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*Multiple scansions in loanword phonology : evidence from Cantonese**

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0 Introduction

In loanword phonology we seek to uncover the processes by which speakers possessing one phonological system perceive, apply native representational constraints on, and ultimately produce forms which have been generated by a different phonological system. We are interested in how speakers instantiate segmental and prosodic structure on an input which may or may not abide by native rules. Crucial to this assumed strategy is the idea that loanwords do not come equipped with their own phonological representation. For any phonetic string, it is only native speakers for whom a fully articulated phonological structure is present; as we will see, the input to loanword phonology is merely a superficial non-linguistic acoustic signal. Thus as host-language speakers perceive foreign forms in accordance with their indigenous phonological system, they instantiate native phonological representations on the acoustic signal, fitting the superficial input into the native phonological system as closely as possible.

Given these assumptions, it should not be surprising that despite the identity of a given acoustic signal when impinging upon the inner ear of speakers of different languages, this input may be perceived, represented and ultimately produced in a distinct manner in each language it enters.

In this article, I provide evidence from segmental, prosodic and tonal operations applied to English loanwords indicating that Cantonese speakers have no access to the phonological representation of incoming loanwords. We will see that the input to the Cantonese loanword phonology indeed consists solely of a superficial acoustic signal, lacking all phonological representation.

The loanword phonology will be shown to possess two distinct levels. The first level of loanword phonology consists primarily of a parsing of the input signal into segment-sized chunks, for which native feature matrices which most closely approximate their articulatory and/or acoustic properties are provided. This process is of course constrained by the native

phonological system itself. As this level of loanword phonology is concerned with providing a preliminary, 'raw' linguistic representation to the perceived non-linguistic input, we may refer to it as the PERCEPTUAL LEVEL of the loanword phonology.

It is only when native phonotactic constraints hold for the incoming form that the raw segmental material may undergo phonological processes, so that it may be realised in conformity with native prosodic constraints on syllable and metrical structure. As this stage of the loanword phonology admits the possibility of true phonological and prosodic processes acting on segments, it may be regarded as the OPERATIVE LEVEL of the loanword phonology.

To provide preliminary exemplification, consider the forms in (1):

(1) a. break → [pik lik]
print → [p'i lin]
cream → [key lim]
b. printer → [p'ɛn t'a]
broker → [puk k'a]
freezer → [fi sa]

All the English forms in (1) possess form-initial consonant–liquid clusters. However, in their Cantonese manifestations, only in the forms in (1a) has the liquid been preserved, through epenthesising a vowel (Cantonese disallows consonant clusters). In (1b), the liquid is not present in the Cantonese form. We might want to say that only in the (a) examples is the liquid *perceived* by Cantonese speakers. However, such a hypothesis quickly becomes untenable when considering near-minimal pairs (e.g. *print* → [p'i lin]/*printer* → [p'ɛn t'a]), and once the proper generalisation is made: the liquid is salvaged if the resulting output is bisyllabic. In forms whose output would exceed bisyllabicity, the liquid deletes, and the output is, again, bisyllabic. Alternatively, we might hypothesise that it is the prosodic shape of the *input* which conditions the processes affecting consonant–liquid clusters: only in monosyllabic inputs are consonant–liquid clusters fully salvaged. Otherwise, the liquid deletes. While I will be arguing for the former analysis, the crucial point is that, either way, the liquid must first be *perceived* in order for the correct strategy to apply. Once perceived, further phonological processes may apply, conditioned by prosodic constraints on the form, resulting in the attested surface forms. We may thus hypothesise the existence of an Operative Level as distinct from the Perceptual Level.

As we will see, the processes which apply at the Operative Level of the Cantonese loanword phonology do not exist in native phonological derivations. Rather, they are processes which are peculiar to the loanword phonology, applying so that non-native forms may be realised in accordance with native constraints. Therefore, phonological processes at the Operative Level of the loanword phonology exist in a separate domain from the native phonological system. Their only property common with

native phonological processes is that the same language-specific constraints exert an influence on the output of both systems.

I will provide evidence for the Perceptual Level and the Operative Level of the loanword phonology by showing that loanwords undergo two distinct, ordered scansions during the course of the derivation. Scansion One will be shown to correspond to the Perceptual Level of the loanword phonology, providing preliminary segmental and prosodic representation to incoming forms. Scansion Two will be shown to correspond to the Operative Level of the loanword phonology, in which native phonotactic and prosodic constraints trigger various phonological operations on the perceived segments.

We will see that English stress patterns are interpreted as tonal patterns by Cantonese speakers. This follows if we assume that loanword operations proceed from a phonetic input, and not a phonological one: English phonological stress tends to correlate with phonetic pitch. As Cantonese is a tonal language, phonetic pitch correlates with phonological tone. And so assuming loanword phonology proceeds from a superficial acoustic signal possessing no phonological structure accounts for English stress-to-Cantonese tone patterns in an intuitive manner.

Maddieson (1985) has argued for the existence of certain phonetic cues to syllabification; that vowels are universally of shorter duration in closed syllables. While such a generalisation may be noteworthy to the phonetician, it is doubtful that the naive listener is sensitive to such subphonemic durational detail. I will thus assume that Cantonese speakers do not have access to English prosodic representation, but instead provide syllable structure for the output of the Perceptual Level of the loanword phonology in accordance with indigenous prosodic constraints and preferences.

Analysing how Cantonese speakers incorporate loanwords whose segmental make-up (the input to the Perceptual Level) cannot be fully accommodated by the Cantonese phonological system (constraints at the Operative Level) may shed light on particular hypothesised grammatical universals. We will see how Cantonese speakers rely on phonological rules and rules of syllabification at the Operative Level which are not a part of the indigenous phonology. Cantonese possesses practically no native processes of epenthesis, syncope or resyllabification; every monosyllabic morpheme almost always surfaces fully intact. However, the Operative Level of the loanword phonology will be shown to require rules triggering these processes, as well as rules triggering segmental processes, not a part of the native phonology, as exemplified in (1).

Furthermore, the analysis of loanwords can open a window into the grammar which may be employed to support or disconfirm hypothesised native representations and derivations. I will provide evidence from the loanword phonology and the native phonology which indicates that Cantonese makes reference to the binary foot, reanalysing data first discussed in Yip (1990a).

Characterising the Cantonese system of loanword incorporation purely in terms of the phonology will result in an incomplete understanding of the forces at work in loanword phonology. As will be seen, speakers' explicit knowledge of the various grammatical levels of the lending language (e.g. syntax, morphology) can and do exert an influence on their phonological instantiations. For example, many Cantonese speakers who employ English loanwords have a reading knowledge of English – hence presumably an explicit knowledge of English grammar – which will be shown to exert an influence on their phonological representations of loanwords. Specifically, we will see that Cantonese speakers exploit their explicit knowledge of English morphology in their analysis of loanwords, which results in surface forms that would be inexplicable without assuming this extraphonological influence on their analysis.

In addition, as the Cantonese syllable is constrained by the language's morphemically based orthographic system, syllable shapes of loanwords are potentially constrained by accidental gaps in the syllable inventory. This constraint is apparently easing as English has come to play an increasingly prominent role in Hong Kong. Bauer (1985) observes that the incorporation of loanwords is resulting in an expansion of the Cantonese syllabary. He divides newly coined syllables into three types:

(i) Those that fill accidental gaps in the syllabary, consisting of new combinations of existing onsets and rhymes, e.g. [fit] *fit*, [win] *win* (where the onsets /f-/ and /w-/, and the rhymes /-it/ and /-in/ are elsewhere attested).

(ii) Those with previously unattested rhymes, e.g. /-ɛn/ ([pɛn] *band*), /-ɛm/ ([kɛm] *game*).

(iii) Those syllables that violate phonotactic constraints of the core syllabary, yet are attested in the mimetic vocabulary, e.g. [pam] *pump*, which possesses both a labial onset and a labial coda – a syllable type attested in the native mimetic vocabulary, though disallowed in the core syllabary.

Finally, certain English loans in Cantonese have entered the language via their Mandarin and Wu incarnations. Such forms are uninformative, as the Cantonese pronunciation is based solely on the characters employed to represent the Mandarin or Wu pronunciation.

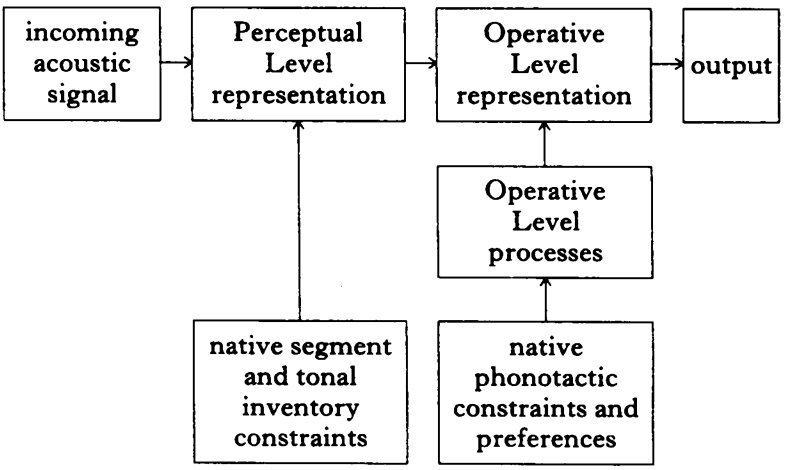
In §1 I discuss properties of Cantonese phonotactics crucial to our analysis. In §2 I present the various motivations for segmental alternations as English words enter Cantonese at both the Perceptual and Operative Levels. In §3 I present Perceptual Level English stress-to-Cantonese tone patterns. In §4 I present evidence from truncated forms indicating that the Perceptual Level and the Operative Level are manifested as an ordered sequence of scansions across a given form. In §5 I show that Cantonese speakers do not have access to English metrical structure, and instead construct a binary foot on incoming forms; a metrical constituent which will be argued to play a role in the native Cantonese phonology.

Most of the data discussed is taken from Cheung (1986). I have collected some further data from native Hong Kong Cantonese speakers.

Finally, when certain crucial English syllable paradigms were absent from the original corpus of data, I provided native speakers with a series of possible Cantonese pronunciations of the relevant English forms, eliciting a forced-choice preference response. Such data are noted by cross-hatching (#). I usually employ Cheung's phonetic transcription of Cantonese loan forms.

I have refrained from formalising the strategies that Cantonese speakers employ as they transpose English segments into Cantonese segments for the following reason: to formalise these operations would be to imply that they are in fact phonological rules, acting on phonological representations (as formal phonological rules imply a phonologically represented input). A main goal of this article, however, is to provide evidence that the input to the Cantonese loanword phonology is *not* a phonological representation. Therefore, while formalising the operations in the traditional manner may serve to clarify for the reader articulatory and/or acoustic relationships between the English and Cantonese forms, this formalism would muddle the theoretical significance of loanword phonology by drawing parallels where they do not exist. In the interest of clarity, however, I provide the following diagram, in order to indicate the hypothesised forces at work within the loanword phonology. This diagram should be kept in mind as data and derivations are presented.

(2)



The input to the loanword phonology is the acoustic signal. At the Perceptual Level, the native segment and tonal inventories constrain the representation of perceived segments. It is only as the Operative Level of the loanword phonology proceeds that perceived segments may undergo true phonological operations, triggered by native phonotactic constraints.

Note that due to the impoverished nature of its indigenous segmental phonology, the Cantonese loanword phonology is particularly well suited for investigation. While in other languages, isolating the loanword phonological operations from indigenous operations would prove an

extremely messy ordeal, the phonology of Cantonese is such that little overlap exists between indigenous and loanword phonological operations: all relevant segmental processes may be relegated to the loanword phonology. That is, the output of the Operative Level of the Cantonese loanword phonology, unlike its counterpart in most other languages, will have been minimally influenced by native phonological processes.

Yip (1990a) also investigates the topic of English loanwords in Cantonese. While Yip's focus is primarily on providing evidence for universally unmarked settings for prosodic parameters, the present study is centred on providing evidence for multiple scansions across a phonetic input, a processing phenomenon perhaps peculiar to loanword phonology, but perhaps not. While many of the basics of Yip's analysis parallel those presented herein, all major differences are noted: the two investigations might best be considered companion pieces to one another.

1 Cantonese phonotactics

We will begin with a brief discussion of those aspects of Cantonese phonotactics which will play a crucial role in our analysis.

1.1 Segments and syllable structure

The Cantonese consonant segment inventory is shown in (3):

(3)	p	t	ts	k	k^w	
	p'	t'	ts'	k'	$k^{w'}$	
	f		s			h
	m	n		ŋ		
		l				
			y		w	

The syllable in Cantonese is superficially of the form (C)VX, allowing neither branching onsets nor branching codas. Acceptable onsets are listed in (4):

(4) p p' m f t t' s n l ts ts' k k' ŋ k^w $k^{w'}$ w y h

(4) shows that all consonantal segments, as well as the glides and /h/, are possible onsets.

Acceptable codas are listed in (5):

(5) p m t n k ŋ w y

(5) shows that only the unaspirated plosives, nasals and glides may close syllables in Cantonese. Stops are unreleased in coda position.

The Cantonese phonetic vowel inventory is presented in (6) (from Hashimoto 1972):

(6)

i:					ü:					u:		
				ɪ						ʊ		
					e		ø			o		
						ɛ:	ö:		ɔ:			
							ɐ					
							a:					

I will have little to say about the transposition of vocalic segments. As length is predictable, it will be indicated only when discussion centres directly on vowel length.

1.2 Tones and patterns of toneme association

I will assume that Cantonese syllables are obligatorily bimoraic on the surface (Duanmu 1990), as all syllables possess either codas or long vowels.

One of six tones is lexically associated with every syllable:

(7)

55 (H)	35 (MH)
33 (M)	24 (LM)
22 (L)	21 (ML)

Tones are presented with traditional notation, where an increase in numerical value corresponds to an increase in pitch. However, the parenthesised notation will be employed throughout this paper, as it is more consistent with recent tonological theory. Note that the phonological representation of tone will not play a crucial role in the present analysis. Therefore, we represent tone solely in terms of its phonetic realisation. No theoretical claims regarding the representation of tone are intended by this notation.

The lexical contour tones will play an extremely limited role in the present discussion, acting only to constrain the form superficial contours may take.

Given the Obligatory Contour Principle (OCP), which prohibits adjacent identical melodic elements, we will assume that long tones are actually represented as in (8):

(8)

In (8), long level tones are represented as single melodic elements associated with two tone-bearing units (TBUs).

2 Segmental constraints and operations

As English words enter Cantonese, Cantonese speakers parse the acoustic signal into segment-sized chunks, instantiating native feature matrices which best capture the articulatory and/or acoustic quality of the input, constrained in their analysis of the incoming acoustic signal by their own phonological system.

As we will now see, constraints on segment realisation in the loanword phonology exist at both the Perceptual Level and the Operative Level.

2.1 Segmental constraints at the Perceptual Level

Many Cantonese speakers who employ English loanwords possess a good command of both spoken and written English, having employed the language extensively during the course of their education. It may thus seem counterintuitive to hypothesise that these speakers do not employ their knowledge of English phonology and orthography as they incorporate English loans. Nonetheless, there exists both experimental and theoretical evidence in support of this hypothesis.

It has been shown experimentally (Elman *et al.* 1977) that bilinguals' perception of isolated syllables is significantly influenced by the language in which the experiment is set. For example, Spanish/English bilinguals presented with bilabial stop–vowel sequences with varying voice onset times (VOTs) tend to perceive such sequences as /ba/ in an English language experimental setting and as /pa/ in a Spanish language experimental setting. The authors hypothesise that this result is due to the fact that English speakers tend to place the phoneme boundary between initial /b/ and /p/ at approximately +25 msec VOT, whereas for Spanish speakers, the boundary has been estimated from +14 msec VOT to −4 msec VOT. Thus when speaking English, bilinguals tend to set the discriminatory threshold at its English level, more readily perceiving /b/, and when speaking Spanish, tend to set this threshold at its Spanish level, more readily perceiving /p/.

These findings are consistent with the hypothesis that the perception of phonetic material is language-set dependent. Accordingly, Cantonese speakers should employ their Cantonese language set when incorporating foreign loans into the native system: as they are speaking Cantonese during the process of loanword incorporation, it is this system which will determine how incoming forms are perceived.

We may consequently hypothesise that at the Perceptual Level of the loanword phonology, Cantonese speakers are constrained in their analysis of incoming forms by their *native* segment inventory. When confronted with a segment whose feature matrix in English does not exist in Cantonese, Cantonese speakers will represent and produce the native segment which most closely approximates the input in articulatory and/or acoustic properties.

When Cantonese possesses a particular contrast in its native segment

inventory, it possesses the necessary phonological primitives to provide an accurate featural representation for segment-sized chunks of the input signal which contrast similarly. I assume that Cantonese speakers perceive each and every parsed element of the input, constrained only by their segment inventory. Therefore, at the Perceptual Level, native segments will be provided irrespective of syllable structure constraints that hold on Cantonese surface forms. We may refer to this notion as the Perceptual Uniformity Hypothesis:

(9) *Perceptual Uniformity Hypothesis*
At the Perceptual Level, the native segment inventory constrains segmental representation in a uniform fashion, regardless of string position.

It should be noted that the Perceptual Uniformity Hypothesis makes no reference to allophonic rules acting within the lending language, as will be exemplified momentarily. We will in fact modify the Perceptual Uniformity Hypothesis in §5.6.

To exemplify Perceptual Level processes, voicing is never contrastive in Cantonese; stops are usually realised voiceless. Thus, as English forms enter Cantonese, both voiced and unaspirated voiceless obstruents are represented identically, as the native Cantonese phonological system does not possess the proper feature matrices to accommodate this contrast. Some examples are given in (10):

(10)		*input*	*Perceptual Level*
	a.	ball	→ [pɔ]
		game	→ [kɛm]
	b.	salad	→ [sa løt]
		sideboard	→ [say put]
	c.	stick	→ [si tik]

In (10a) onsets are realised voiceless, and in (10b) form-final codas are realised voiceless. In (10c) unaspirated English /t/ is faithfully realised in Cantonese.

English onset /r/ is always represented as /l/ in Cantonese. Again, the perception of this chunk of the acoustic signal is constrained by the Cantonese segment inventory. As Cantonese lacks an /l/ ~ /r/ contrast, speakers are only equipped to represent the native feature matrix which most closely approximates the system's sole liquid:

(11)	*input*	*Perceptual Level*
	bearing	→ [pɛ liŋ]
	warrant	→ [wɔ løn]
	lorry	→ [lɔ ley]

(11) shows that prevocalic English /r/ is perceived as /l/ by Cantonese speakers.

As Cantonese forms are based upon British pronunciation, coda /r/ is normally not represented in the Cantonese forms:

(12) *input* *Perceptual Level*
pair → [p'ɛ]
mark → [mak]

In the forms in (12), we observe that /r/'s are not represented in their Cantonese counterparts, as they are not present in the input.

English possesses a contrast between /s/ and /ʃ/. Cantonese, on the other hand, possesses only a single coronal fricative. As Cantonese speakers are thus ill-equipped to fully accommodate the English /s/ ~ /ʃ/ contrast, they represent the Cantonese segment closest in phonetic quality to the input:

(13) *input* *Perceptual Level*
show → [sou]
sharp → [sap]
shaft → [sɐp]
essay → [ɛ sey]
soda → [sɔ ta]

(13) shows that both English /ʃ/ and /s/ are represented identically in Cantonese.

Similarly, /z/ (and marginally /ʒ/), while present in English, are absent from Cantonese. Therefore, /z/ (and presumably /ʒ/) are represented as /s/:

(14) *input* *Perceptual Level*
size → [say si]
cheese → [tsi si]

Aspiration is predictable in English, and therefore not underlyingly specified. In English stressed syllables, and word-initially in unstressed syllables, voiceless plosive onsets acquire aspiration. As English forms enter Cantonese, operations proceed on surface forms, not on underlying representations. As Cantonese possesses an underlying aspiration distinction, speakers are capable of perceiving an aspiration distinction that English speakers may be unaware of. They therefore (usually) supply the appropriate feature matrix from their native segment inventory, thus realising the aspirated/unaspirated contrast:

(15) *input* *Perceptual Level*
a. pie → [p'ay]
tie → [t'ay]
cut → [k'ɐt]
b. bumper → [pɐm pa]
motor → [mɔ ta]
chocolate → [tsü ku lik]

In (15), English aspirated voiceless plosives are perceived as such by

Cantonese speakers. English unaspirated voiceless plosives are also fully accommodated.

Cantonese lacks the voiced labio-dental fricative /v/. Therefore, when encountering this segment, Cantonese represent and subsequently produce the native segment which most closely approximates /v/'s acoustic properties, /w/:

(16) *input* *Perceptual Level*
valve → [wa low]
volume → [wɔ lɐm]

(16) shows English /v/ being realised as /w/ in Cantonese. Note that for reasons which are not fully clear, the voiceless counterpart to /v/, /f/, is not represented.

2.2 Segmental constraints at the Operative Level

The phoneme inventories of Cantonese and English may both possess a particular segment, but due to the more constrained structure of the Cantonese syllable, certain operations must apply as native phonotactics constrain the surface forms which loanwords may take. Thus, at the Operative Level of the loanword phonology, native syllable structure constraints (SSCs) will trigger phonological operations. It is at this point that the Perceptual Uniformity Hypothesis ceases to exert a force on the derivation.

It should be repeated here that the Operative Level of the loanword phonology must be contrasted with phonological processes operating on native forms. Due to the highly constrained nature of the Cantonese morphophonology, segmental processes are virtually non-existent. The processes of the Operative Level of the loanword phonology are therefore peculiar to this domain.

To exemplify Operative Level operations, while both English and Cantonese possess fricatives and affricates in their phoneme inventories, only in English may these surface in both onset and coda position. In Cantonese they may only serve as onsets. I assume that at the output of the Perceptual Level, before native SSCs hold, Cantonese speakers indeed represent English fricatives and affricates as such, although always voiceless. It is only at the Operative Level, when SSCs hold, that a phonological process of occlusivisation will apply to fricatives and affricates that have been assigned to coda positions in Cantonese. The process may be stated informally as $C \rightarrow [-\text{cont}] / —]_{\sigma}$. Examples are in (17):

(17) *input* *Operative Level* (*output*)
a. film → [fey lɐm]
floorshow → [fɔ sow]
b. shaft → [sɐp]
lift → [lip]

(17a) shows that when fricative /f/ is assigned to onset position in

Cantonese, it surfaces intact. However, when /f/ surfaces in coda position (17b), occlusivisation applies, the output thus abiding by Cantonese phonotactics. I assume the following derivations for such forms:

(18)	*input*	shaft	lift
	Perceptual Level	[sɐf]	[lif]
	Operative Level	[sɐp]	[lip]

(The absence of final stops at the Perceptual Level will be discussed in §5.6.)

At the Perceptual Level, a segment-by-segment representation is provided. As Cantonese lacks a contrast in coronal fricatives, English /ʃ/ is perceived as the native feature bundle which most closely approximates it: /s/. At the Operative Level, SSCs trigger phonological processes: /f/ occlusivises to /p/, as fricatives are not permissible codas in Cantonese. Alternatively, Yip (1990a) points out that occlusivisation primarily applies to coda continuants when they are followed by a stop. She argues for a process of segment merger in such environments, place of articulation surviving from the fricative, manner of articulation surviving from the stop. She notes that fricatives in non-branching codas normally undergo epenthesis, thus *bus* → [pa si] (*[pat]).

We have already noted the fact that Cantonese disallows released stops in coda position. While form-final unreleased stops are in free variation with released stops in English, Cantonese forms do not reflect this low-level contrast. Given the Perceptual Uniformity Hypothesis, I assume that the output of the Perceptual Level may contain released stops wherever in the segmental string they arise, the release presumably perceived as aspiration (aspirated stops exist in Cantonese, and therefore may be represented by Cantonese speakers). However, at the Operative Level, as SSCs hold, a phonological process results in the loss of aspiration in segments surfacing in coda position. The loanword phonology thus possesses a rule of the following form: C → [−spread glottis] / —]$_\sigma$. Derivations are in (19):

(19)	*input*	cut	mark
	Perceptual Level	[k'ɐt(')]	[mak(')]
	Operative Level	[k'ɐt]	[mak]

(19) shows that aspiration may be present anywhere in the string at the Perceptual Level of the loanword phonology. However, at the Operative Level, when SSCs hold, a rule of syllable-final deaspiration applies.

I have already discussed the Perceptual Level processes affecting the form *valve* → [wa low], i.e. *v* → /w/. The Operative Level of the loanword phonology exerts a further influence on this form. The input to the Operative Level of the loanword phonology possesses two instances of the high glide ([wa lw]). As SSCs hold at the Operative Level, the first /w/ may be syllabified as an onset, as the following low vowel exceeds /w/ in

sonority. However, as the second /w/ is encountered, we witness a process of epenthesis (/lw/ → [low]).

2.3 The treatment of /l/ and /s/

We have already observed a positive constraint that only unreleased stops may close syllables in Cantonese. As /l/ is thus not permitted in coda position in Cantonese, /l/'s which would otherwise be prosodised as codas normally surface as an onset to a derived syllable:

(20) *input* *Operative Level*
coil → [k'ɔy low]
file → [fay low]
valve → [wa low]

Again, I assume that the output of the Perceptual Level possesses no vowel to the right of /l/; each segment of the input is represented as faithfully as the Cantonese segment inventory will permit. According to the Perceptual Uniformity Hypothesis, the initial perception of the acoustic signal should not be constrained by anything other than the segment inventory of Cantonese. Surely, as no post-liquid vocalic segment exists in the incoming acoustic signal, Cantonese speakers do not perceive such a segment. It is only during the Operative Level, when SSCs hold, that /l/ is provided with an epenthetic segment so that it may be realised in the Cantonese incarnation of the form, in conformity with native SSCs. As only unreleased stop codas are allowed, a vowel must be epenthesised to the lateral's right. This rule of epenthesis is thus a phonological process peculiar to the Operative Level of the loanword phonology. Significantly, no such process exists in the native phonology.

All /s/'s (and segments perceived as /s/: /ʃ/, /z/ and presumably /ʒ/) occurring preconsonantally or word-finally are treated in identical fashion: the segment is retained by epenthesising a vowel to its right. I will later provide evidence that the correct formulation of this rule is: $\emptyset \rightarrow V / s]_{\sigma}$—. Again, as /s/ is not a stop, a vowel must be epenthesised when this segment would otherwise surface in coda position. The one exception I am aware of is *gross* → [lɔ]:

(21) *input* *Operative Level*
a. tips → [tip si]
waste → [wɐy si]
bus → [pa si]
b. stamp → [si tam]
store → [si tɔ]

In (21a) and (21b), /s/ triggers epenthesis in onset and coda position respectively. The epenthetic segment is always /i/.

3 The analysis of pitch contrasts: stress-to-tone

Stress languages tend to possess a loose correlation between the degree of stressing and pitch height, as determined by F0 of the vocalic elements of the speech signal. For example, in English unmarked intonation, syllables receiving primary stress tend to be higher in pitch than other syllables. The phonetic phenomenon of pitch contrast is lexical in tonal languages such as Cantonese. As Cantonese speakers do not have access to English phonological representation, English phonetic pitch patterns will be represented at the Perceptual Level as phonological tonal patterns.

3.1 Primary stress and non-primary stress

Cheung (1986) presents all the major patterns of stress-to-tone mapping in Cantonese loanword phonology. A monosyllabic English form such as *pie* will receive a H tone when the form enters Cantonese, as it receives primary stress (higher pitch) in English. However, a disyllabic form which receives final stress in English will enter Cantonese with a H tone on the final syllable, and a M tone on the initial syllable, which is unstressed (and lower in pitch) in English:

(22) a. card → [kat[H]]
gin → [tsin[H]]
b. cigar → [süt[M] ka[H]]
guitar → [kit[M] t'a[H]]

In (22a) a monosyllabic English word enters Cantonese receiving a H tone, whereas in (22b), bisyllabic English forms receiving final stress enter Cantonese with a M tone assigned to the unstressed syllable, and a H tone assigned to the stressed syllable.

3.2 Tone on derived syllables

A further tonal process applies to forms that undergo epenthesis due to Cantonese SSCs. Recall that while English permits both branching onsets and branching codas, the Cantonese syllable is of the form (C)VX. There are two strategies by which Cantonese speakers analyse an input with unsyllabifiable material, making the output conform to Cantonese SSCs. According to one method, the feature matrix which is supplied for the second offending consonant is deleted from the representation, truncating the branching structure to a non-branching one: $[C_1C_2V\ldots] \rightarrow [C_1V\ldots]$. According to the other method, epenthesis is applied to break up a consonant cluster: $[\ldots CC\ldots] \rightarrow [\ldots CVC\ldots]$. Below, we will formally discuss what motivates these distinct strategies. For now, note that the tone provided for epenthetic segments is not the M tone applied to underived non-primary stressed syllables. Instead, such forms are provided with a L tone:

(23) fluke → [fu[L] luk[H]]
stamp → [si[L] tam[H]]
stick → [si[L] tik[H]]
break → [pik[L] lik[H]]
cream → [key[L] lim[H]]

As no tonal material is perceivable within the consonant clusters of the input, I assume that the output of the Perceptual Level does not possess a toneme associated with consonantal elements. At the Operative Level, however, syllables are constructed in conformity with native SSCs. At this point, epenthesised vocalic segments are toneless. I assume a well-formedness condition requires that each syllable in Cantonese be realised with a tone. Thus a L tone is supplied for the epenthesised vowel, so that the surface form conforms with native SSCs, while the tonal pattern best mimics that of the input: a L tone (the least prominent tone) is provided, since its acoustic properties most closely correspond to those of the input. Note in particular that epenthesised segments do not receive M tones, as these are apparently reserved for non-primary stressed vowels existing at the Perceptual Level. In other words, Cantonese loanword phonology possesses a tonological distinction which, while relevant within the context of the loanword phonological system as a whole, may not be relevant within a given form.

This tonological process is peculiar to the loanword phonology, as no such process exists in the native phonology, and is thus presumably available through universal grammar:

(24)	*input*	stamp	stick
	Perceptual Level	[s tam[H]]	[s tik[H]]
	Operative Level		
	a. *epenthesis*	[si tam[H]]	[si tik[H]]
	b. *tone insertion*	[si[L] tam[H]]	[si[L] tik[H]]
	surface	[si[L] tam[H]]	[si[L] tik[H]]

3.3 Morphemic tone

Within the loanword vocabulary, all final syllables that are not perceived as possessing a H tone surface with a pitch rise. I will assume along with Whitaker (1955/56) that this tone possesses independent morphemic status:

(25) body → [pɔ[H] ti[MH]]
cello → [ts'ɛ[H]] low[MH]]
fashion → [fa[H] sɐn[MH]]

Extending the autosegmental analysis first presented in Yip (1980), I assume that a high H boundary tone attaches form-finally at some stage in

the Operative loanword phonology. This offers the clearest explanation of why almost all loanwords end with a H tone. This also explains why, for example, the tone realised on derived syllables is superficially different word-internally *vs.* word-finally:

(26) a. buffet → [pow[M] fey[H]]
cigar → [süt[M] ka[H]]
b. motor → [mɔ[H] ta[MH]]
soda → [sɔ[H] ta[MH]]
c. stick → [si[L] tik[H]]
fluke → [fu[L] luk[H]]
d. lace → [ley[H] si[MH]]
film → [fey[H] lɐm[MH]]

In (26a) the unstressed syllable in non-final position receives a M tone, while the final syllable receives a H tone, as this syllable is stressed in English. I assume that in such forms, the H suffix may attach vacuously.

In (26b) the underived final syllable presumably possesses an underlying M tone, yet surfaces MH, as the tonal suffix has attached. In (26c) we see that derived syllables in non-final position receive a L tone, while the non-derived stressed syllable, which occurs form-finally, receives a H tone. Finally, in (26d), we observe a derived final syllable which presumably has an underlying L tone. After suffixation, which creates a LH contour, a late rule raises the L to M to accord with general tone contour constraints, resulting in the observed superficial [MH]:

(27) $L \rightarrow M \ / \ [\text{—H}]_{\sigma}$

Cantonese possesses a MH lexical contour tone, while lacking a LH tone, and thus this rule is triggered by Structure Preservation.

Finally, note that tonal suffixation applies *after* surface constraints on prosodisation have triggered the necessary Operative processes. This explains why form-final epenthesised vowels possess the pitch rise (cf. *bus* → [pa[H] si[MH]] (*[pa[H] si[L]]).

3.4 The domain of pitch contrast analysis

In this section I argue that each free morpheme within an English compound form is treated independently for the purpose of tone realisation, despite superficial pitch contrasts. Thus, at the Perceptual Level, the domain of pitch contrast analysis (hereafter PCA domain) is the English free morpheme.

Consider the data in (28):

(28) dockyard → [tɔk[H] ya[H]]
floorshow → [fɔ[H] sow[H]]
sideboard → [sɐy[H] put[H]]

The first syllable of the English free-root compounds in (28) receives primary stress, whereas the second syllable receives secondary stress.

Nonetheless, Cantonese speakers are employing H tones on both syllables. Therefore, we can tentatively conclude that Cantonese speakers establish a strict domain in which relative pitch contrasts are analysed:

(29) *PCA domain*
<English free morpheme>

(29) indicates that Cantonese speakers' explicit knowledge of English morphology is, at least under certain circumstances, influencing their phonological analysis of the phonetic input. We may tentatively hypothesise that at the Perceptual Level of the loanword phonology tone is perceived independently on each distinct lexical item encountered by Cantonese speakers. Therefore, it follows that English compounds composed of two free roots will each be treated independently by Perceptual Level processes, and thus two distinct PCA domains are established for such forms.

We therefore assume the following pitch-to-tone strategy:

(30)

input	dockyard	sideboard
Perceptual Level	[<tɔk[H]> <ya[H]>]	[<say[H]> <put[H]>]
Operative Level	[tɔk[H] ya[H]]	[say[H] put[H]]
surface	[tɔk[H] ya[H]]	[say[H] put[H]]

Phonological tone is represented in terms of relative pitch contrasts, not absolute pitch contrasts. Therefore, each PCA domain will be independent of all others. Despite the fact that the syllables within the forms *dockyard* and *floorshow* contrast in pitch, this contrast exists only beyond the PCA domain, and so it plays no observable role in the cases at hand.

Note that English forms that bear identical stress patterns to those in (28) (i.e. σ́ σ̀), yet are not compounds composed of two free roots, are treated in a different manner from compounds:

(31) #import → [im[H] p'ɔt[MH]] (*[im[H] p'ɔt[H]])
#proton → [pow[H] t'an[MH]] (*[pow[H] t'an[H]])
#photon → [fow[H] t'an[MH]] (*[fow[H] t'an[H]])

In the forms in (31), despite identical stress patterns to the forms in (28), the PCA domain is obviously the full form, as tone is perceived relative to this full form. As the forms in (31) are not composed of two free English roots, Cantonese speakers establish a single PCA domain at the Perceptual Level, and perceive tone accordingly.

Note further that pitch contrasts are determined relative to the highest pitch in a PCA domain. The highest pitch in a given PCA domain receives a H tone, while pitches of lower height are assigned tones relative to this H tone – normally, a M tone. Note in particular that we do not observe forms like *sideboard* → *[say[M] put[M]] or *buffet* → *[pow[L] fey[MH]]. This explains why monosyllabic English forms always receive H tones in Cantonese:

(32) jam → [<tsɛm[H]>] → [tsɛm[H]]
sink → [<siŋ[H]>] → [siŋ[H]]
game → [<kɛm[H]>] → [kɛm[H]]
gin → [<tsin[H]>] → [tsin[H]]

In the form *saxophone* → [sik[H] si[L] fuŋ[H]], the final syllable receives a H tone, suggesting that the syllable is treated as a free morpheme, and thus forms a separate PCA domain. Given that speakers who employ English loanwords presumably have an imperfect knowledge of English morphology, it is not surprising that *saxo-* and *-phone* should be treated in this manner. Note that the second syllable is realised with a L tone. As the [i] in /si/ is often devoiced in the input, this syllable is quite possibly phonetically indistinct from coda /s/, and hence is supplied with a L tone, after epenthesis has been triggered. Finally, note that if this analysis is correct, this form provides evidence that tonal suffixation follows lexical word-building operations, as the second syllable derived from the first 'free' morpheme surfaces without the high H suffix (cf. *[sik[H] si[MH] fuŋ[H]]). The forms *telephone* → [tik[H] lɔt[M] fuŋ[H]] and *dictaphone* → #[tik[H] ta[M] fuŋ[H]] confirm that *-phone* compounds are indeed treated as free-root compounds.

This analysis still cannot account for *disco* → [tik[H] si[L] kow[H]], which displays the same tonal pattern as *saxophone*, yet cannot appeal to morphological structure for motivation (cf. *[tik[H] si[L] kow[MH]]).

3.5 Further exemplification and summary of stress-to-tone

The following minimal pairs support several claims made in this section:

(33) a. post → [p'ow[H] si[MH]]
postcard → [p'ow[H] si[L] k'ak[H]]
b. pass → [p'a[H] si[MH]]
passport → [p'a[H] si[L] p'ɔt[H]]

These forms support the hypothesis that a H boundary tone attaches form-finally, late in the derivation. In the monomorphemic forms, the derived syllables possess a MH tonal pattern, while in the polymorphemic forms, the derived syllables are realised with L tones. According to the analysis presented here, this tonal contrast is due to the fact that the Operative Level of the loanword phonology possesses a late, post-prosodisation rule of tonal suffixation. When the derived syllable is not in form-final position, suffixation has no effect on its tonal shape, and the form surfaces with a L tone. However, when in final position, the derived syllable undergoes tonal suffixation, and a subsequent rule raises L to M, so that the superficial tonal pattern abides by native contour tone constraints.

Furthermore, observe that each stressed element of the free-root compounds is realised with a H tone, despite superficial pitch contrasts.

This indicates that two PCA domains are established at the Perceptual Level.

To summarise, primary stressed English syllables are perceived as possessing H tones in Cantonese. Non-primary stressed syllables are perceived as possessing M tones. A H tonal morpheme attaches form-finally, late in the Operative Level phonology. When the final English syllable receives primary stress (i.e. receives a H tone in Cantonese), the tonal morpheme presumably attaches vacuously. When the final syllable does not receive primary stress, a M tone is perceived, but the high tone suffix subsequently attaches, creating a MH contour tone. A L tone is provided for derived rhymes at the Operative Level. Word-finally – when a vowel is epenthesised to the right of the final syllable coda – the H tone suffix attaches, creating a LH contour tone. A subsequent rule raises the L to a M to accord with general tone-contour constraints.

4 Evidence for multiple scansions in loanword phonology: the analysis of truncated forms

Up to this point, our theoretical model of loanword phonology has been claimed to possess two ordered levels. At the Perceptual Level, the acoustic signal is parsed into segment-sized chunks, whose representation is constrained by the segment inventory of the host language and by the Perceptual Uniformity Hypothesis, which states that input perceived as acoustically identical is uniformly provided with identical feature matrices, regardless of string position. Subsequent to the Perceptual Level, we have argued for the existence of an Operative Level of the loanword phonology. At this level, native SSCs hold for the segmental string constituting the output to the Perceptual Level. The segments now undergo the phonological processes of the loanword phonology, so that the resulting representation is in accordance with indigenous constraints on syllabic (and, as we will see, metrical) structure.

In this section, I provide evidence from truncated English loanwords in Cantonese which clearly supports the existence of these two levels of the loanword phonology. We will see that the tonal pattern of truncated forms requires that we hypothesise the application of two ordered scansions on incoming loanwords. I will argue that each scansion corresponds to a particular level of the loanword phonology. Scansion One will be shown to correspond to the Perceptual Level of the loanword phonology, while Scansion Two will be shown to correspond to the Operative Level of the loanword phonology:

(34) Scansion One = Perceptual Level
Scansion Two = Operative Level

As I will now be arguing that there are phonologically isolable correlates to the hypothesised Perceptual and Operative Levels of the loanword phonology, I will henceforth employ the terms Scansion One when

referring to the Perceptual Level and Scansion Two when referring to the Operative Level.

4.1 Truncation, the domain of pitch contrast analysis and tonal suffixation

In at least one lexical class – university subjects – not all the syllables in English forms are superficially realised in Cantonese. Normally, these truncated forms consist of the first two syllables of the full form. This truncation process will be formalised in §5:

(35) a. economics → [i[M] [k'ɔn[M]]
sociology → [sow[M] si[M]]
biology → [pay[M] ɔ[H]]
insurance → [in[M] sɔ[H]]
b. assignment → [a[M] say[H] mɐn[MH]]
condenser → [k'ɔn[M] tɛn[H] sa[MH]]
commission → [k'ɔm[M] mi[H] sœn[MH]]
professor → [pow[M] fa[H] sa[MH]]

Contrast the truncated forms in (35a) with those in (35b), where the full form is realised.

In (35a), the PCA domain remains the full English form, despite the fact that only a portion of the form is realised in Cantonese. The pitches of the surviving syllables are contrasted not solely with each other, but with those of the full English form. To exemplify, the tones in the truncated form [i[M] k'ɔn[M]] are realised as if tone had been assigned to every syllable in the full English form (*economics*). And so, despite the fact that a pitch contrast exists in the surviving English syllables (cf. *econ*), this contrast is neutralised. This neutralisation is motivated by the fact that subtle pitch contrasts cannot always be accommodated by the limited (though healthy) set of tone options that Cantonese possesses.

(36)

input		*Scansion One*		*Scansion Two*		*output*
economics	→	ik'ɔnamiks	→	ik'ɔn	→	i[M] k'ɔn[M]
		M M H M		M M		

The Perceptual Level representation of the form for *economics* has exhausted the set of tonal contrasts Cantonese allows; H is perceived on primary stressed syllabic elements, and thus only M remains (recall that L is reserved for epenthesised vowels). Therefore, the pitch distinction between secondary stressed syllables and non-stressed syllables cannot be represented by Cantonese speakers, and thus all such syllables are perceived as possessing M tones. Therefore, syllables receiving secondary stress are not tonologically distinguished from unstressed syllables in a PCA domain containing a fully stressed element. However, such a contrast *can* be distinguished in a PCA domain that does *not* possess a

fully stressed element, as there is no greater pitch contrast to trigger neutralisation:

(37)

	a. economics	b. economics
PCA domain	[<σ̀ σ σ́ σ σ>]	[<σ̀ σ>] (σσσ)
	[<ik'ɔnamiks>]	[<ik'ɔn>]
tones perceived	[σ σ σ σ σ] M M H M	[σ σ] H M
	[ik'ɔnamiks] M M H M	[ik'ɔn] H M

(Below, we will discuss data displaying the pattern in (37b).)

We therefore posit the following derivations for [i[M] kɔn[M]] and [sow[M] si[M]]:

(38)

input	economics	sociology
Perceptual Level (including PCA Domain Establishment)	[<ik'ɔnamiks>] M M H M	[<sowsi ɔlɔtsi>] M MHM M
Operative Level and truncation	[i[M] k'ɔn[M]]	[sow[M] si[M]]
surface	[i[M] k'ɔn[M]]	[sow[M] si[M]]

The Cantonese tones present in these forms are not based on the pitch of the two surviving English syllables when pronounced in isolation: [i k'a:n], [sow si]. Had Cantonese speakers employed this strategy, the following forms would surface:

(39) economics → *[i[H] k'ɔn[M]]
sociology → *[sow[H] si[M]]

These forms would be predicted if the PCA domain were established across the truncated form, as syllables receiving secondary stress are higher in pitch than unstressed syllables. We might therefore expect that the syllable receiving secondary stress would enter Cantonese with a H tone, since no syllable possessing primary stress is present in the PCA domain to neutralise the contrast between secondarily and non-stressed elements.

It is apparent then, that as English forms enter Cantonese, they are preliminarily scanned in their entirety. Then, in at least one lexical class,

syllables beyond an initial left-to-right binary foot may be deleted. Syllable deletion crucially follows the establishment of a PCA domain. In other words, the Perceptual Level of the loanword phonology is manifested as a preliminary scansion across the entire form. It is only after this preliminary scansion that phonological operations such as truncation may apply. Thus the Operative Level of the loanword phonology follows the Perceptual Level.

The natural science cluster (*physics chemistry biology*) displays a slightly different pattern:

(40) physics chemistry biology → [fi[H] k'ɛm[H] pay[M]]

Each element is assigned tone in relation to its full underlying form. We therefore posit the derivation in (41):

(41) *input* physics chemistry biology

Scansion One [<fi[H] sik[M]s> <k'ɛ[H] mi[M] stli[M]> <pai[M] ɔ[H] lɔ[M] tsi[M]>]

Scansion Two [fi[H] k'ɛm[H] pai[M]]

There is evidence beyond stress-to-tone perception supporting this analysis. Observe that, unlike most other forms, those in (39) do not have the H tone suffix attached word-finally (i.e. we do not observe the form *[i[H] k'ɔn[H]] or perhaps *[i[M] k'ɔn[MH]]). Since the tonal suffix fails to surface in these forms, I assume that within the loanword phonology – on Scansion Two – the boundary tone indeed attaches, but when the form is truncated, the tone is deleted with the segmental material. Thus the H tone suffix attaches earlier in the derivation than the deletion of material from the surface representation. Were the high tone attached very late in the derivation, it would be expected to surface in the forms in (39).

In fact, there are certain truncated forms that *do* possess this superficial tonal pattern, indicating that the PCA domain for such forms is not based on the full English form, but is instead based on the truncated form:

(42) composition → [k'ɐm[H] p'ow[MH]]
geography → [tsɔk[H] ka[MH]]
marketing → [ma[H] k'ɛt[MH]]

In these data, it is apparent that truncation precedes Scansion Two. Two independent lines of evidence support this analysis:

(i) The PCA domain is the truncated form, not the full underlying form. Cantonese speakers are perceiving these relative pitch contrasts with respect to the syllables present on the surface. Despite the fact that the initial syllable in *composition* receives secondary stress in English, Cantonese speakers are perceiving its pitch as H. This falls out naturally if the PCA domain includes only the syllables surfacing in the Cantonese form:

(43)	*input*	composition
	Scansion One	[<k'ɐm[H] p'ow[M]>] (sition)
	Scansion Two	[k'ɐm[H] p'ow[MH]]
	surface	[k'ɐm[H] p'ow[MH]]

As the first syllable is the highest in pitch within the PCA domain, it is perceived as possessing a H tone in Cantonese. Note specifically that tone perception is indeed a result of relative pitch contrasts, and not absolute pitch contrasts. As truncation proceeds on Scansion One, no ternary pitch contrast exists to neutralise the perception of this contrast.

(ii) Further evidence indicating that truncation precedes further prosodic analysis in these forms stems from the behaviour of the boundary tone. Note that the boundary tone is present in these forms. Unlike the data in (39), the boundary tone is not deleted along with segmental material. This indicates that it attaches after truncation.

Note that we cannot assume that the H tone suffix can attach at the Perceptual Level of the loanword phonology. In addition to the theory-internal argument against such an analysis (i.e. the tonal suffix is not perceived in the input, and therefore will not be present at the output of the Perceptual Level), there exists data-driven evidence as well. Specifically, no truncated form possesses the tonal pattern M MH. This would be the expected surface form of both truncation and tonal suffixation applying at the Perceptual Level. As such forms are unattested, I conclude that such a derivation is unavailable.

Cantonese speakers apparently may apply truncation at the earliest stages of the derivation, i.e. upon reception of the acoustic input on Scansion One. As pitch is perceived solely in relation to those pitches present in the representation, the tonal patterns in (42) can be accounted for only if we assume that Cantonese speakers are attending only to the first two perceived pitches of the acoustic input, subsequent material not undergoing any phonological analysis.

I have thus far provided evidence that Scansion One provides melodic representation for the incoming acoustic signal, only implicitly assuming the construction of some preliminary prosodic structure. However, I have just presented evidence that truncation may apply as Scansion One proceeds. Therefore, it must be the case that a certain amount of prosodic structure, namely syllable nodes and moras, is supplied immediately upon reception of the acoustic signal. This is the only way in which Cantonese speakers are capable of applying truncation so that exactly two syllables are salvaged as Scansion One tone perception proceeds. (Indeed, in §5 I will argue that further prosodic structure is supplied at the earliest stages of the loanword derivation.)

Alternatively, truncation may apply on Scansion Two. This strategy accounts for forms like *economics* → [i[M] k'ɔn[M]], which have been argued to have undergone both Scansion One and Scansion Two processes before truncation applies.

The two strategies are schematised in (44):

(44)

Strategy A		*Strategy B*
incoming acoustic signal	1.	incoming acoustic signal
Scansion One/truncation	2.	Scansion One
Scansion Two	3.	Scansion Two/truncation
surface	4.	surface

(44) displays the two truncation strategies that Cantonese loanword phonology employs. Truncation may apply either on Scansion One (Truncation Strategy A) or on Scansion Two (Truncation Strategy B). At the end of the derivation, unlicensed material deletes. These two derivations account for both truncation paradigms, exemplified in (35a) and (42). Cantonese speakers seemingly employ either of these strategies on an optional basis, though this optionality holds only between forms, and not within them.

There is a strikingly similar interaction between truncation and suffixation in the native morphophonology of English. While Americans truncate *mathematics* to *math*, Britons truncate the form to *maths*. Thus in American, the suffixal morpheme attaches before truncation (*mathematic* + *s* → *mathematics* → *math*), whereas in British English, the suffixal morpheme attaches after truncation (*mathematic* + *s* → *math* + *s* → *maths*). An additional example comes from distinct truncation strategies of *statistics*. While some truncate this form to *stat*, others truncate it to *stats*. The distinct derivations proceed exactly as those for *math/maths*.

Let us now consider how a theory of loanword phonology which posits only a single scansion would handle the truncation facts.

Forms undergoing Truncation Strategy A appear unproblematic. As such forms do not crucially rely on material that does not surface, a single scansion across the first two syllabic elements is sufficient to generate the attested forms:

(45)

input	marketing	composition
analysis	[mak'ɛt] (ing) H LH	[k'ɐm p'ow] (sition) H LH
fix-up/surface	[ma[H] k'ɛt[MH]]	[k'ɐm[H] p'ow[MH]]

Truncation Strategy B, however, poses immediate problems. Assuming that only a single scansion is performed across incoming forms, observed tonal patterns cannot be explained:

(46)

input	economics	sociology
analysis	[ik'ɔn] (omics) H LH	[sowsi] (ology) H LH
fix-up/surface	*[i[H] k'ɔn[MH]]	*[sow[H] si[MH]]

An alternative account of Strategy B forms would require positing a derivation in which segmental material is analysed only so far as the second perceived syllable, but tonal analysis proceeds through the entire form:

(47) *input* sociology

analysis [sowsi] (ology)

M M HM MH

stray erasure/ surface [sow[M] si[M]]

It is far from clear how such a derivation would proceed. How could tonal material associate with segmental material that has not been provided with any linguistic representation?

Positing multiple scansions avoids this conundrum, while additionally providing a straightforward account of the superficial contrast between forms undergoing Strategy A and those undergoing Strategy B.

To conclude this section, I would like to reiterate that we have now isolated phonological manifestations of the hypothesised Perceptual and Operative Levels of the loanword phonology. Truncation Strategy B has provided evidence that there are indeed phonologically isolable correlates to the hypothesised Perceptual and Operative Levels of the loanword phonology, in that two scansions of the incoming form must be made. Truncation Strategy A has provided evidence that syllable nodes and moras are provided at the Perceptual Level of the loanword phonology.

4.2 The ordering of tonal suffixation

We have isolated the ordering of the H tone suffix attachment to late in Scansion Two, after SSCs trigger Operative Level processes. The forms below represent a different paradigm, in which a form derived from English is lexically associated with a native Cantonese morpheme. The tonal structure indicates that the entire form is represented as a single lexical item in the Cantonese lexicon:

(48) cherry → [ts'ɛ[H] ley[M] + tsi[MH]]
X-ray → [ɛk[H] si[L] + kwoŋ[H]]

In the forms in (48), the first two syllables are derived from English, whereas the third is a native Cantonese morpheme ([tsi[MH]] 'seed, son' and [kwoŋ[H]] 'light, bright'). Note that the syllables derived from the English forms do not end with the H tone suffix: *[tsɛ[H] ley[MH]...], *[ɛk[H] si[MH]...]. This indicates that the entire form is treated as a single lexical item by the loanword phonology in that segmental suffixation applies on Scansion Two, crucially, before tonal suffixation.

(49)	*input*	cherry(-seed)	X(-ray)
	Scansion One	[<ts'ɛ[H] ley[M]>]	[<ɛk[H] s>]
	Scansion Two		
	a. *lexical suffixation*	[ts'ɛ[H] ley[M] tsi[MH]]	[ɛk[H] si[L] kwoŋ[H]]
	b. *tonal suffixation*	—	—
	surface	[ts'ɛ[H] ley[M] tsi[MH]]	[ɛk[H] si[L] kwoŋ[H]]

Recall that in the form [sik[H] si[L] fuŋ[H]] (from *saxophone*), we saw that boundary tone attachment followed concatenative processes of a different sort. We can now further isolate the stage at which suffixation occurs: suffixation obviously follows processes of lexical word-building such as those in (48).

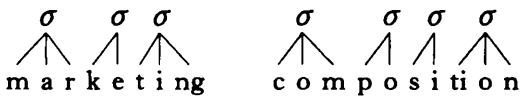
4.3 Maximising syllable construction: evidence for universal strategies

Note that the /n/ in the Cantonese truncated form of *economics* syllabifies as the preceding syllable coda. This suggests that syllable structure is constructed maximally in the loanword phonology. Observe the following forms:

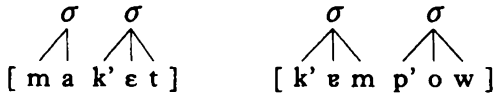
(50)	a.	chemistry	→ [k'ɛm]
		marketing	→ [ma k'ɛt]
		political science	→ [pow lit]
	b.	composition	→ [k'ɐm p'ow]
		insurance	→ [in sɔ]
		psychology	→ [say k'ɔ]

In all the above forms, the onset of the leftmost deleted English syllable surfaces as the coda of the rightmost retained Cantonese syllable, but only when the segment in question is an acceptable coda. In (50a), the /m/ from *chemistry* and the /t/'s from *marketing* and *political science* are acceptable codas in Cantonese, and thus are syllabified so that a maximally well-formed syllable surfaces. However, in the forms in (50b), in which the onset of the leftmost deleted syllable is not an acceptable coda in Cantonese (/s/, /l/), the segment does not syllabify to its left, and is deleted along with its original English syllable. I am aware of one exception: *resident* → [rɛ si] (I assume the /r/ is either a misprint in Cheung's data, or is in free variation with /l/). The contrastive syllabification strategies are exemplified in (51):

(51) *English syllabification*



Cantonese syllabification



As Cantonese speakers have no access to the phonological and prosodic representation of the input, they presumably are not aware of syllable boundaries in the preliminary acoustic signal (cf. Maddieson 1985), and thus must provide their own syllable structure. As stated in the introduction, Cantonese has virtually no indigenous processes of epenthesis, syncope or resyllabification. And so in their treatment of certain loanwords, Cantonese speakers are employing rules of syllable construction which they could not have learned during the initial acquisition process. They are scanning the acoustic signal, supplying feature matrices, and are constructing syllables maximally up to well-formedness. Cantonese speakers are thus appealing to a universal strategy as syllabification of loanwords proceeds.

These facts reinforce the claim that Scansion Two Cantonese loanword phonology is distinct from the native phonology, in that Scansion Two processes, while constrained by the identical phonotactics which exist in the native phonology, do not themselves exist in the native phonology. Furthermore, native phonotactic constraints indeed appear to hold not at the earliest stages of the loanword phonology (on Scansion One), but instead hold later in the derivation (on Scansion Two).

5 Metrical structure: the role of the binary foot

5.1 Evidence from truncation

McCarthy & Prince (1986) show that prosodic morphological processes such as reduplication and truncation exploit prosodic constituents to which the language in question makes reference elsewhere in its phonology, for example, the mora, the syllable and the foot.

Now recall that Truncation Strategy B applies on Scansion One. We have already seen that this truncation strategy requires a certain amount of prosodic structure, namely syllable nodes and moras, to be supplied at this stage of the derivation, as Scansion One truncation requires a full syllable count to have been made as truncation applies.

Further recall that truncation normally reduces a form to bisyllabicity. I now suggest that still more prosodic structure is present at the Perceptual Level of the loanword phonology. I propose that a binary foot template is supplied at the left edge of a form as Scansion One proceeds.

I will argue below that the native Cantonese phonology possesses this metrical constituent. Therefore, its presence at the Perceptual Level of the loanword phonology may follow as a natural consequence: while syllabification of loanwords requires processes peculiar to the loanword phonology, template provision, which does not require reference to melodic material, may apply at the earliest stages of the loanword phonology, i.e. at the Perceptual Level. The binary foot will be shown to act as a template, pressuring forms to achieve bisyllabicity.

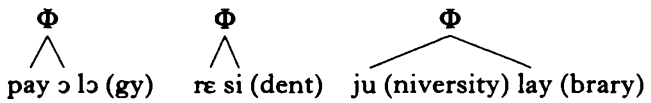
Assuming the loanword phonology indeed provides metrical structure, observe that Cantonese foot construction cannot proceed from English foot construction:

(52) *English*

Cantonese

If Cantonese speakers had access to English metrical structure, *biology* and *tutorial* would surface in Cantonese either as [pay] and [t'iw], or perhaps as [pay ɔ low] and [t'iw t'ɔ li], as such forms contain complete English metrical constituents. The forms actually employed by Cantonese, [pay ɔ] and [t'iw t'ɔ], do not contain English metrical constituents. Note further that appeals to morphological structure cannot be made when characterising truncation strategies. While the bisyllabic *bio-* possesses morphemic status in English, forms like [iŋ lit] (from *English literature*) and [rɛ si] (from *resident*) do not. Obviously, neither can appeals to native English truncation strategies be made. Although [ɪŋ lɪt] is employed by native English speakers, [ju lay] (from *university library*) and [fi k'ɛm pay], which, like [iŋ lit], target initial syllables for salvation, are not present in English. I therefore conclude that neither English metrical structure nor English morphological structure nor English truncated forms are considered as truncation proceeds. Rather, an indigenous strategy of template provision, targeting the first two syllables of single-word forms, initial syllables elsewhere, is the only explanation which generalises across all attested truncated forms. (The one exception of which I am aware is *political science* → [p'ow[M] lit[H]], which is a multi-word form, yet the first two syllables are targeted.) Cantonese speakers are apparently constructing a binary foot left to right (as opposed to English right-to-left foot construction) as Scansion One proceeds, to supply the incoming form with metrical structure:

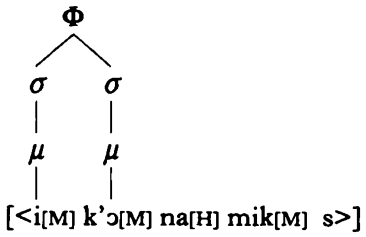
(53)



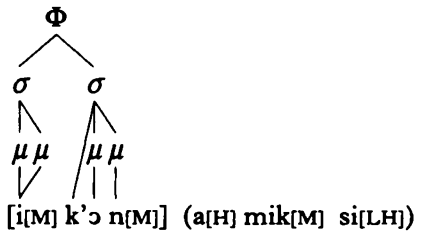
We can now assume the following derivation of a truncated form like [i k'ɔn]:

(54) *input* economics

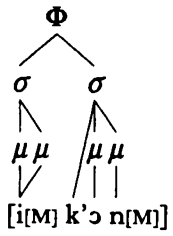
Scansion One



Scansion Two



Stray Erasure



surface [i[M] k'ɔ n[M]]

5.2 Consonant–liquid clusters

We will now consider further data which support the hypothesis that syllable nodes and a binary foot are provided on Scansion One. As already discussed in the introductory section, English liquids sometimes delete when occurring in a consonant cluster. Elsewhere, they are salvaged by epenthesis:

(55) a. break → [pik[L] lik[H]]
#print → [pi[L] lin[H]]
cream → [key[L] lim[H]]
fluke → [fu[L] luk[H]]
#blonde → [pi[L] lan[H]]

b. #printer → [p'ɛn[H] t'a[MH]]
broker → [puk[H] k'a[MH]]
professor → [pow[M] fa[H] sa[MH]]
#proton → [pow[H] t'an[MH]]
place → [p'ey[H] si[MH]]
#price → [p'ay[H] si[MH]]
#blender → [pɛn[H] ta[MH]]
freezer → [fi[H] sa[MH]]

To repeat the observation made in the introduction, we observe liquid deletion in polysyllabic English forms. Otherwise, in monosyllabic English forms, the liquid is preserved and a vowel is epenthesised. Thus in both cases the output is bisyllabic. These data suggest that the binary foot exerts an influence in Cantonese in that a segment which normally undergoes deletion in loanwords is preserved in one instance: just in case the resulting form is bisyllabic, i.e. consists of one binary foot. The form *brandy* → [pɐt[L] lan[H] tey[MH]] is uninteresting for the present analysis, as its pronunciation is based on the characters employed in the Mandarin English loanword. The only true exceptions of which I am aware are *clutch* → [kik lik tsi] and *spring* → [si pit liŋ], in which the liquid is retained despite the fact that the output exceeds bisyllabicity.

Note that the decision to delete or retain the liquid cannot be made until syllables have been constructed across the entire form. After it is determined that, for example, *break* is monosyllabic, epenthesis applies to break the cluster, resulting in a bisyllabic form. The algorithm employed is apparently:

(56) monosyllabic on Scansion One: epenthesis
polysyllabic on Scansion One: deletion

Therefore, syllable nodes must be provided on Scansion One so that the correct prosodisation strategy is applied.

The behaviour of consonant–liquid clusters thus provides further evidence for multiple scansions, and for syllable node and binary foot provision on Scansion One. As Scansion One proceeds, syllable nodes are provided for elements perceived as possessing syllabicity, and a binary foot template is provided, attaching to the first two syllable nodes. Subsequent to Scansion One, after a full syllable count has been made, the appropriate prosodisation strategy is employed for consonant–liquid clusters. If the output of Scansion One is monosyllabic, the liquid is salvaged and a vowel is epenthesised to fill the binary foot template. If the output of Scansion One is polysyllabic, the liquid deletes, as the template has already been filled.

Furthermore, observe that, for example, the near-minimal pair [p'i lin]/[p'ɛn t'a] (from *print/printer*) confirms that segments perceived at the Perceptual Level (Scansion One) may undergo phonological rules – in this case, deletion – as prosodic structure is supplied at the Operative Level (Scansion Two).

The Cantonese form for *floorshow* ([fɔ[H] sow[H]]) possesses some interesting properties. We have already seen that the tonal pattern for this form shows that it is composed of two PCA domains, indicating that Scansion One applies independently to each free morpheme encountered. Yet although *floor* is treated independently for the purpose of pitch contrast analysis, it is not treated independently for further aspects of the prosodic analysis. Specifically, we do not witness liquid retention and epenthesis to derive a bisyllabic form. Instead, as the full form (*floorshow*) is already bisyllabic, the liquid deletes, and *floor* surfaces as a monosyllable.

We have now provided evidence both from Truncation Strategy A and from consonant–liquid prosodisation strategies that the Perceptual Level of the loanword phonology includes the perception of syllabicity, and provides a binary foot template for the incoming form. I propose that on Scansion One, syllable nodes are provided for the most salient components of the phonetic input, i.e. those segments which are perceived as syllabic: vocalic sonority peaks, as well as phonetically salient consonants which are otherwise unsyllabifiable. For example, postvocalic /s/'s salience is most likely due to both its duration and its sibilance. When this segment is perceived postvocalically, and is either preconsonantal or form-final, it is perceived syllabically by Cantonese speakers, and hence provided with a syllable node on Scansion One. Some derivations are given in (57):

(57)

input	printer	print	tips	file
Scansion One	Φ σ σ [p'lɛnt'a]	Φ σ [p'lin]	Φ σ σ [t'ips]	Φ σ [fayl]
Scansion Two	Φ σ σ [p'ɛnt'a]	Φ σσ [p'ilin]	Φ σ σ [t'ipsi]	Φ σ σ [faylow]

On Scansion One, feature matrices are provided, as well as syllable nodes for sonority peaks and phonetically salient segments that are otherwise unsyllabifiable. A binary foot template is provided, seeking to associate with syllable nodes. As Scansion Two proceeds, prosodisation strategies apply, constrained by the template. Therefore, the perceived liquid in *printer* is deleted, while the liquids in *print* and *file* are salvaged through epenthesising a vowel. Thus the output is bisyllabic in either case, satisfying the template. *Tips* is perceived as possessing two syllables, and is consequently prosodised as such on Scansion Two.

Note that unsyllabifiable /s/ and /l/ exhibit distinct behaviour in the following way: /s/ is always perceived syllabically when not prevocalic,

and is thus retained and salvaged by epenthesis. /l/, on the other hand, triggers epenthesis conditionally: only if the resulting output will fill the binary foot template.

We may therefore conclude that /s/ acquires a syllable node on Scansion One. /l/ in onset consonant–/l/ clusters, however, is never perceived as syllabic, but may trigger the construction of a syllable node on Scansion Two. The decision relies crucially on the post-Scansion One syllable count.

5.3 Further exemplification

The following forms provide further support for a number of conclusions drawn in previous sections:

(58) a. forecast → [fɔ[H] k'a[H] si[MH]]
b. high-class → [hɐy[H] k'a[H] si[MH]]
c. passport → [pa[H] si[L] p'ɔt[H]]
d. wide-angle → [way[H] ɛŋ[H] kow[MH]]

As all four forms are free-root compounds in English, the theory outlined here predicts that each root will possess its own PCA domain, despite possible superficial pitch contrasts, as in *forecast*. Indeed, the tonal pattern for this form indicates that two PCA domains have been established, as both members of the compound are perceived with H tones on their stressed syllable.

Furthermore, the theory outlined here hypothesises that phonetically salient consonants which are otherwise unsyllabifiable are perceived syllabically, i.e. are supplied with syllable nodes on Scansion One. These forms display surface patterns supporting this hypothesis. /s/ is realised in a derived syllable in (58a–c), despite the fact that the output exceeds preferred bisyllabicity (cf. *floorshow* → [fɔ[H] sow[H]], where /l/ deletes).

The present theory draws a sharp distinction between the two ordered levels of the loanword phonology. At the Perceptual Level, the input is supplied with melodic structure, and segments perceived as syllabic are provided with syllable nodes, as well as a binary foot template. Thus on Scansion One, the /s/'s from *high-class*, *forecast* and *passport* are supplied with syllable nodes. At the Operative Level, on Scansion Two, loanword phonological processes apply to the output of Scansion One, conditionally constrained by a preference for bisyllabicity. Therefore, as *forecast*, *high-class* and *passport* are perceived as trisyllabic on Scansion One, the output of the Operative Level is indeed trisyllabic. Note in particular that the /l/ from *-class* has been deleted; as bisyllabicity has already been forfeited on Scansion One, there is no motivation to salvage this segment, and it deletes from the representation.

5.4 Native evidence for the binary foot

I have provided several lines of evidence which support the claim that a

binary foot is constructed as Scansion One proceeds. There exist two possible origins for this prosodic constituent in the Cantonese loanword phonology. One possibility is that the native phonology possesses the binary foot. If this is the case, its instantiation at the Perceptual Level of the loanword phonology follows as a natural consequence. The other possibility is that binary foot provision is peculiar to the loanword phonology. If this is the case, it suggests that the binary foot is the universally unmarked foot structure, as all processes which are peculiar to the loanword phonology presumably have their origins in universal grammar. In this section I will argue for the former; that the native phonology of Cantonese indeed possesses the binary foot.

Yip (1990a) also argues for the existence of metrical structure in Cantonese. However, she argues that the foot to which Cantonese phonology makes reference is specifically iambic in quality, corresponding to a Low–High (i.e. less prominent–more prominent) tonal pattern, applied to the right edge of a form. She reanalyses the form-final pitch rise as a type of weight marker, which results in a weak–strong pattern, thus achieving quasi-iambicity. Note that such an iamb is still quantity-insensitive, as all syllables in Cantonese are presumed superficially bimoraic, and thus the iamb to which Cantonese refers must be regarded as unprecedented as a type (Hayes 1991).

Under Yip's analysis, truncated forms such as *economics* → [i[M] k'ɔn[M]], *sociology* → [sow[M] si[M]] and *physics chemistry biology* → [fi[H] k'ɛm[H] pay[M]] must be regarded as exceptional, as they do not display an iambic stress pattern. Under the analysis presented here, the Cantonese binary foot is quantity-insensitive. The form-final rise is due to the attachment of the boundary tone (before truncation). Forms which undergo Truncation Strategy B thus suggest that most loans are quasi-iambic in quality as an artifact of the preference for bisyllabicity, in conjunction with H-tone suffixation, and not to an overt preference for iambicity.

There is evidence from the native phonology to suggest that the tonal rise is not due to a preference for iambicity, but instead possesses productive morphemic status in Cantonese, and further, surfaces in forms that are not iambic in quality. Cantonese adjectival reduplication is accompanied by tonal suffixation. When the tonal suffix attaches to the second copy, the resulting form possesses the meaning 'rather ADJ'. The tonal suffix may instead attach to the first copy however, resulting in a 'quasi-trochaic' metrical structure (i.e. high–non-high, corresponding to a strong–weak pattern). Here, the resulting form possesses the meaning 'very ADJ'. Examples are in (59) (Whitaker 1955/56; Kao 1971):

(59)	[pak[L]]	→ [pak[L] pak[LH] tey[LH]]	'rather white DE'
	white	→ [pak[LH] pak[L]]	'very white'
	[man[M]]	→ [man[M] man[MH] tey[LH]]	'rather slow DE'
	slow	→ [man[MH] man[M]]	'very slow'
	[say[M]]	→ [say[M] say[MH] tey[LH]]	'rather small DE'
	small	→ [say[MH] say[M]]	'very small'

Further evidence against a metrical motivation for the pitch rise is available from verbal reduplication/truncation, which results in a bisyllabic surface form:

(60) [tok[L] yɐt[H] tok[L]] → [tok[LH] tok[L]]
measure one measure 'to measure (once)'
[kwaŋ[M] yɐt[H] kwaŋ[M]] → [kwaŋ[MH] kwaŋ[M]]
stroll one stroll 'to walk around (for a while)'
[t'iw[M] yɐt[H] t'iw[M]] → [t'iw[MH] t'iw[M]]
jump one jump 'to jump (once)'

In these forms, the segmental material associated with [yɐt[H]] 'one' deletes, while the tonal material presumably reassociates to its left, resulting in a 'quasi-trochaic' pattern.

Finally, as Yip assumes that the iambic template is provided at the right edge of a form, she requires that the process of loanword truncation be a completely independent process from iambic template provision, as truncated forms retain material from the left edge, not the right. Under the analysis presented here, no such templatic dichotomy is necessary: the quantity-insensitive binary foot is supplied at the left edge in all loanwords as Scansion One proceeds. Tonal suffixation is a completely independent process.

Further evidence for the binary foot comes from Cantonese hypocoristics. Hypocoristics (Yip 1990b), in which a high tonal suffix attaches to a monosyllabic name, are always prefixed by *a-* (e.g. [pɐy[HM]] → [ɐ[M] pɐy[H]] 'The Lame', [fey[LM]] → [ɐ[M] fey[LH]] 'The Fat'). Furthermore, when hypocoristic tonal suffixation applies to disyllabic forms, *a-* prefixation does not apply (e.g. [woŋ[ML] mow [ML]] → [woŋ[ML] mow[MH]] 'The Yellow-Haired One', [mɐŋ[L] pey[L]] → [mɐŋ[L] pey[LH]] 'Deformed Nose'. This phenomenon is found in several other lexical classes, usually referring to humans (Whitaker 1955/56): familial relationships ([po[H]] → [ɐ[M] po[H]] 'grandmother'), the numerical order of children or servants ([ŋ[L]] → [ɐ[M] ŋ[LH]] 'number five', but [sɐp[L] sey[M]] → [sɐp[L] sey[MH]] 'number fourteen'). Thus the output in Cantonese hypocoristics is always bisyllabic. Assuming with McCarthy & Prince (1986) that prosodic morphological processes necessarily make reference to prosodic constituents, these facts may be accounted for by assuming that a single binary foot is supplied to pressure forms to achieve surface bisyllabicity.

The only apparent exceptions to bisyllabicity in potentially bisyllabic loanwords are *physics* → [fi[H]] and *chemistry* → [k'ɛm[H]]. However, recall that the natural science cluster (*physics chemistry biology* → [fi[H] k'ɛm[H] pay[M]]) fills (and in fact must exceed) a binary foot template, as does the Cantonese form for *biology*, when it stands on its own ([pay[M] ɔ[H]]). [fi[H]] and [k'ɛm[H]] are both derived from English syllables that receive primary stress, thus receiving H tones underlyingly in Cantonese, without tonal suffixation. It is therefore not possible to determine whether truncation strategies (A or B) have applied to these forms, or whether a process of lexicalisation has taken place, as the surface forms would be identical in

any case. Given the opacity of these derivations, we may assume that a reanalysis has taken place, and the truncated forms have become lexicalised. Therefore, when standing alone, they cannot attain bisyllabicity, as they are underived monosyllables.

However, [pay[M]] (from [fi[H] k'ɛm[H] pay[M]]), as it does not possess a final rise, is transparently a derived (truncated) form. Therefore, when in isolation, it must achieve bisyllabicity, and thus [pay[M] ɔ[H]] surfaces.

We may tentatively conclude with Yip (1990a) that bisyllabic minimality (McCarthy & Prince 1986) is preferred in the Cantonese loanword phonology. Departing from Yip, I conclude that this preference is phonologically implemented as the construction of a quantity-insensitive binary foot template on the left edge of a form. Finally, I conclude with Yip (1990a) that this preference, which is widespread in the loanword phonology, and present, though restricted, in the native phonology, suggests that foot structure is indeed evolving in Cantonese phonology.

5.5 The Onset Principle

As prosodisation proceeds on Scansion Two, there is a preference for syllables to close in loanwords. As already discussed, the Cantonese syllable will close if the corresponding English postvocalic segment is an acceptable Cantonese coda. When only one consonant is present intervocalically, this segment will naturally syllabify to its right in accordance with the Onset Principle (avoid $_{\sigma}$[V...: Itô 1989). However, under fairly regular circumstances, we observe gemination of this intervocalic segment:

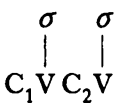
(61) a. copy → [k'ɐp p'i]
shutter → [sɐt t'a]
letter → [lɛt t'a]
guitar → [kit t'a]
vanilla → [wan lɛ la]

b. market → [ma: k'ɛt]
soda → [sɔ: ta]
motor → [mɔ: ta]
major → [mɛ: tsa]

Yip (1990a) notes that the generalisation is as follows: only short English vowels (61a) tend to trigger gemination of the intervocalic consonant. This result is not surprising when we recall the shape of the Cantonese syllable ((C)VX), and the principle of maximising syllable construction up to well-formedness. The segmental string which constitutes the output to Scansion One is provided with subsyllabic moraic structure to accommodate perceived vowel length. As Scansion Two proceeds, SSCs exert pressure on each syllable to achieve bimoraicity. As Yip concludes, intervocalic consonants will syllabify to their left if the

preceding vowel is short, since the resulting syllable will be a maximally well-formed one:

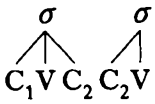
(62) a. *Scansion One*



Scansion Two

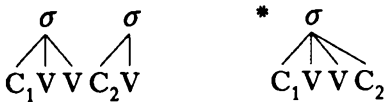
Then, in order to satisfy the Onset Condition the coda C spreads so that the following syllable is provided with an onset:

(63)



When the first English vowel is long, the intervocalic consonant will naturally syllabify to its right, as the first syllable must be constructed maximally, but not in violation of well-formedness:

(64)



Of course, gemination only applies when the intervocalic segment may serve as an appropriate coda in Cantonese. When this segment can not serve as a coda, no gemination is observed: *essay* → [ɛ: sei]. This observation requires no stipulations concerning the principles of maximising syllable structure. If gemination were to apply, an ill-formed syllable would result: *[ɛs sei].

Furthermore, as the Onset Principle does not play an active role in the indigenous Cantonese phonology, I conclude that evidence from Cantonese loanword phonology supports the claim that onsets are universally preferred.

5.6 Consonant–obstruent clusters

English consonant clusters are treated differently depending on where they fall in the syllable:

(65)		*Onset cluster*	*Coda cluster*
a.	plosive// sonorant	pleat → #[p'i[L] lit[H]] clean → #[ki[L] lin[H]]	band → [pɛn[H]] friend → [fɛn[H]]
b.	fricative// sonorant	fluke → [fu[L] luk[H]] flea → #[fu[L] li[H]]	length → #[lɛn[H]]
c.	fricative// plosive	—	lift → [lip[H]] shaft → [sɐp[H]]

(65a) shows that plosive–sonorant onset clusters trigger epenthesis, whereas sonorant–plosive coda clusters are simplified. (65b) shows that fricative–sonorant onset clusters also trigger epenthesis, whereas sonorant–fricative coda clusters are simplified. Finally, in (65c) fricative–plosive coda clusters are simplified (but cf. *soft* → [sɔ fu]).

We have already provided several lines of evidence suggesting that the Cantonese phonology possesses the binary foot. However, obstruent-final coda clusters in monosyllabic inputs are deleted, despite the fact that their salvation through epenthesis would result in the preferred bisyllabic form. I therefore propose that these obstruents are never represented by Cantonese speakers, due to their insufficient phonetic salience. This lack of salience is most likely due to a combination of factors. First, note that final stops are often unreleased in English. For example, since the /t/ in *printer* is released by English speakers, it is therefore recoverable by Cantonese speakers, and thus salvaged. However, the /t/ in *print*, which often remains unreleased in English, and which is in fact often realised with solely a laryngeal constriction, is quite possibly imperceptible to Cantonese speakers, thus unrecoverable.

Yet this cannot be the full story, since English non-branching plosive codas are always recoverable (e.g. *card* → [kat], *mark* → [mak]). This is surely the expected result, as Cantonese coda plosives are never released. We can thus assume that branching coda obstruents delete as a result of their proximity to acceptable Cantonese codas, which are phonetically salient.

This analysis can be restated in terms of phonetic theory. Cantonese speakers are fully capable of distinguishing formant transitions in vowel–obstruent strings, as the native phonotactics of Cantonese (indeed, of every language) permit such strings. However, in non-native vowel–consonant–obstruent strings, the acoustic quality of the initial consonant disrupts the transition from vowel to obstruent. As native Cantonese phonotactics do not permit such a sequence, the Cantonese speaker is ill-equipped to discern obstruents in this environment, and the segment is rendered unanalysable. To illustrate, when the form *band* is encountered, the postvocalic /n/ is represented without difficulty. However, the /d/ cannot be analysed, as Cantonese speakers have no experience with formant transitions between nasals and obstruents. As no vocalic segment exists to the obstruent's right, Cantonese speakers have no opportunity to analyse its formant transitions. The /d/ is consequently unanalysable, and thus is not incorporated into the Cantonese representation.

I have previously argued that all segments which are perceivable in Cantonese, regardless of their position in the string, should be provided with native feature bundles as Scansion One proceeds. I must now retreat from this strong version of the Perceptual Uniformity Hypothesis by employing the following caveat: input whose acoustic phonetic properties cannot be discerned due to its presence in an impoverished context (a context to be determined on a language-specific basis) is not supplied representation on Scansion One of the loanword phonology.

Indeed, findings of Flege & Wang (1989) support this hypothesis. These authors find that Cantonese speakers are capable of discerning a voicing contrast in syllable-final stops, where no contrast exists in Cantonese. Mandarin speakers, however, whose native phonotactic system prohibits obstruent codas altogether, are far less successful at this task. It thus seems reasonable to conclude that the perception of the acoustic signal is indeed partially dependent upon native phonotactic constraints.

Note that in the following forms, we do observe epenthesis to repair coda clusters:

(66) film → [fey[H] lɐm[MH]]
#kiln → [k'i[H] lon[MH]]

If consonant deletion were to apply in these forms, we might obtain the following:

(67) a. *[fey low] *[k'i low]
b. *[feym] *[k'in]
c. *[fey] *[k'i]

In (67a) the nasal has deleted, and the /l/ has triggered epenthesis. In (67b) the liquid has deleted, and the nasal closes the syllable. In (67c) both sonorants delete, leaving a single open syllable on the surface. It is apparent that sonorant-final clusters possess sufficient phonetic salience to be perceived by Cantonese speakers. In order to salvage such segments, a vowel is epenthesised, and bisyllabicity is achieved.

6 Conclusion

I have provided evidence that Cantonese loanword phonology possesses two distinct levels. I have employed empirical evidence in conjunction with the Perceptual Uniformity Hypothesis to support my claim that the initial level of the loanword phonology consists of a parsing of a non-linguistic acoustic input into segment-sized chunks, for which native feature matrices are provided. This level of representation has been termed the Perceptual Level of the loanword phonology, as it is concerned solely with providing a preliminary, perceptually based 'raw' representation for incoming forms.

The second level of the loanword phonology applies to the output of the Perceptual Level. During this stage, native constraints hold on prosodic structure. I have provided evidence from segmental, tonal and prosodic phenomena, in conjunction with the Perceptual Uniformity Hypothesis, arguing for this Operative Level of the loanword phonology.

The theory proposed herein is supported by the experimental findings of Elman *et al.* (1977) concerning the influence of linguistic setting on perception, as well as those of Flege & Wang (1989) concerning the limited influence of native phonotactic constraints on the perception of foreign forms.

The analysis of truncated forms has provided strong supporting evidence for bi-levelled loanword phonology, enabling us to phonologically isolate the Perceptual and Operative Levels as a series of ordered scansions which forms undergo. Scansion One has been shown to correspond to the Perceptual Level, while Scansion Two has been shown to correspond to the Operative Level. It is left to further research to explore the possibility that such a processing strategy is employed beyond the domain of loanword phonology.

Finally, I have discussed evidence, both from the loanword phonology and the native phonology, that the binary foot plays a role in Cantonese.

NOTE

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