



From a Syllable System to a Phoneme System

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Purpose

This paper intends to establish a standardized procedure to create the phoneme inventory of a Chinese dialect, given all the syllables in that dialect.

Motivations

1. Chinese traditional phonology study focuses on syllable system rather than phoneme system. This work serves as a bridge between the Eastern syllabic analysis tradition and the Western phonemic analysis tradition, by finding a method to derive a phoneme system based on the data of the syllable system.
2. Some studies on the origin of human beings rely upon the statistical analysis of the phoneme size in modern languages, and many concerns arise regarding how the phoneme inventories are obtained (Atkinson, 2011b; Cysouw, Dediu, & Moran, 2012; Hay & Bauer, 2007; Wang, Ding, Tao, & Li, 2012).

Data

All the syllables in one of the Wu Dialects, Songjiang Dialect (Zhang, 2003), which is claimed to have at least 17 basic vowels (Qian, 1992, 1994; Li, 2008; Li & Hong, 2012).

Methodology

The following is a description of the steps to find contrastive sounds. Most of the steps are realized in Microsoft Office Excel 2007, with occasionally use of Microsoft Office Word 2007. The codes used to carry out the steps can be found in [the Author's website](#).

Step 1: Divide syllables into environments

Divide the 650 syllables in Songjiang dialect into environments. An example is shown in Table 1.

Table 1. An example of environments

Syllable	Envir_1	Envir_2	Envir_3	Envir_4
doŋ	d, #_o	o, d_ŋ	ŋ, o_#	
diə?	d, #_i	i, d_ə	ə, i_?	?, ə_#

Step 2: find distinctive environments

Sort the 2224 environments and find the 849 distinctive environments (Table 2).

Table 2. An example of distinctive environments

Envir	Dist_Envir	Envir	Dist_Envir
p, #_i		p, #_u	
b, #_i		b, #_u	
ɸ, #_i	→ #_i	ɸ, #_u	→ #_u
β, #_i		β, #_u	
t, #_i		t, #_u	
d, #_i		d, #_u	
s, #_i		s, #_u	
z, #_i		z, #_u	
...		k, #_u	
		g, #_u	
		...	

Step 3: Contrastive sounds as phonemes

List all the occurrences of sounds in each distinctive environment (Table 3).

Table 3. An example of contrastive sounds

Envir	Cont_Sounds
#_i	p, b, ɸ, β, t, d, s, z, ʔ, ə, fi
#_u	p, b, ɸ, β, t, d, s, z, k, g, h, fi, ʔ, β

Preliminary Results

All the contrasts in all the distinctive environments are collected, and there are 20 consonants and 17 vowels (Table 4).

The results are similar to previous studies (Qian, 1992, 1994).

Table 4. Possible Phonemes in Songjiang Dialect

Cs	β, ʔ, z, t, s, ɸ, p, ŋ, n, m, l, k, fi, h, g, d, ə, b, ʔ
Vs	y, ʌ, u, ɿ, œ, ə, o, u, i, i, ε, e, ə, æ, a, e

A Problem

The contrastive sounds are *possibly* in contrast. An example: /i/ and /y/, /i/ and /u/ are in contrast, so we concludes /i/, /y/ and /u/ are phonemes according to our method. **But are /y/ and /u/ in contrast? Could they be one phoneme?**

Solving the Problem: another Method

List all the possible distributions of consonants and vowels in Songjiang Dialect, under CGVX theory of Chinese syllable pattern, where C, G, V, X represent a consonant, a glide, a vowel, and either a consonant or a vowel, respectively.

Table 5. Examples of GGVX Syllable Structure

	C	G	V	X
p ^h iɛŋ	p ^h	i	ɛ	ŋ
io?		i	o	?

Step 1: VX environment for X

List all the possible VX in Songjiang Dialect (Table 6). Findings:

- No contrast between nasalized vowels / \tilde{V} / and / $\tilde{V}\eta$ /; and only two possible finals, / η / and / $ʔ$ /, plus empty-final;

Therefore, all / \tilde{V} / can be taken as / $V\eta$ / under CGVX theory. / \tilde{V} / is not a single phoneme (Table 6).

Table 6. VX structure

V	X ₁	X ₂	V	X ₁	X ₂
a	?		a	?	η
ã			ã		
ɔ	?	η	ɔ	?	η
ε	?		ε	?	η
ẽ			ẽ		
o	?	η	o	?	η
œ	?		œ	?	η
õ			õ		

Step 2: CG environment for consonants

1. List all the possible CG in Songjiang Dialect (Table 7). Findings:

- /tɛ, tɛ^h, dz, ɛ/ and /k, k^h, g/ are in complementary distribution, but since their pronunciations are quite different, they can be left as different sets of phonemes (Table 7(1)).
- The initial consonants /fiŋ, ʔŋ/ and /fiŋ, ʔŋ/ are in complementary distribution (Table 7(2)). Since /ŋ/ and /ŋ/ only both occur in these environments, they can combine together.

Table 7. CG structure for consonants(1 & 2)

		CG structure (1)			CG structure (2)		
		Dor	Lab	Lab+Dor			
		i	u	y	i	u	y
Lab	p	+	+				
	p ^h	+	+		fiŋ		
	b	+	+				
	β	+	+				
	ɸ	+	+		fiŋ	+	+
Cor	t	+	+				
	t ^h	+	+		ʔŋ		
	d	+	+				
Cor	ts	+	+	+			
	ts ^h	+	+	+			
	s	+	+	+			
Cor+Dor	z	+	+	+			
	tɛ	+		+			
	tɛ ^h	+		+			
Dor	dz	+		+			
	ɛ	+		+			
	k		+				
	kh		+				
	g		+				

Step 3: GVX environment for vowels

List all the possible GVX in Songjiang Dialect (Table 8). X0 stands for an empty final.

Findings:

The vowels with the same color, namely, /ɔ/ and /o/, /u/ and /i/, /ɛ/ and /æ/, /e/ and /ə/, /œ/ and /ø/ are in complementary distribution, and thus can be combined as one phoneme respectively.

Table 8. GVX structure for vowels

G	V	X0	η	?
i	ɑ	+	+	+
	ε	+	+	
	ɔ	+		+
	u	+		
	u	+		
	o		+	+
	ɛ		+	
	æ			+
	ə			+
	i			+
u	ɑ	+	+	+
	ε	+	+	
	ɛ	+		
	ɛ		+	
	ə			+
y	œ		+	+
	ø	+		

Results and Conclusion

- All together we further get ride of 1 consonant and 5 vowels. The rest are 19 consonants and 12 vowels:
Consonants: β, ʔ, z, t, s, ɸ, p, ŋ, n, m, l, k, fi, h, g, d, ə, b, ʔ
Vowels: y, ʌ, u, ɿ, œ, ə, o, i, i, ε, e, ə, æ, a
- Therefore, under the template of CGVX structure, which is general to all the dialects of Chinese, we can identify all the contrastive sounds, namely, phonemes, in the dialects.

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