Contrast in Cantonese vowels*

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This paper analyses vowels in Hong Kong Cantonese within a contrastive hierarchy framework. I examine both allophonic variation and co-occurrence restrictions in the language, accounting for two diachronic changes. The first is a reduction in the inventory of palatalisation triggers from the older generation to the younger generation. This is the result of a change in the features required to specify the vowels in question. The second change consists of a reduction in the set of vowels subject to a co-occurrence restriction between labiovelars and labial vowels. Again, I argue that this is due to a change in the features needed to specify the vowels in question. I argue that both of these changes can be accounted for by a single alteration in the hierarchy of feature cuts, namely, the scope of the feature cut [labial] is promoted in the younger dialect. This single promotion accounts for both diachronic changes between the two dialects.

0. Introduction

A major means of studying phonology in Chinese languages is by coming to an understanding of co-occurrence restrictions within the syllable. Phonological processes, although present, do not tell the complete story. We will see that an account of the Cantonese vowel system requires an understanding of both phonotactics and processes. The goal of this paper is to establish the vowel system of Cantonese through a study of co-occurrence restrictions and allophonic variation. Both vocalic allophonic variation and consonantal allophonic variation will be examined, as I will show that consonantal allophony is sensitive to the surrounding vocalic environment. We will be dealing primarily with the Hong Kong variety of Cantonese, although some references to other dialects of Cantonese will be made. Unless otherwise mentioned, the reader can assume all examples and discussions deal with the Hong Kong variety of Cantonese.

Co-occurrence restrictions are important in any discussion of Cantonese phonology. Co-occurrence restrictions involve the structure of the syllable. Cantonese syllables can

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either be CVC or CV.[1] Each syllable is associated with one of six tones.[2] Unlike Mandarin, there are no toneless syllables in Cantonese. Finally, there is the possibility of syllabic nasals (with tones) in Cantonese:

(1) [m̩˩] 唔 NEG [ŋ˧˩] 五 'five'

The analysis presented here makes use of the theory of contrast using the machinery of the Successive Division algorithm (SDA) proposed by Dresher (2001a, 2001b, 2002). The details of the SDA are spelled out in more detail in section 2.1. Briefly, what the SDA allows us to do is pick out the features that are relevant to any given phoneme, where relevance refers to the native speaker's use of the feature during acquisition to contrast one phoneme from another. Thus, features that are not needed to achieve the contrasts necessary to specify given phonemes as distinct are not part of the phonological representation of those sounds.

In addition to accounting for the vowel inventory, I examine two recent changes in the phonology of Cantonese and suggest a common origin for both. The first change is the set of vowels which triggers palatalisation of affricates in onset position. The second change involves the loss, in certain environments, of the secondary articulation in the labiovelar stops [k^{hw}] and [k^{w}], resulting in [k^{h}] and [k], respectively. I suggest that these two changes occur as the result of re-ordering the feature cuts so that [labial] moves up from under [palatal] to take scope over it in the younger dialect of Cantonese.

This paper is organized as follows. Section 1 describes the issues in describing the vowel system of Cantonese including co-occurrence restrictions (Section 1.2), allophonic variation (Section 1.3) and diachronic facts (Section 1.4). Section 2 presents my analysis of these facts within the framework of the Successive Division algorithm. In Section 3, I discuss some residual issues, and in Section 4, I state my conclusions.

1. The Issues

1.1. What is the Inventory?

The inventory of vowels in Cantonese is not an uncontroversial topic. Matthews & Yip (1994) give the following phonemic inventory:

1. There is a small number of VC syllables in Cantonese. All but one of these, according to Yip (1997), is the result of optional deletion of initial [ŋ] as in [ŋaːlpˀ]~[aːlpˀ] 鴨 'duck.' The lone true VC syllable [aːɬk] 呃 is a sentence-final particle, which conveys a sense of finality to a conversation (Yip, 1997). Matthews & Yip (1994), however, give other examples of VC syllables which often undergo hypercorrection to include an initial [ŋ] onset:

i) onl t͡ʃʰyːn → ŋonl t͡ʃʰyːn 安全 'safe'

ii) aːwl t͡saːwl → ŋaːwl t͡saːwl 歐洲 'Europe'

2. There are six tones in Cantonese (Barrie, 2002; Bauer & Benedict, 1997). Although the tones will not play a large role in this paper, I mention them here for completeness. The tones and their corresponding IPA symbols are high-level ˥, high-rising ˧˥, mid-level ˧, low-falling ˩, low-rising ˨˩ and low-level˩.

Table 1 Vowel Inventory (Matthews & Yip 1994)

i	y		u
ɛ	ɵ[3]		ɔ
		ɐ	
		a	

They also make the following observations. /i/ and /u/ surface as [e] and [o], respectively when the syllable ends in a velar consonant. Also, /ɵ/ surfaces as [œ] before a velar coda consonant. Finally, the following diphthongs are given: [iw], [ɵɥ], [uj], [ej], [ɔj], [ow], [ɐj], [ɐw], [aj] and [aw]. Thus, the inventory given by Matthews and Yip (1994) is a list of the phonemes.

Hashimoto (1972) provides the following inventory, which includes all allophones:

Table 2 Vowel Inventory (Hashimoto 1972)

iː	yː		uː
ɪ			ʊ
e	ø		o
ɛː	œː		ɔː
		ɐ	
		Aː	

Hashimoto does not describe the phonetic properties of [Aː], but notes that it is sometimes transcribed as [aː] or [ɑː]. Hashimoto does not discuss diphthongs in the inventory of vowels since they are considered a combination of vowel in the nucleus and a glide in the coda. Thus, for Hashimoto, a diphthong is not a separate vowel *per se*; rather, its glide is the coda of the syllable.

Bauer & Benedict (1997), using detailed phonetic analysis based on a large number of speakers, present the following the following inventory:

Table 3 Vowel Inventory (Bauer & Benedict 1997)

iː		yː			uː
eʲ					oʷ
e			ɵ		o
ɛː	ɛ	œː			ɔː
				ɐ	
				aː	

The differences between Hashimoto (1972) and this inventory are the high lax vowels ([ɪ] and [ʊ] in Hashimoto; [eʲ] and [oʷ] in Bauer & Benedict) and the round, tense mid vowel ([ø] in Hashimoto; [ɵ] in Bauer & Benedict). Bauer & Benedict (1997) still consider [eʲ] and [e] to be different phonemes, however. Lee (1983), also using detailed phonetic analysis, came to nearly the same conclusions as Bauer & Benedict with respect

3. Matthews and Yip (1994) describe this vowel as a rounded central vowel which sounds "similar to French *eu*, or not unlike the vowel in British *her* but with rounded lips."

to [ɵ]. Lee (1983) uses the symbols [I] and [U] (for IPA [ɪ] and [ʊ]), but does not deal with [e] or [o] since these vowels appear only before glides. Lee (1983) only considered vowels not followed by a glide for his study. To understand the difference between the two analyses, consider the following example (tone marking left off of transcriptions):

(2)	Yale[4]	B&B transcription	Hashimoto transcription	English
a.	sihk 食	[seʲɻk]	[sɪɻk]	'eat'
b.	sei 四	[sejɻ]	[sejɻ]	'four'

Thus, for both authors, example (2a) is composed of an onset /s/, a coda, /k/ and a single vowel – a diphthong for Bauer & Benedict and a lax vowel for Hashimoto – in the nucleus. Example (2b) consists of an onset /s/, a single vowel in the nucleus /e/ and a glide in the coda /j/.

Based on these previous studies and on fieldwork with my consultants, I assume the following surface vowel inventory for Hong Kong Cantonese:

Table 4a Surface Vowel Inventory of Cantonese, present study

iː	yː		uː
ɪ			ʊ
e	ø		o
ɛː	œː		ɔː
		ʌ	
		aː	

This inventory includes all major allophonic variation. My next major goal is to consider the phonological vowel inventory of Cantonese. In the following sections, I argue that the underlying inventory of Cantonese can be represented as in Table 4b:

Table 4b Underlying Inventory of Cantonese Vowels

iː	yː		uː
	ø	ə	
ɛː			ɔː
		ʌ	
		aː	

I begin this task by examining co-occurrence restrictions in the language, focussing on the co-occurrence restrictions that hold within the rhyme.

1.2. Co-occurrence restrictions

The co-occurrence restrictions in Cantonese are rather complex, making it difficult to tease apart linguistically significant generalizations from those which are not

4. I include throughout the Yale romanization of Cantonese lexical items, in addition to the IPA transcriptions.

significant. In other words, it can be difficult to separate the systematic gaps in the Cantonese syllabary from the accidental gaps. There are several kinds of co-occurrence restrictions in Cantonese: restrictions between the vowel and coda, between the onset and rhyme, between the onset and coda, and between the tone and various part of the syllable, including the whole syllable. We will be dealing with vowel-coda and onset-nucleus co-occurrence restrictions in this paper. Table 5 shows the co-occurrence restrictions between vowels and coda consonants (Hashimoto 1972: 90). Across the top of the table we see the various codas available in Cantonese. Down the left-hand column we find the vowels that can appear in the nucleus (ignoring the nasal nuclei given in example (1)). Note that I treat diphthongs as complex, with the glide portion occupying the coda.

Table 5 Cantonese Rhymes

final / V	Ø	j	ɥ	w	m	n	ŋ	p	t	k
iː	iː			iːw	iːm	iːn		iːp	iːt	
ɪ							ɪŋ			ɪk
e		ej								
ɛː	ɛː			ɛw[5]			ɛːŋ			ɛːk
uː	uː	uːj				uːn			uːt	
ʊ							ʊŋ			ʊk
o				ow						
ɔː	ɔː	ɔːj				ɔːn	ɔːŋ		ɔːt	ɔːk
yː	yː					yːn			yːt	
ø			øɥ			øn			øt	
œː	œː						œːŋ			œːk
aː	aː	aːj		aːw	aːm	aːn	aːŋ	aːp	aːt	aːk
ʌ		ʌj		ʌw	ʌm	ʌn	ʌŋ	ʌp	ʌt	ʌk

Notice that the vowels are grouped in tense/lax pairs separated by a dotted line. For each pair of vowels, only one member can appear with any given coda. In other words, they are in complementary distribution. Note that the two low vowels /ʌ/ and /aː/ do not follow this pattern. In fact, these two vowels do not participate in any co-occurrence restrictions. For each pair of vowels, only the lax member can appear before a velar coda. I assume that the tense vowel has the feature [ATR]. The following co-occurrence restriction has been advanced to capture this generalization (Wang 1999):

(3) *[ATR][velar]

Throughout the discussion, I assume that vowels and consonants draw from the same set of Place features – Palatal, Labial and Velar[6] (Clements 1989). The following list gives the phonetic Place features for the vowels under consideration:

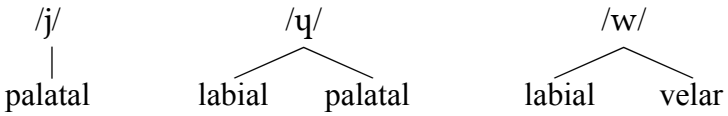
5. This vowel and glide combination appears in borrowed words only.
6. I use the terms *velar* and *palatal* in place of *dorsal* and *coronal*, respectively.

(4) a.

front vowels	i, ɪ, e, ɛ, y, ø, œ	Palatal
round vowels	u, ʊ, o, ɔ, y, ø, œ	Labial
back vowels	u, ʊ, o, ɔ	Velar

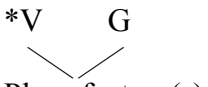
I assume the following Place features for the glides:

(4) b.



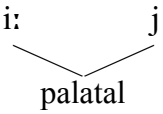
Ignoring for the moment the mid vowels /e/, /o/ and /ø/, we see another co-occurrence restriction in the rhyme. If we examine the ungrammatical VG sequences—*iːj *iːɥ *yːj *yːɥ *yːw *uːɥ *uːw etc.—we observe that vowels and glides cannot share Place features.

(5)



Example (6) shows this with the ungrammatical VG sequence *iːj. Note that only the features under the Place node are shown:

(6)



The presence of the two labial features creates a violation of the co-occurrence restriction in (5), thus ruling out *iːj.[7]

Now consider the vowels /e, o, ø/. Given the co-occurrence restriction against shared Place, these vowels exhibit rather unusual behaviour. First, they can only appear with one specific coda consonant each: [ej] and [ow] (see Table 5). Second, the glides that appear with the vowels are unexpected. In Cantonese, palatal vowels appear with a labiovelar glide and velar vowels appear with palatal glides:

(7)

[iːw]	[uːj]
[ɛw]	[ɔːj]

I will return to the vowels /e/, /o/ and /ø/ and their apparent violation of the co-occurrence restriction in (5) in section 2.2.

Another observation to be drawn from Table 5 is that only long vowels can appear in coda-less (open) syllables. This is the result of a restriction in Cantonese that all syllables are bimoraic (see Table 5). Notice that in general vowels are long (ignoring ʌ and aː) with some exceptions. The issue of syllable weight is beyond the scope of this paper.

7. This restriction can also be analysed as an OCP violation. I do not examine the ramifications of this line of thought in this paper.

I will make use of the following co-occurrence restrictions[8] which are not of the nucleus-coda type, and hence not able to be determined from Table 5 above:

(8) a. *$k^{(h)w}$ V
|
[labial]

b. * $k^{(h)w}$ V C
|
[labial]

The co-occurrence restriction in (8a) prevents the appearance of labiovelar stops in front of labial vowels (e.g., *$k^{(h)w}$y), and the restriction in (8b) ensures that syllables with a labiovelar onset do not have a labial coda, (/p/, /m/, or /w/; see example (15) below).

1.3. Allophonic variation

One pair of allophones pertinent to the current discussion is [t͡s]/[t͡sʰ] and [t͡ʃ]/[t͡ʃʰ], that is, palatalisation of the affricate onset. I discuss this pair of consonantal allophones here because the palatal and non-palatal are in complementary distribution, with the allophone depending on the following vowel. A study of palatalisation provides useful insights into the vowel system of Cantonese. Bauer & Benedict report that [t͡s] and [t͡sʰ] become [t͡ʃ] and [t͡ʃʰ], respectively, before the vowels [iː], [yː], [ø] and [œː]. Matthews & Yip report the same allophonic variation except with a reduced conditioning environment: [yː], [ø] and [œː]. They also report that not all speakers have this contrast. Many earlier descriptions of Cantonese phonology include [iː] in the set of palatalisation triggers (Hashimoto 1972), while more current descriptions only give the smaller inventory without [iː]. All of my consultants produced this contrast consistently before the vowels [yː], [ø] and [œː], but not before [iː]. This is consistent with the dialect of younger speakers. Table 6 compares older and younger Cantonese with respect to different vocalic environments.

Table 6 Comparison of Triggers of Palatalisation

Yale	Vowel	Older	Younger	English
jih 字	iː	[t͡ʃiːɻ]	[t͡siːɻ]	‘character’
chi 次	iː	[t͡ʃʰiːɻ]	[t͡sʰiːɻ]	‘time’; ‘order’
jyū 豬	yː	[t͡ʃyː˥]	[t͡ʃyː˥]	‘pig’
jeui 最	ø	[t͡ʃøɻɥ]	[t͡ʃøɻɥ]	‘most’
chéuhng 腸	œː	[t͡ʃʰœːʎŋ]	[t͡ʃʰœːʎŋ]	‘intestine’
chah 茶	aː	[t͡saːɻ]	[t͡saːɻ]	‘tea’

Thus, the set of vowels, [yː], [ø] and [œː], must constitute a natural class in contemporary Cantonese, while [iː],[yː], [ø] and [œː] must have comprised a natural class

8. These co-occurrence restrictions were determined from the syllabary in Bauer & Benedict (1997: 486).

in an earlier variety of Cantonese.[9] This change is one of many concomitant changes which have become established since World War II (Bauer 1986). I discuss some other changes in the next section.

Based on the distribution of vowels shown in Table 5, it is easy to see that most analyses have treated the tense/lax pairs as allophones (Hashimoto 1972; Bauer & Benedict 1997). As noted above, the vowels for each tense/lax pair are in complimentary distribution. Notice also that each member of the pair differs in length. Researchers are split as to whether it is [ATR] that is the relevant contrast (Wang 2002) or length (Lee 1983). Since [ATR] is conditioned by the Place feature of the coda consonant, I assume that [ATR] is the relevant contrast. Length cannot be predicted in such an obvious manner. I take as a point of departure in my analysis the allophonic variation shown in Table 7.[10]

Table 7 Allophones in Cantonese

/iː/ → [iː], [ɪ]	/e/ → [e], [ɛː]	/yː/ → [yː]	/ø/ → [ø], [œː]
/uː/ → [uː], [ʊ]	/o/ → [o], [ɔː]	/aː/ → [aː]	/ʌ/ → [ʌ]

Table 7 is fairly representative of most analyses of the vowel inventory of Cantonese. Note that this classification will only serve as a point of departure for the forthcoming discussion. Several revisions to the system in Table 7 will be made before the end of the discussion.

1.4. Diachronic Issues

There have been several concomitant changes in the recent history of Cantonese phonology (Bauer 1986).[11] These changes can be traced back to the end of World War II. One such change is the loss of labiovelar onsets before velar, labial vowels:

Table 8 Loss of Labialization

Yale	Older	Younger		English
gwok 國	[kʷɔːɬk]	[kɔːɬk]	} loss of labialization	‘country’
gwūnjung 觀眾	[kʷuː˥n…]	[kuː˥n…]		‘audience’
gwai 貴	[kʷʌjɬ]	[kʷʌjɬ]	– no loss	‘expensive’

Here we see a co-occurrence restriction holding for younger speakers that bars two labials when one is in the onset and the second is in the nucleus. This constraint does not

9. I assume that the vowel [ɪ] is included in this set, but I have no way of testing this since none of my consultants palatalise before high, front, unrounded vowels. However, Bauer & Benedict (1997) do not include [ɪ] as a palatalisation trigger.

10. As Table 7 shows, the choice of [ATR] over length as the relevant contrast is not crucial. It is not my intention to resolve the conflict between the choice of [ATR] and length as the relevant contrast between allophones. Indeed, the analysis I present here does not hinge on this choice.

11. Bauer (1986) mentions about a half-dozen such changes. Note that not all changes occur simultaneously, even within a given speaker. Speakers typically adopt the changes in consecutive stages. Thus, it is common to find older speakers (or speakers in Toronto who have learned Cantonese solely from older speakers such as parents or grand-parents) who exhibit a mixture between the two varieties.

hold for older speakers. Recall the co-occurrence restriction in (8a) which bars labiovelar onsets with a labial vowel (e.g., *$k^{(h)w}$y). This constraint holds across both dialects. I argue that the data in Table 8 reflect a change in the feature specification of the vowels /u/ and /ɔ/, rather than a change in the co-occurrence restriction in (8a).

I have touched briefly on another diachronic issue in the previous section, namely that of the difference in triggers of palatalisation between younger and older speakers. Example (9) summarizes the facts:

(9) Palatalisation triggers for older speakers: [iː], [yː], [ø] and [œː]
Palatalisation triggers for younger speakers: [yː], [ø] and [œː]

1.5. Summary

I have raised several issues in the phonology of Cantonese vowels in this section, which can be divided into three categories. The first deals with co-occurrence restrictions, which are abundant in Chinese languages. Here, we deal mainly with co-occurrence restrictions within the rhyme. Vowel-glide restrictions are found (see (5)) as are restrictions on vowels possessing the feature [ATR] with velar consonants (see (3)). Specifically, I observe that vowel-glide codas cannot share Place features and [ATR] vowels cannot appear with [velar] coda consonants. Two other co-occurrence restrictions involving the labiovelar onsets /k^{w}/ and /k^{hw}/ are found. Namely, /k^{w}/ and /k^{hw}/ cannot appear with a phonetically back round vowel in nucleus position for younger speakers (see Table 8) or a [labial] consonant in coda position for all speakers (see (8b)). The second category concerns allophonic variation in the language and what this can tell us about vowels. There are two instances of allophony which concern us here. The first is palatalisation of affricates in Cantonese, which is triggered by [iː], [yː], [ø] and [œː] in the older variety and by [yː], [ø] and [œː] in the younger variety (see Table 6). The second instance (as mentioned above) concerns the interaction between [velar] coda consonants and [ATR] vowels. The third category is the diachronic phenomena of the co-occurrence restrictions and allophonic variation. Specifically, I examine changes in the inventory of vowels which trigger palatalisation of affricates in onset position, and changes in the inventory of vowels which are subject to co-occurrence restrictions with the labiovelar consonants /k^{w}/ and /k^{hw}/ (see Table 8). In the following discussion, I use the symbols in Table 4b to represent the underlying vowel inventory.

2. Analysis

In this section, I briefly describe the Successive Division Algorithm, which provides the theoretical backbone to carry out the analysis of vowels in Cantonese. I go on to discuss the status of the mid tense vowels /e/, /o/ and /ø/ and re-evaluate their place in the vowel inventory. The rest of this section is devoted to an analysis of both varieties of Cantonese taking into account the phenomena in the first section and the re-evaluation of the mid tense vowels /e/, /o/ and /ø/.

2.1. The Successive Division algorithm (SDA)

The Successive Division algorithm (Dresher 1998a, b, 2002) is assigns features to a subset of the set of phones in the inventory until all such phones have been differentiated from each other. The algorithm is presented in (10):

(10) Successive Division Algorithm (SDA)

a. In the initial state, all tokens in the inventory, I, are assumed to be variants of a single member. Set I = S, the set of all members.

b. i) If S is found to have more than one member, proceed to c.
ii) Otherwise, stop. If a member, M, has not been designated contrastive with respect to a feature, G, then G is *redundant* for M.

c. Select a new *n*-ary[12] feature, F, from the set of distinctive features. F splits members of the input set, S, into *n* sets, $F_1 – F_n$, depending on what value of F is true of each member of S.

d. i) If all but one of $F_1 – F_n$ is empty, then loop back to c.
ii) Otherwise, F is *contrastive* for all members of S.

e. For each set F_i, loop back to b, replacing S by F_i.

I will apply this algorithm to the analysis of vowels in Cantonese. The algorithm effectively creates a hierarchy of contrastive features. Features at the top of the hierarchy are those that are particularly salient and are predicted to be acquired first. Features at the bottom of the hierarchy are those that are predicted to be learned last and lost first. Furthermore, absences in the inventory can be divided into systematic gaps and accidental gaps.

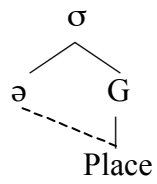
2.2. The Mid Tense Vowels

Recall that the vowels [e], [o] and [ø] do not follow the co-occurrence restriction laid out in (5) which any Place feature from being shared by a consonant and glide within the same rhyme. In fact, the Place features of the vowel and glide in the surface forms [ej], [o w] and [ø ɥ] are identical ([palatal], [labial, velar] and [labial, palatal] respectively). I propose that the sequences [ej], [ow] and [øɥ] are derived, arising from /əj/, /əw/ and /əɥ/ respectively, through a process of vowel colouring.[13] Although, I do not give a full account of the process of vowel colouring here, an encouraging point of departure is to acknowledge that the vowel /ə/ has no features, so it assimilates the place features of the following glide (G). The following example shows how the Place feature of the glide spreads to the preceding vowel:

12. The SDA presented here is often presented as the Successive Binary Algorithm (SBA) which uses the term *binary* in place of *n-ary*. This allows for the strict use of binary features. Here, we use privative features, so *n*=1. Step c could begin, "Select a new unary feature…."

13. See Wu (1994) for a similar treatment of vowels in Mandarin. It is interesting to note that the constraint in (5) prohibits shared features between vowel and glide, while (11) actually creates such configurations. The reasons why /ə/ can take on features from the following glide and why it cannot constitute a syllable nucleus on its own remains a topic for future study.

(11)



Since the Place features spread as a unit, we observe strict identity between vowel and glide features.

Thus, I remove the two vowels /e/ and /o/ from the inventory and replace them with the featureless vowel /ə/. Note that although I posit that [øɥ] arises from /əɥ/, the vowel /ø/ must still be present in the inventory since it appears with other consonants (see Table 5). Example (12) shows the two origins of the surface vowel [ø]:

(12)

Word	Surface Rhyme	Underlying Rhyme	English
seun 信	[øn]	/øn/	'letter'
séui 木	[øɥ]	/əɥ/	'water'

This change in the inventory has the consequence of eliminating /e/ /ɛː/ and /o/ /ɔː/ as allophonic pairs. Rather /ɛː/ and /ɔː/ are individual phonemes without any allophones. The traditional treatment of these vowels as shown in Table 7 is probably due to the symmetrical behaviour of the corresponding high vowels. If we set aside allophonic variation for the moment, we now have the following reduced environment:

Table 9 Inventory of Underlying Vowels in Cantonese

iː	yː		uː
	ø	ə	
ɛː			ɔː
		ʌ	
		aː	

2.3. Features and Divisions

It is clear that several features will be needed to successfully execute a SDA analysis of vowels in Cantonese. I discuss in this section the features which are necessary. Both place features and height or aperture features will be required, given the size of the inventory in Table 9. Place features have already been discussed in section 1.2. I assume the two Aperture features [high] and [low] for this discussion. Given the co-occurrence restriction in example (4a), we see that [labial] must come into play. The feature [ATR] is conditioned by velar coda consonants. This allophony is found only in the non-low vowels. Since the non-[ATR] allophones are not part of the underlying inventory, this feature will not play a role in determining the feature cuts. I assume that [ATR] values are assigned by default. Length will not play a role throughout the discussion, but will make a brief appearance near the end.

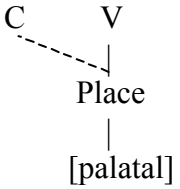
We now turn to the actual divisions, starting with the older variety of Cantonese, then moving on to the younger variety of Cantonese.

2.3.1. Older Cantonese

In this section, I examine Older Cantonese and argue that the underlying inventory is specified as follows: iː (palatal) yː (palatal labial high) ø (palatal labial) uː (-) ɛː (low palatal) ʌ (low) aː (low) ɔː (low back). I begin my analysis with an investigation into the Place features and triggers of palatalisation.

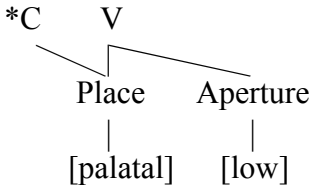
It was noted in section 1.3. (Table 6) that the vowels /iː/, /yː/ and /ø/ must form a natural class to account for the palatalisation of affricates in older varieties of Cantonese. Cross-linguistically, the typical triggers of palatalisation include [palatal] and, less commonly, [high]. Since /ø/ is one of the palatalisation triggers, [high] is an unlikely candidate. Since /ɛ/ does not serve as a trigger, it seems that [-low] is the better choice. However, negatively valued features are not possible candidates for phonological activity, since I assume privative features. I propose that the feature [palatal] alone serves as the trigger for palatalisation:

(13)



The rule in (13) acts in conjunction with the following surface co-occurrence restriction, which prevents [palatal] from spreading from a low vowel.

(14)



Recall also that /uː/ and /ɔː/ can appear with the labiovelar stops /k^{w}/ and /k^{hw}/ in onset position in this dialect. Under the assumptions that the co-occurrence restriction against a labial onset and labial vowel is inviolable, these vowels must not be specified for the feature [labial], since labial vowels cannot co-occur with labiovelar onsets (example (8a)). So far I have determined that the vowels /iː, yː, ø/ are [palatal] and the vowels /uː, ɔː/ are not [labial]. I have furthermore assumed that /ɛː, ɔː/ are [low]. By the SDA, this leads to the following order of feature cuts for the older variety of Cantonese.

Table 10 Older Cantonese: low>palatal>velar>labial>high

palatal				
	labial			
iː	yː high	ə		uː
	ø			
ɛː		ʌ	ɔː	
		aː	velar	low
palatal				

The first cut in Table 10 is [low]. This is shown by the horizontal, thick triple line. All vowels under the line are specified with the feature [low]. The vowels above the line are not specified with the feature [low]. The next cut is [palatal]. This cut is represented by the vertical triple line. The vowels to the left of this line are specified [palatal]. The third cut is [velar], which is represented by the vertical double line. The fourth cut is [labial] (vertical single line) and the last cut is [high] (horizontal dashed line). Notice that the set of vowels which trigger palatalisation can be described as those non-low vowels with the feature [palatal]. Also, the only labial vowels are /yː/ and /ø/, which are also the only vowels which cannot co-occur with labiovelar onsets (see footnote 8). Note that the vowels /ʌ/ and /aː/ are not distinctive for any feature. I return to this in section 2.4.

2.3.2. Younger Cantonese

In this section, I examine Younger Cantonese, and argue that the underlying inventory is specified as follows: iː (-), yː (palatal labial high), ø (palatal labial) uː (labial) ɛː (low palatal) ʌ (low) aː (low) ɔː (low labial). I begin by comparing this variety to the older variety to determine how the features of the vowels must be altered to retain the same co-occurrence restrictions across varieties, but also allow us to account for the differences between the two varieties.

In the dialect of Cantonese spoken by younger generations, the inventory of vowels which triggers palatalisation is reduced to /yː/ and /ø/ (see Table 6), and the vowels /uː/ and /ɔː/ can no longer appear with labiovelar onsets (see Table 8). Thus, the non-low [palatal] vowels must be comprised of the smaller set of vowels /yː/ and /ø/, and the vowels /uː/ and /ɔː/ must now be specified as [labial]. This can be partially accomplished by a promotion of the feature cut labial:

Table 11 Younger Cantonese: low>labial>palatal>high

palatal		labial		
i:		palatal		
	ə	y: high		u:
		ø		
ɛ:	ʌ		ɔ:	low
palatal	aː		labial	

The first cut in Table 11 is [low], represented by a horizontal triple line. The second cut is [labial] (vertical double line). The third cut is palatal (vertical single line), which happens twice in the inventory: once in the [labial] set and once in the non-labial set. The last cut is [high] (horizontal dashed line). There are two observations that must be made here. First, the feature [velar] has been eliminated from the hierarchy. This is because once the cuts [low], [labial] and [palatal] have been made, the only vowels that can be specified for [velar] have already been uniquely specified and are ineligible for further specifications. Table 12 shows the feature cuts at the stage just before the feature cut for [velar] would be made:

Table 12 Younger Cantonese: low>labial >palatal (intermediate stage)

palatal		labial		
i:		palatal		
	ə	y:		u:
		ø		
ɛ:	ʌ		ɔ:	low
palatal	aː		labial	

At this stage, /ɔː/ and /u ː/ are already uniquely specified. The only further specification that needs to be made is [high] for the palatal, labial vowels.

The second, and more serious, observation is that /iː/ is still specified for [palatal], even though it is not a trigger for palatalisation in this dialect. Given the inventory of non-low vowels, there is no combination of feature cuts that will produce the desired results, unless the vowel /ə/ is ignored. There are two possible arguments that can be made for ignoring this vowel. First, /ə/ has been argued to be featureless (Clements 1989). As such, it might fall into a different category from the other vowels which are capable of entering into contrast relations on the basis of their feature specifications. In other words, the first cut could be between placed and placeless vowels. The second argument is based on the claim that /ə/ can be mora-less (Shaw 1996). Again, this contrasts with the other segments under consideration in that they possess one or two moras (see next section for brief discussion on moras). Under this analysis, the first cut would be between mora-less (ə) and mora-ful vowels (all other vowels), with a mora (or perhaps two) being assigned contrastively to the latter set. These two lines of argumentation suggest that /ə/ is of a different nature than the other vowels, and that its

inclusion with the other vowels in the algorithm in inappropriate. Removing it, then, gives us the following divisions for the two dialects of Cantonese:[14]

Table 13 Older Cantonese: low>palatal>velar>labial>high (no schwa)

palatal labial i: y: high ø		u:	
ɛ: palatal	ʌ a:	ɔ: velar	low

Table 13 shows the order of the feature cuts for the older variety of Cantonese. The order is the same as in Table 10; however, since the phoneme /uː/ was uniquely specified before the [velar] cut was made, it is not specified for this feature. Table 14 shows the order of the feature cuts for the younger variety of Cantonese. Again, the order is the same as in Table 11, except that /iː/ now has been uniquely specified before the cut [palatal] is made. Therefore, /iː/ is not specified [palatal], which is consistent with the pattern of palatalisation in this dialect (see Table 6, Example (9)).

Table 14 Younger Cantonese: low>labial >palatal>high (no schwa)

i:		labial palatal y: high ø	u:
ɛ: palatal	ʌ a:	ɔ: labial	low

As mentioned above, the first feature cut could be based on moraicity or placed versus placeless. If the first feature cut is moraic versus non-moraic vowels, the vowels in Tables 13 and 14 would then all be specified moraic. If the first feature cut is based on Place, the vowels in Tables 13 and 14 would all be specified for Place.

14. These feature specification cause problems for the VG constraint in (5). Given the co-occurrence restriction in (5), it now becomes difficult to rule out *[uːw] and *[iːj] since /uː/ is not specified for any features in the older dialect and /iː/ is not specified in the younger dialect. It was the labial feature on /uː/ and the palatal feature in /iː/ that prevented these two vowels from appearing with the glides /w/ and /j/, respectively. One possibility, not pursued here, is that the constraint also blocks [labial] from being inserted phonetically, yielding a phonetically uninterpretable representation.

2.4. The low vowels /ʌ/ *and* /a:/

Until now, I have ignored how the two low vowels /ʌ/ and /a:/ are distinguished. These vowels have a different character from the other vowels in that they are not subject to any co-occurrence restrictions. One may object to this claim and cite the following co-occurrence restrictions:

(15)	*kwaw	*[k^{wh}ʌw]	*gwaw	*[k^{w}ʌw]
	*kwam	*[k^{wh}ʌm]	*gwam	*[k^{w}ʌm]
	*kwaaw	*[k^{wh}a:w]	*gwaaw	*[k^{w}a:w]
	*kwaam	*[k^{wh}a:m]	*gwaam	*[k^{w}a:m]

However, recall the co-occurrence restriction in (4b) which states that labiovelar onsets cannot co-occur with any labial coda. This is an onset-coda restriction, which is not dependent on the vowel that happens to reside in the nucleus position. Thus, I reaffirm my position that the two low vowels are not subject to any co-occurrence restrictions. I propose, then, that the only quality that discriminates these two vowels is the length feature. This view is corroborated by Lee (1983), who gives phonetic evidence that the qualities of these two vowels are very similar, and, in fact, exhibit a much larger range in phonetic execution than the other vowels in Cantonese.[15] Since these two vowels specified only with the feature [low] and not for Place, they are free to manifest in a much larger portion of the articulatory space, as long as they remain phonetically low. Vowels specified for Place are much more limited in where they can appear. Thus, the two low vowels are represented as follows with moras pre-specified (Pulleyblank 1994):

(16)

Length is determined by the number of moras on the vowel. Long vowels have two moras and short vowels have one mora. Although I have only represented two vowels here, this representation can be applied to all vowels in Cantonese. In other words, the other vowels are also specified as containing either one or two moras, as do the vowels /ʌ/ and /a:/. The other vowels, however, are uniquely specified with respect to other phonetic features, namely Place and Aperture. The vowels /ʌ/ and /a:/, which are both specified [low], are differentiated solely on the number or moras.

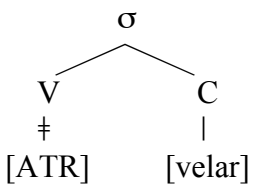
2.5. The lax allophones

There are now three more vowels to consider – [ɪ], [ʊ] and [œ:]. These three variants are accounted for by the following rule (only relevant features/nodes shown):[16]

15. Lee (1983) was looking specifically at the values of F_1 and F_2-F_1, which essentially determine vowel height and degree of frontness versus backness.

16. See Wang (1999, 2002), where she argues that the distribution of tense versus lax vowels can be accounted for by co-occurrence restrictions.

(17)



Note that I assume the feature [ATR] is a part of the feature specification of the vowel. Since the tense/lax vowel pairs do not contrast (they are allophones), they do not enter into the SDA analysis. I assume the feature [ATR] is added to the appropriate vowels at some stage after the SDA has taken effect. Recall also that the vowel /œː/ appears additionally in coda-less syllables. This is due to a constraint in Cantonese that all syllables are bimoraic. Since /ø/ only has one mora, and /œː/ has two, /œː/ must appear when there is no coda. Notice further the change in specification of the number of moras when a vowel is subjected to the rule in (17). High vowels lose a mora and mid vowels gain a mora (see Table 5). I leave for future research how the change is moraic structure is handled and how the rule in (17) should be accounted for.

2.6. Summary

I conclude this section with a brief summary of the proposals made here. The chart below summarizes the feature cuts and vowel features for the two diachronic dialects of Cantonese under consideration. Short vowels are monomoraic and long vowels are bimoraic. I show the moraicity of only the low vowels /aː/ and /ʌ/ to highlight the fact that it is the only characteristic which is contrastive for these two vowels. This, in turn, requires us to assume that the moraic structure for vowels in Cantonese is pre-specified (Pulleyblank 1994).

Older Cantonese	**Younger Cantonese**
low>palatal>velar>labial>high	low>labial>palatal>high
iː - palatal	iː -
yː - palatal labial high	yː - palatal labial high
ø - palatal labial	ø - palatal labial
uː -	uː - labial
ɛː - low palatal	ɛː - low palatal
ʌ - low μ	ʌ - low μ
aː - low μμ	aː - low μμ
ɔː - low velar	ɔː - low labial

These two columns show minimal changes to the feature make-up of the vowels, other than where it is necessary to account for the changes between to the two dialects. The change is accomplished by a promotion in the feature cut [labial] above [palatal]. This has the added result of eliminating the need for the feature cut [velar] in the dialect spoken by younger speakers.

3. Residual Issues

The ideas presented so far have solved the problem in Cantonese phonology of what leads to the differences in CV co-occurrence restrictions between the Older and Younger varieties of Cantonese. We are left with a problem with VG co-occurrence restrictions (see footnote 14). Combinations of VG such as *[iːj] were ruled out by the co-occurrence restriction in example (5) because both the vowel and the glide shared the Place feature [palatal]. In the younger variety of Cantonese, /iː/ is underspecified for Place, so there is apparently nothing to stop it from appearing with the glide /j/ to give the surface form *[iːj]. This sequence is ruled out in both varieties of Cantonese. One possible solution is that the co-occurrence restriction in example (5) hold only at the phonetic level. Another possible solution is to re-evaluate the features of the glides. If /j/ is also underspecified for Place, then *[iːj] can still be ruled out on the grounds that the vowel and glide are alike for Place features in that they are both underspecified. The same problem exists with /uː/ in the older variety. In the older variety, /uː/ is not specified for any Place features, but earlier it was assumed that a Place feature was needed to bar sequences such as */uːw/ in the same manner just described for /iː/.

4. Conclusions

I have proposed an SDA approach to the study of vowels in Hong Kong Cantonese with the following two feature hierarchies: low>palatal>velar>labial>high, which is found in older varieties of Cantonese and low>labial>palatal>high, which is found in younger varieties of Cantonese. I have abstracted away from all allophones for my revised analysis of Cantonese vowels and have concentrated solely on contrastive phonemes; however, I do not believe that a future analysis which adopts the ideas developed here would be unable to account for the finer distinctions between allophones.

The phenomenon of palatalisation in Cantonese was shown to be triggered by [+palatal] in both varieties, with a co-occurrence restriction between palatalized affricates and [low] vowels.

Finally I have argued that the change in the ordering of feature cuts which give [labial] scope over [palatal] is based on other changes that have been taking place in the phonology of Cantonese. Specifically, in order to preserve the onset-vowel constraint against labiovelar onsets and labial vowels, this re-ordering was necessary.

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