in context. For illustration, let us consider how many morphemes a syllable can represent. We can define a Chinese morpheme in two ways: (a) a monosyllabic lexical entry or (b) a monosyllabic sense. In the dictionary *Xiàndài Hànyǔ Cídiǎn* 《现代汉语词典》 (fifth edition, 2005), there are 10,242 monosyllabic entries; each entry on average has two senses, which usually differ in the part of speech (POS). For example, the entry *chǎn* 鏟 has the senses ‘shovel’ (a noun) and ‘to shovel’ (a verb), and the entry *chǎng* 敞 has the senses ‘open’ (an adjective) and ‘to open’ (a verb). If we ignore POS, Chinese has about 10,000 morphemes, which are represented by about 9,000

distinct written graphs (*zì*). In other words, each *zì* more or less represents a morpheme. About 99% of daily usage is covered by 2,500 common *zì* (Da 2004, Duanmu 2008: 90), which are represented by 1,001 different syllables (including tone). The number of morphemes per syllable ranges from one to twenty, as shown in (17).

(17) Top five and bottom two numbers of morphemes per syllable among the 2,500 most common *zì* 字.

Number of morphemes represented by one syllable	Number of syllables representing that many morphemes	
20	1	*shì*
15	1	*yì*
13	2	*fù, jiàn*
12	3	*jí, jì, yù*
11	2	*lì, zhī*
2	229	(23%)
1	432	(43%)

It can be seen that 43% of the syllables are unambiguous, representing just one morpheme each. It is also worth noting that most Chinese morphemes or words have elastic length (Guō 1938, Huáng and Duānmù 2013), with a monosyllabic form and a disyllabic form, such as *xué-(xí)* 學習 'study', *méi-(tàn)* 煤炭 'coal', and *(lǎo)-hǔ* 老虎 'tiger', where the redundant part (semantically empty) is shown in parentheses. So should there be a risk of ambiguity, the speaker has little trouble avoiding it by employing the disyllabic form.

6. Summary

Despite its seemingly simple structure, there are many interesting questions about the Chinese syllable, such as the maximal size of the syllable, its structure, its interaction with stress and tone, and the high percentage of missing forms in the syllable inventory. Some of the issues relate to long-standing debates in Chinese phonology, such as whether a Chinese syllable can be larger than CGVX, whether Chinese syllables can be divided into heavy and light types, and whether Chinese has stress. Some of the issues bear on general linguistic theories or the universality of certain phonological constraints, such as whether an onset is obligatory, whether every syllable must have a vowel, whether tones or pitch accents are always assigned to stressed syllables, and the relation between syllable weight and stress.

References:

Ao, Benjamin X.P., *Phonetics and phonology of Nantong Chinese*, Doctoral dissertation, Ohio State University, Columbus, 1993.

Bāo Zhìmíng 包智民, Shì Jiànguó 侍建国, and Xǔ Débǎo 许德宝, *Shēngchéng yīnxìxué lǐlùn jíqí yìngyòng* 《生成音系学理论及其应用》 [Generative phonology: theory and usage]. Běijīng 北京: Zhōngguó Shèhuì Kēxué Chūbǎnshè 中国社会科学出版社, 1997.

Boersma, Paul and Bruce Hayes, "Empirical tests of the Gradual Learning Algorithm", *Linguistic Inquiry* 32.1, 2001, 45–86.

Chao, Yuen-Ren, *A grammar of spoken Chinese*, Berkeley: University of California Press, 1968.

Cheng, Robert L., “Mandarin phonological structure”, *Journal of Linguistics* 2.2, 1966, 135-158.
Cheung, Kwan-Hin, *The phonology of present-day Cantonese*, Doctoral dissertation, University of London, 1986.
Coetzee, Andries W., “Variation as accessing ‘non-optimal’ candidates”, *Phonology* 23.3, 2006, 337–385.
Da, Jun. 2004. Chinese text computing. Murfreesboro: Department of Foreign Languages and Literatures, Middle Tennessee State University. http://lingua.mtsu.edu/chinese-computing/
Dǒng Shàokè 董少克, “Yánggǔ fāngyán de érhuà 阳谷方言的儿化” [Er affixation in the Yanggu dialect], *Zhōngguó Yǔwén* 《中国语文》 4, 1985, 273-276.
Dǒng Shàowén 董少文, *Yǔyīn chángshì* 《语音常识》 [Introduction to phonetics]. Běijīng 北京: Wénhuà Jiàoyù Chūbǎnshè 文化教育出版社, 1958.
Duanmu, San, *A formal study of syllable, tone, stress and domain in Chinese languages*, Doctoral dissertation, MIT, Cambridge, MA, 1990.
Duanmu, San, “Metrical structure and tone: evidence from Mandarin and Shanghai”, *Journal of East Asian Linguistics* 8.1, 1999, 1-38.
Duanmu, San, *The phonology of Standard Chinese*, second Edition, Oxford: Oxford University Press, 2007.
Duanmu, San, *Syllable structure: The limits of variation*, Oxford: Oxford University Press, 2008.
Duanmu, San, “Chinese syllable structure”, in: Marc Van Oostendorp, Colin Ewen, Elizabeth Hume, and Keren Rice, eds., *The Blackwell Companion to Phonology*, volume 5, Malden, MA and Oxford: Wiley-Blackwell, 2011, 2151-2777.
Guō Shàoyú 郭紹虞, “Zhōngguó yǔcí zhī tánxìng zuòyòng 中國語詞之彈性作用” [The function of elastic word length in Chinese], *Yànjīng Xuébào* 《燕京學報》 24, 1938, 1-34.
Frisch, Stefan A., Nathan R, Large, and David B. Pisoni, “Perception of wordlikeness: Effects of segment probability and length on the processing of nonwords”, *Journal of Memory and Language* 42.4, 2000, 481-496.
Goldsmith, John, “English as a tone language”, in: Didier L. Goyvaerts, ed., *Phonology in the 1980's*, Ghent, Belgium: E. Story-Scientia, 1981, 287-308.
Halle, Morris, “Phonology in generative grammar”, *Word* 18, 1962, 54-72.
Hartman, Lawton M., The segmental phonemes of the Peiping dialect, *Language* 20.1: 28-42, 1944.
Huáng Lìjūn 黄丽君 and Duānmù Sān 端木三, Xiàndài Hànyǔ cí cháng tánxìng de liànghuà yánjiū 现代汉语词长弹性的量化研究 [A quantitative study of elastic word length in modern Chinese]，*Yǔyán Kēxué* 《语言科学》[Linguistic Sciences] 12.1, 2013, 8-16.
Huang, Parker Po-fei. 1970. *Cantonese dictionary: Cantonese-English, English-Cantonese*. New Heaven and London: Yale University Press.
Karlgren, Bernhard, *Études sur la phonologie chinoise*, Upsala: K.W. Appelberg and Leyde : E.-J. Brill, 1915-1926.
Lee, Wai-Sum and Eric Zee, “Standard Chinese (Beijing)”, *Journal of the International Phonetic Association* 33.1, 2003, 109-112.
Liberman, Mark, *The intonational system of English*, Doctoral dissertation, MIT, Cambridge, MA, 1975.
Lin, Maocan and Jingzhu Yan, “The characteristic features of the final reduction in the neutral-tone syllable of Beijing Mandarin”, *Phonetic Laboratory Annual Report of Phonetic*

Research, Beijing: Phonetic Laboratory, Institute of Linguistics, Chinese Academy of Social Sciences, 1988, 37-51.

Lin, Yen-hwei, *Autosegmental treatment of segmental processes in Chinese phonology*, Doctoral dissertation, University of Texas, Austin, 1989.

Lin, Yen-hwei, "Degenerate affixes and templatic constraints: rime change in Chinese", *Language* 69.4, 1993, 649-82.

Luó Chángpéi 罗常培 and Wáng Jūn 王均, *Pǔtōng yǔyīnxué gāngyào* 《普通语音学纲要》 [Outline of general phonetics], Běijīng 北京: Kēxué Chūbǎnshè 科学出版社, 1957.

McCawley, James D, *The accentual system of modern standard Japanese*, Doctoral dissertation. MIT, Cambridge, 1965.

Pierrehumbert, Janet, *The phonetics and phonology of English intonation*, Doctoral dissertation, MIT, Cambridge, 1980.

Ramsey, S. Robert, *The languages of China*, Princeton: Princeton University Press, 1987.

Wiese, Richard, "Underspecification and the description of Chinese vowels", in: Jialing Wang and Norval Smith, eds., *Studies in Chinese phonology*, Berlin: Mouton de Gruyter, 1997, 219-249.

Woo, Nancy, *Prosody and phonology*, Doctoral dissertation, MIT, Cambridge, Mass., 1969.

Xiàndài Hànyǔ Cídiǎn 《现代汉语词典》: Zhōngguó Shèhuì Kēxuéyuàn Yǔyán Yánjiūsuǒ Cídiǎn Biānjìshǐ 中国社会科学院语言研究所词典编辑室，*Xiàndài Hànyǔ Cídiǎn* (dì wǔ bǎn) 《现代汉语词典》(第五版) [Modern Chinese Dictionary (fifth edition)], Běijīng 北京：Shāngwù Yìnshūguǎn 商务印书馆, 2005.

Xú Shìróng 徐世荣, *Pǔtōnghuà yǔyīn zhīshí* 《普通话语音知识》 [Phonology of Standard Chinese], Běijīng 北京: Wénzì Gǎigé Chūbǎnshè 文字改革出版社, 1980.

Yóu Rǔjié 游汝杰, Qián Nǎiróng 钱乃荣, and Gāo Zhēngxià 高钲夏, "Lùn Pǔtōnghuà de yīnwèi xìtǒng 论普通话的音位系统" [On the phonemic system of Standard Chinese], *Zhōngguó Yǔwén* 《中国语文》 5 (158), 1980, 328-334.

Zee, Eric and Wai-Sum Lee, "Vowel typology in Chinese", *Proceedings of the 2007 International Congress of Phonetic Sciences* (*ICPhS 2007*), 2007, 1429-1432. http://www.icphs2007.de/.

Short biography

San Duanmu is Professor of Linguistics, University of Michigan. He received his PhD in Linguistics from MIT in 1990 and has held teaching posts at Fudan University, Shanghai (1981-1986) and the University of Michigan, Ann Arbor (1991-present). He is the author of *The Phonology of Standard Chinese* (2nd edition, Oxford 2007) and *Syllable Structure: The Limits of Variation* (Oxford 2008).

Terms for indexation (5-10):

Syllable size, syllable structure, syllable weight, Weight-Stress Principle, Tone-Stress Principle, foot, syllable inventory, possible syllable, missing syllable