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Level-Ordered Loanword Phonology:
Evidence From Cantonese

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by

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ABSTRACT OF THE THESIS

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Evidence from segmental, tonal, and prosodic phenomena shows that Cantonese loanword phonology is a level-ordered process, consisting of a Perceptual Level and an Operative Level.

Cantonese speakers do not have access to English phonological representation as they incorporate English words into Cantonese. Instead, I show that Cantonese speakers provide native phonological and prosodic representation in a series of scansions to the incoming English form. The incoming form is initially perceived as a non-linguistic acoustic signal. During Scansion One, the acoustic signal is parsed into un-prosodized segment-sized chunks, whose perception, representation, and subsequent production are constrained by the segment inventory of Cantonese. It is only during Scansion Two, when rules of prosodization apply to the form, that the perceived segmental material undergoes phonological processes so that it may be realized in conformity with native prosodic constraints on syllable and metrical structure. Thus Scansion One is the phonological manifestation of the Perceptual Level, in that the native segmental phonology constrains the perception of incoming forms. Scansion Two is the manifestation of the Operative Level, in that native phonological and prosodic constraints may trigger processes

applied to the output of the Perceptual Level.

As Operative Level processes do not exist in native phonological derivations, the loanword phonology is distinct from the native phonology, the source of its rules being Universal Grammar.

0. INTRODUCTION

0.1 Outline of the Theory

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. The input to loanword phonology is thus merely a superficial non-linguistic acoustic signal. As host language speakers perceive foreign forms solely 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 thesis, 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 of a parsing of the input signal into unprosodized segment-sized chunks, for which native feature matrices which most closely approximate the articulatory and/or acoustic properties of the perceived acoustic chunks are provided. This process is of course constrained by the native phonological system itself. As this level of loanword phonology is solely concerned with providing a preliminary, "raw" linguistic representation to the perceived non-linguistic input, we may refer it it as the Perceptual Level of the loanword phonology.

It is only when full prosodic structure is supplied for the incoming form that the raw segmental material may undergo phonological processes, so that it may be realized 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.

As we will see, the processes which apply at the Operative Level of the 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 realized 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, presumably supplied by Universal Grammar. Their only common property with native phonological processes is that the same 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 raw segmental representation to incoming forms. Scansion Two will be shown to correspond to the Operative Level of the loanword phonology, providing prosodic representation which will be shown to 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 on which all phonological structure has been obliterated accounts for English stress - to - Cantonese tone patterns in an intuitive manner.

We will additionally see 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.

Analyzing how Cantonese speakers incorporate loanwords whose segmental make-up (the output of the Perceptual Level) cannot be fully accommodated by the Cantonese phonological system (constraints at the Operative Level) may serve to support or disconfirm particular hypothesized 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 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. I will claim that the source of these rules is not the native Cantonese phonology; instead, I will claim that the source is Universal Grammar.

Furthermore, the analysis of loanwords can open a window into the grammar which may be employed to support or disconfirm hypothesized native representations and derivations. We will provide evidence from the loanword phonology and the native phonology which indicate that Cantonese makes reference to the binary foot.

0.2 Extra-Phonological Influences on Loanword Phonology

Loanword phonology is not only influenced by the native phonological system, but by the familiarity the speaker has with the lending language. Following Kiparsky (1973), I assume that the idealized extremes of this continuous scale are casual contact, by which individual loanwords are assimilated purely on the basis of phonetic approximation, and extensive bilingualism, by which the analysis of the phonetic input is placed in the context of the entire phonetic repertoire of the foreign system, and

thus incoming forms may be altered in a fashion that serves to best accommodate all potential phonetic contrasts, as opposed to only those exhibited within a single form. Assuming extensive bilingualism thus serves to account for seeming inaccuracies of phonetic transposition within a given loanword, by allowing for the possibility that certain phonetic alterations must apply to accommodate contrasts which are absent within a given form, but present elsewhere in the loanword inventory. As will be seen, Cantonese users of English loanwords are situated toward the casual contact end of Kiparsky's scale.

Characterizing the Cantonese system of loanword incorporation solely along Kiparsky's scale will result in an incomplete understanding of the extra-phonological forces at work in the loanword phonology. A scale orthogonal to this phonetically-based one must be assumed as well. 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, some 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 extra-phonological influence on their analysis.

Another aspect of loanword phonology which does not immediately follow from Kiparsky's model is a consequence of its level-ordered nature. As Cantonese phonotactics and syllable structure constraints (SSCs) are quite distinct from those of English, native forces will exert an influence such that certain segment-by-segment transpositions will be disrupted. This disruption exists as the Operative Level of the loanword phonology is entered, as the provision of full prosodic structure will trigger phonological processes so that segments abide by native SSCs. 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. While it appears that on occasion certain SSCs are relaxed in the loanword phonology, and certain non-occurring syllable shapes are allowed (Bauer 1985), these constraints nonetheless do seem to exert an influence on the representation of loanwords at the Operative Level.

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.

0.3 Outline of the Thesis, and Miscellany

In Section 1 I discuss properties of Cantonese phonotactics crucial to our analysis. In Section 2 I present the various motivations for segmental alternations as English words enter Cantonese at both the Perceptual and Operative Levels. In Section 3 I present Perceptual Level English stress - to - Cantonese tones patterns. In Section 4, I present evidence from truncated form supporting the claim that the Perceptual Level and the Operative Level are manifested as an ordered sequence of scansions across a given form. In Section 5 I show that 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 shown to play a role in the native Cantonese phonology.

Most of the data discussed is taken from Zhang (1986).

Some further data has been collected by me 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 ("#"). For ease of exposition, the input (which is British R.P.) is represented in bracketed English orthography. I employ Zhang's phonetic transcription of Cantonese loan forms.

I have refrained from formalizing the strategies that Cantonese speakers employ as they transpose English segments into Cantonese segments for the following reason: to formalize these operations would be to imply that they are in fact phonological rules, acting on phonological representations (as phonological rules imply a phonologically represented input). A main goal of this thesis, however, is to provide evidence that the input to the Cantonese loanword phonology is not a phonological representation, but a non-linguistic one. Therefore, while formalizing 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 theoretic

significance of loanword phonology by drawing parallels where they do not exist.

It is only as the Operative Level of the loanword phonology proceeds that perceived segments may undergo true phonological operations. It is therefore only these processes for which formalism is provided.

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 Segmentals, and Syllable Structure

The Cantonese consonant segment inventory is shown in (1).

(1)

p		t	ts	k	k^w
p'		t'	ts'	k'	k^w'
	f		s		h
m		n		ng	
		l			
			y		w

(aspiration is indicated by inverse commas, ng =)

The syllable in Cantonese is superficially of the form (C)VX (or perhaps underlyingly always CV(X) [Yip 1989]), allowing neither branching onsets nor branching codas. Acceptable onsets are listed in (2).

(2) p, p', m, f, t, t', s, n, l, ts,
ts', k, k', ng, k^w, k^w', w, y, h

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

Acceptable codas are listed in (3).

(3)
p	t	k
m	n	ng
w	y	

(3) shows that only the unaspirated plosives, nasals and glides may close syllables in Cantonese. The Cantonese phonetic vowel inventory is presented in (4).

(4)
i	u	u
E	o o	O
	A a	

(E= , O= , A=)

I will have little to say about the transposition of vocalic segments.

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 (*CV). One of seven tones is lexically associated with every syllable.

(5) 55 ([H]) 53 ([HM])
33 ([M]) 35 ([MH])
22 ([L]) 24 ([LM])
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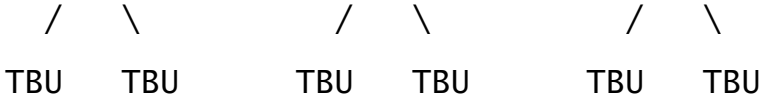
The lexical contour tones will play an extremely limited role in the present discussion, acting only to constrain the form superficial contours may take. The only tonemes which play an active role in the present analysis are [L], [M], and [H]. Tones are presented with traditional notation. However, the parenthesized 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 realization. No theoretical claims regarding the representation of tone are intended by this notation.

Given the Obligatory Contour Principle (OCP), which prohibits adjacent identical melodic elements, we will assume that long tones are actually represented as in (6).

(6)



In (6), long level tones are represented as single melodic elements associated with two TBUs (tone-bearing units).

2. SEGMENTAL 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 realization in the loanword phonology exist at both the Perceptual Level and the Operative Level.

2.1 Segmental Constraints at the Perceptual Level

At the Perceptual Level of the loanword phonology, Cantonese speakers are constrained in their analysis of incoming forms by their own phonological system. As I will now show, when confronted with a segment whose feature matrix in English does not exist in Cantonese, Cantonese

speakers will perceive, represent, and produce the native segment which most closely approximates the input in articulatory/acoustic properties.

When Cantonese possesses a particular contrast in its native segment inventory, it possesses the necessary tools to provide an accurate featural representation for segment-sized chunks of the input signal which contrast similarly. I assume that Cantonese speakers perceived each and every parsed element of the input, constrained only by their segment inventory. There is, prima facie, no principled reason to assume that a segment which is perceptible in one position within the input signal should be perceived distinctly in another position. 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.

(7)
Perceptual Uniformity Hypothesis:

At the Perceptual Level, input perceived as acoustically identical is uniformly provided with identical feature matrices

We will henceforth assume the Perceptual Uniformity

Hypothesis, unless empirical facts prove it incorrect.

To exemplify Perceptual Level processes, voicing is never contrastive in Cantonese; stops are usually realized voiceless. Thus, as English forms enter Cantonese, both voiced and unaspirated voiceless obstruents are perceived identically, as the native Cantonese phonological system does not possess the proper feature matrices to accommodate this constrast. Some examples are given in (8).

(8) a. [ball] -> [pO] b. [sideboard] -> [sai put]
[game] -> [kEm] [salad] -> [sa lot]

In (8a) onsets are realized voiceless, and in (8b) form-final codas are realized voiceless.

English onset /r/ is always perceived as /l/ in Cantonese. Again, the perception of this chunk of the acoustic signal is constrained by the Cantonese segment inventory. As Cantonese lacks /r/, speakers are only equipped to perceive, represent, and ultimately produce the native feature matrix which most closely approximates this segment, namely /l/.

(9) a. [bearing] -> [pE ling]
b. [warrant] -> [wO loen]

c. [lorry] -> [lO lei]

(9) shows that pre-vocalic English /r/ is perceived as /l/ by Cantonese speakers.

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

(10) a. [pair] -> [p'E]
b. [mark] -> [mak]

In the forms in (10), we observe that /r/ in both branching and non-branching English codas is not represented in their Cantonese counterparts, as they are not present in the input.

English possesses a contrast between /s/ and /sh/. Cantonese, on the other hand, does not possess the palato-alveolar voiceless fricative. As Cantonese speakers are thus ill-equipped to fully accommodate English /sh/, they perceive the segment as /s/, which is the Cantonese segment closest in phonetic quality to the input:

(11) [show] -> [sou]

[sharp] -> [sap]

[shaft] -> [sAp]

(11) shows that English /sh/ is perceived as /s/ in Cantonese.

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 realizing the aspirated/unaspirated contrast.

(12) [pie] -> [p'ai] [bumper] -> [pAm pa]

[tie] -> [t'ai] [motor] -> [mO ta]

[cut] -> [k'At] [chocolate] -> [tsu ku lik]

In (12), 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 speakers perceive, represent, and subsequently produce the native segment which most closely approximates /v/'s feature matrix: /w/.

(13) [valve] -> [wa lou]
[volume] -> [wO lAm]

(13) shows English /v/ being realized as /w/ in Cantonese.

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 the English input is provided with Cantonese prosodic structure. It is only when full syllabification is provided -- at the Operative Level of the loanword phonology -- that native SSCs will trigger phonological operations. It is at this point in the derivation of a loanword where the Perceptual Uniformity

Hypothesis ceases exerting 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 he highly constrained nature of the Cantonese morpho-phonology, 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 prosodic structure is provided, Cantonese speakers indeed represent English fricatives and affricates as such. It is only at the Operative Level, when full syllabification is provided, and SSCs consequently hold, that a phonological process of occlusivization will apply to fricatives and affricates that have been assigned to coda positions in Cantonese. The rule may be stated as follows: C -> [-cont] / ___ $]_s$. Examples are in (14).

(14) [film] -> [fei lAm] [shaft] -> [sAp]

[floorshow] -> [fO sou] [lift] -> [lip]

(14) shows that when /f/ is assigned to an onset position in Cantonese, it surfaces intact. However, when /f/ surfaces in coda position, occlusivization applies, the output thus abiding by Cantonese phonotactics. I assume the following derivations for such forms:

(15)	1.	input:	[shaft]	[lift]
	2.	Perceptual Level:	[saft]	[lift]
	3.	Operative Level:	[sAp]	[lip]

At the Perceptual Level, a segment - by - segment representation is provided. As Cantonese lacks the voiceless palato-alveolar fricative, English /sh/ is perceived as the native feature bundle which most closely approximates it: /s/. At the Operative Level, full syllable structure is supplied for the form, and SSCs consequently trigger phonological processes: codas are rendered non-branching (a process to be discussed formally in Section 5.6), and /f/ occlusivizes to /p/, as fricatives are not permissable codas in Cantonese.

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 phonetic 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 relase perceived as aspiration, as aspirated stops exist in Cantonese, and therefore may be perceived by Cantonese speakers. However, at the Operative Level, as full prosodic structure is provided and SSCs hold, a phonological process results in the loss of aspiration in segments surfacing in coda position. Universal Grammar presumably supplies a rule of the following form: C -> [-s.g.] / V ___ $]_s$. Derivations are in (16).

(16)	input:	[salad]	[card]
	Perceptual Level:	[sa lot(')]	[k'at(')]
	Operative Level:	[sa lot]	[k'at]

(16) shows that aspiration may be present anywhere in the string at the Perceptual Level of the loanword phonology. However, at the Operative Level, when full prosodic structure is supplied and SSCs hold, a rule of

syllable-final de-aspiration applies.

I have already discussed the Perceptual Level processes affecting the form [valve] -> [wa lou], 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 full syllabification applies to the form, 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 (/w/ -> [ou]). Interestingly, we do not observe glide formation here (*[wa lu]). (The process of epenthesis is discussed in the next section.)

2.3 The Treatment of /l/ and /s/

As /l/ is not permitted in coda position in Cantonese, /l/'s which would otherwise be prosodized as codas normally surface as an onset to a derived syllable:

(17) a. [file] -> [fai lou]
b. [coil] -> [k'Oi lou]
c. [valve] -> [wa lou]

Again, I assume that the output of the Perceptual Level possesses no epenthetic vowel; 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 segmental 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 full prosodic structure is supplied and SSCs hold, that /l/ is provided with an epenthetic segment so that it may be realized in the Cantonese incarnation of the form, in conformity with native SSCs. This rule of epenthesis is thus a phonological process peculiar to the Operative Level of the loanword phonology: $0 \rightarrow V / V\ [+lat]\ \_\_\_\ C_0]_s$. Significantly, no such process exists in the native phonology.

All /s/s (and segments perceived as /s/, i.e. /sh/) occurring pre-consonantally or word-finally, are treated in identical fashion: the segment is retained by epenthesizing a vowel to its right. I will later provide evidence that the correct formulation of this rule is : 0

-> V / $s]_s$ ___. The one exception I am aware of is [gross] -> [lO].

(18) a. [tips] -> [tip si]
[waste] -> [wAi si]
b. [stamp] -> [si tam]
[store] -> [si tO]

In (18a) and (18b), /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 F_0 of the vocalic elements of the speech signal. For example, in English, syllables receiving primary stress tend to be higher in pitch than other syllables. The phonetic phenomenon of pitch distinction 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 perceived at the Perceptual Level as phonological tonal patterns.

3.1 Primary Stress and Non-primary Stress

Zhang (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.

(19) a. [card] -> [kat[H]]

[gin] -> [tsin[H]]

b. [cigar] -> [syt[M] ka[H]]

[guitar] -> [kit[M] t'a[H]]

In (19a) a monosyllabic English word enters Cantonese receiving a high [H] tone, whereas in (19b), bisyllabic English forms receiving final stress enter Cantonese with a mid [M] tone assigned to the unstressed syllable, and a high [H] tone assigned to the stressed syllable.

Despite the fact that monosyllabic English inputs are produced with a pitch fall when uttered in isolation, Cantonese speakers produce such forms with an even [H] tone. There is a neutralization process in Cantonese that may account for this phenomenon. Whenever a [HM] tone is followed by a [H(M)] tone, a rule of Tone Sandhi applies, changing the [HM] to [H] (e.g. /tong[HM] kwa[HM]/ -> [tong[H] kwa[HM]] ("winter melon")). As there is no [H]/[HM] distinction perceived in the acoustic signal of loanwords, Cantonese speakers are apparently assuming all such inputs are actually [H].

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 analyze an input with unsyllabifiable material, making the output of the Perceptual Level 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..] -> [C_1V..]. According to the other method, epenthesis is applied to break up a consonant cluster: [..CC..] -> [..CVC..]. Later, we will discuss what motivates these distinct strategies. For now, note that tone perceived on segments which trigger epenthesis is not the [M] tone applied to underived non-primary stressed syllables. Instead, such forms such forms are perceived as possessing a low [L] tone: [fluke] --> [fu[L] luk[H]]. Examples follow.

(20) [fluke] -> [fu[L] luk[H]]
[stamp] -> [si[L] tam[H]]
[stick] -> [si[L] tik[H]]
[break] -> [pik[L] lik[H]]
[cream] -> [kei[L] lim[H]]

I assume that all tones realized in the superficial Cantonese form are perceived at the Perceptual Level. It is only when prosodization applies, at the Operative Level, that syllables are constructed in conformity with native SSCs. At this point, perceived [L] tones may re-associate with epenthesized vocalic segments. This tonological process is thus peculiar to the loanword phonology, as no such process exists in the native phonology, and is thus presumably available through Universal Grammar:

(21)

input:	[stamp]	[stick]
Perceptual Level:	[s[L]tAm[H]]	[s[L]tik[H]]
Operative Level:	[si[L]tAm[H]]	[si[L]tik[H]]
surface:	[si[L]tAm[H]]	[si[L]tik[H]]

3.3 Morphemic Tone

All final syllables that are not perceived as possessing a [H] tone surface with a pitch rise:

(22) (a) [body] -> [pO[H] ti[MH]]
(b) [cello] -> [ts'E[H] lou[MH]]
(c) [fashion] -> [fa[H] son[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 why almost all words end with a [H] tone. This also explains why, for example, the tone realized on derived syllables is superficially different word-internally versus word-finally.

(23) a. [buffet] --> [pou[M] fei[H]]
[cigar] --> [syt[M] ka[H]]
b. [motor] --> [mO[H] ta[MH]]
[soda] --> [sO[H] ta[MH]]
c. [stick] --> [si[L] tik[H]]
[fluke] --> [fu[L] luk[H]]
d. [lace] --> [lei[H] si[MH]]

[film] --> [fei[H] lAm[MH]]

In (23a) the unstressed syllable in non-final position receives a mid [M] tone, while the final syllable receives a high [H] tone, as this syllable is stressed in English. The high tone suffix presumably does not attach in such forms, if we assume that the OCP, which prohibits adjacent identical melodic elements, holds on the tonal tier within the syllable. This analysis is supported when we recall that the syllable normally consists of a single morpheme in Cantonese, and that, cross-linguistically, the morpheme is quite often the domain over which the OCP holds. Cohn (1991) shows that in Sundanese the domain of the OCP is prosodically, not morphologically determined, and so the syllable may indeed be the domain over which the OCP holds, without reference to morphological constituency. Alternatively, we can assume that the boundary tone is never constructed for forms which are underlyingly [H]-tone final. As the loanword rule appears to be one of ending a form with a [H] tone, the boundary tone need never attach in forms perceived as possessing [H] endings. I will hereafter assume this latter possibility, although nothing crucial depends on this assumption.

In (23b) the underived final syllable presumably

possesses an underlying [M] tone, yet surfaces [MH], as the tonal suffix has attached. In (23c) 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 high [H] tone. Finally, in (23d), 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]:

(24) [L] -> [M] / [___[H]]$_s$

Cantonese possesses a [MH] lexical contour tone, while lacking a [LH] tone.

Finally, note that tonal suffixation applies after prosodization. This explains why form-final epenthesized 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 show that each free morpheme within

an English compound form is treated independently for the purposes of tone realization, 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 (25).

(25) a. [dockyard] -> [tOk[H] ja[H]]
b. [floorshow] -> [fO[H] sou[H]]
c. [sideboard] -> [sai[H] put[H]]

The first syllable of the English free-root compounds in (25), 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 analyzed:

(26) PCA Domain: <English free morpheme>

(26) indicates that Cantonese speakers' explicit knowledge of English morphology is, at least under certain circumstances, influencing their phonological analysis of the phonetic stimulus. We may tentatively hypothesize 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:

(27)

input:	[dockyard]	[sideboard]
Perceptual Level:	[<tOk[H]><ya[H]>]	[<sai[H]><put[H]>]
Operative Level:	[tOk[H]ya[H]	[sai[H]put[H]]
Surface:	[tOk[H]ya[H]]	[sai[H]put[H]]

(for ease of exposition, tones perceived at the Perceptual Level are linearly arranged following the syllable boundaries which come to exist at the Operative Level)

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 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] -> *[sai[M] put[M]], or [buffet] -> *[pou[L] fei[MH]].

This explains why monosyllabic English forms always receive [H] tones in Cantonese:

(28)	[jam]	->	[<tsEm[H]>]	->	[tsEm[H]]
	[sink]	->	[<sing[H]>]	->	[sing[H]]
	[game]	->	[<kEm[H]>]	->	[kEm[H]]
	[gin]	->	[<tsin[H]>]	->	[tsin[H]]

Note that English forms that bear identical stress patterns to those in (16) (i.e. s s), yet are not compounds composed of two free roots, are treated in a different manner from compounds:

(29)	#[import] ->	[im[H] p'Ot[MH]	(*[im[H] p'Ot[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 (29), despite identical stress patterns to the forms in (25), the PCA domain is obviously the full form, as tone is perceived relative to the full form. Presumably, as the forms in (29) are not composed of two free English roots, Cantonese speakers establish a single PCA domain at the Perceptaul Level, and perceive tone accordingly.

In the form [saxophone] -> [sik[H]si[L] fung[H]], the final syllable receives a high [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 perceived as possessing 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 perceived with a [L] tone, eventually triggering epenthesis. 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] fung[H]]). The forms [telephone] -> [tik[H] lOt[M] fung[H]] and [dictaphone] -> #[tik[H] ta[M] fung[H]] confirm that "-phone" compounds are indeed treated as free-root compounds.

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

3.5 Further Exemplification, and Summary of Stress - to - Tone

The following minimal pairs support several claims made in this Section.

(29)
[post]	->	[p'ou[H] si[MH]
[postcard]	->	[p'ou[H] si[L] k'ak[H]]
[pass]	->	[p'a[H] si[MH]]

[passport]-> [p'a[H] si[L] p'Ot[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 possess [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-prosodization 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 raising [L] to [M], so that the superfical tonal pattern abides by native contour tone constraints.

Furthermore, observe that each stressed element of the free-root compound forms is realized with a [H] tone, despite superficial pitch contrasts. This indicates that two PCA domains are established at the Perceptual Level.

To summarize, 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 does not attach, as a pitch rise is unnecessary. When the final syllable does not receive primary stress, a mid [M] tone is perceived, but the high tone suffix subsequently attaches creating a [MH] contour tone. A [L] tone is perceived on segments which trigger epenthesis, which subsequently reassociates to the derived rime at the Operative Level. Word-finally -- when a vowel is epenthesized to the right of the final syllable coda -- the high [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 LEVEL-ORDERED 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 perception, representation, and production are constrained by the phonological system 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. Subsequent to the Perceptual Level, we have argued for the existence of the Operative Level of the loanword phonology. At this level, full prosodic structure is provided 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 ordered levels of the loanword phonology. We will see that the tonal pattern of truncated forms requires that we hypothesize 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:

(30) Scansion One = Perceptual Level

Scansion Two = 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 realized in Cantonese. Normally, these truncated forms consist of the first two syllables of the full form. This process will be formalized in Section 5.

(31) a. [economics] --> [i[M] [k'On[M]]
[sociology] --> [sou[M] si[M]]
[biology] --> [pai[M] O[H]]
[insurance] --> [in[M] sO[H]]

b. [assignment] --> [a[M] sai[H] mAn[MH]]
[condenser] --> [[k'On[M] tEn[H] sa[MH]]
[commission] --> [k'Om[M] mi[H] soen[MH]]
[professor] --> [pou[M] fa[H] sa[MH]]

Contrast the truncated forms in (31a) with those in

(31b), where the full form is realized.

In (31a), the PCA domain remains the full English form, despite the fact that only a portion of the form is realized 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'On[M]] are realized 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 neutralized. This neutralization is motivated by the fact that subtle pitch contrasts cannot always be accommodated by the limited set of tone options that Cantonese possesses.

As the Perceptual Level representation of the form for [economics] presumably possesses a [L] tone attached to /s/, the representation has exhausted the set of tonal contrasts Cantonese possesses; [H] is perceived on primary stressed syllabic elements, and thus only [M] remains. Therefore, the pitch distinction between secondary stressed syllables and non-stressed syllables is imperceptible to 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 both a fully stressed element, and a segment perceived as possessing a [L] tone. However, such a contrast <u>can</u> be distinguished in a PCA domain that does <u>not</u> possess a fully stressed element, as there is no greater pitch contrast to trigger neutralization:

(32)	(a)	(b)
PCA domain:	[<s s s s>]	[<s s>]
	?[<i k'O na mics>]	[<i k'On>]
tones perceived:	[s[M]s[M]s[H]s[M]]	[s[H]s[M]]
	?[i[M]k'O[M]na[H]mic[M]s[L]]	[i[H]k'On[M]]

("?" indicates the hypothesized output of the Perceptual Level.

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

We therefore posit the following derivations for [i[M] kOn[M]] and [sou[M] si[M]]:

(33) input:

[economics] [sociology]

Perceptual Level (including PCA Domain Establishment):

```
?[<i k'On na mik s>]     ?[<sou si O lO tsi>]
   |   |   |  |  |           |   | |  |   |
   M   M   H  M  L           M   M H  M   M
```

Operative level, and truncation:

[i[M]k'On[M]] [sou[M]si[M]]

surface:

[i[M]k' On[M]] [sou[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:

(34) [economics] --> *[i[H] k'On[M]]
[sociology] --> *[sou[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 therefore might 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 neutralize this contrast.

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 the Operative Level phonology is reached.

The natural science cluster displays a slightly different pattern:

(35) [physics chemistry biology] -> [fi[H] k'Em[H] pai[M]]

Each element is assigned tone in relation to its full underlying form. We therefore posit the derivation in (36). As I am now arguing that there are phonologically isolable correlates to the hypothesized Perceptual and Operative Levels of the loanword phonology, I will henceforth employ the term Scansion One when referring to

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

(36)

input: [physics chemistry biology]

Scansion One: ?[<fi[H]sik[M]s[L]>
<k'E[H]mi[M]s[L]tli[M]>
<pai[M]O[H]lO[M]tsi[M]>]

Scansion Two: [fi[H]k'Em[H]pai[M]]

surface: [fi[H]k'Em[H]pai[M]]

There is evidence beyond stress-to-tone perception supporting this analysis. Observe that, unlike most other forms, those in (34) do not have the high [H] tone suffix attached word-finally (i.e. we do not observe the form *[i[H] k'On[MH]] or perhaps *[i[M] k'On[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 (34).

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:

(37)	[composition]	->	[k'Am[H] p'ou[MH]]
	[geography]	->	[tsOk[H] ka[MH]]
	[marketing]	->	[ma[H] k'Et[MH]]

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

1) 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:

(38)	input:	[composition]
	Scansion One:	[<k'Am[H]p'ou[M]>]

Scansion Two: [k'Am[H]p'ou[MH]]

surface: [k'Am[H] p'ou[MH]]

As the first syllable is the highest in pitch within the PCA domain, it is perceived as 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 quaternary pitch contrast exists to neutralize the perception of this contrast. We may thus characterize Cantonese speakers' familiarity of English as approaching Kiparsky's casual contact end of the scale, as pitch contrasts are perceived only within the domain of the form under analysis, and not in the context of the entire loanword inventory.

2) The second line of evidence indicating that truncation precedes further prosodic analysis in these forms stems from the behavior of the boundary tone. Note that the boundary tone is present in these forms. Unlike the data in (34), the boundary tone is not deleted along with segmental material. This indicates that it attaches after truncation.

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 (37) can be accounted for only if we assume that Cantonese speakers are attending only to the first two perceived pitches of the acoustic input.

I have been assuming that Scansion One provides melodic representation, and melodic representation only for the incoming acoustic signal. 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, are 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. I assume, of course, that syllabicity is not represented as part of the defining segmental feature matrices, but instead consists of the construction of syllable nodes over perceived syllabic segments. (Indeed, in Section 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'On[M]], which have obviously undergone both Scansion One and Scansion Two processes before truncation applies.

The two strategies are schematized in (39).

(39)

Strategy (A)	Strategy (B)
1. incoming acoustic signal	1. incoming acoustic signal
2. Scansion One/truncation	2. Scansion One
3. Scansion Two	3. Scansion Two/truncation
4. Stray Erasure	4. Stray Erasure
5. surface	5. surface

(39) displays the two truncation strategies that Cantonese loanword phonology employs. Truncation may apply either during Scansion One (Truncation Strategy (A)), or during Scansion Two (Truncation Strategy (B)). At the end of the derivation, unlicensed material deletes through Stray Erasure. These two derivations account for both truncation paradigms, exemplified in (34) and (37).

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 morpho-phonology 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, the suffixal morpheme attaches after truncation (/mathematic+s/ -> [math+s] -> [maths].

To conclude this section, I would like to reiterate that we have now isolated phonological manifestations of the hypothesized Perceptual and Operative Levels of the loanword phonology. Truncation Strategy (B) has provided evidence that there are indeed phonologically isolable correlates to the hypothesized 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 are provided at the Perceptual Level of the loanword phonology.

4.2 The Ordering of Stray Erasure

In this section, I show that Stray Erasure applies very late in the derivation, at the end of Scansion Two. Recall the tonal pattern for [marketing] -> ma[H]k' t[MH]. As tonal suffixation is present, and as pitch contrast exists, Truncation Strategy (A) (Scansion One truncation) has applied. If Stray Erasure were to appply at the end of Scansion One, there would be no way to salvage the /t/, since it will not possess the proper licensing conditions until syllabified on Scansion Two:

(40) input: [marketing]
Scansion One: [ma[H]k'E[M](ting)]
Stray Erasure: [ma[H]k'E[M]]
Scansion Two: [ma[[H]k'E[MH]]
surface: *[ma[H]k'E[MH]]

However, if Stray Erasure applies after full syllabification -- a Scansion Two process -- the /t/ will be present at the crucial point in the derivation where it may acquire licensing:

(41) input: [marketing]
Scansion One: [ma[H]k'E[M](ting)]
Scansion Two: [ma[H]k'Et[MH](ing)]

Stray Erasure: [ma[H]k'Et[MH]]

surface: [ma[H]k'Et[MH]]

Given that this segment survives the derivation long enough to be incorporated into a syllable, we may conclude that Stray Erasure applies late in the Scansion Two (Operative) phonology, regardless of whether Truncation Strategy (A) or (B) is employed.

4.3 The Ordering of Tonal Suffixation

We have isolated the ordering of the [H] tone suffix attachment to late in Scansion Two, after prosodization, but before Stray Erasure. 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:

(42) [cherry] -> [ts'E[H] lei[M] + ts'i[MH]]

[X-ray] -> [Ek[H] si[L] + kang[H]]

In the forms in (42), the first two syllables are derived from English, whereas the third is a native Cantonese morpheme ([ts'i[MH]], meaning "seed" or "son", and [kang[H]], meaning "light" or "bright"). Note that the syllables derived from the English forms do not end with the high [H] tone suffix: *[tsE[H]lei[MH]...], *[Ek[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.

(43)

input:	[cherry]	[X](-ray)
Scansion One:	[<ts'E[Hllei[M]>]	[<Ek[H]s[L]>]
Scansion Two:		
lexical suffix.:	[ts'E[H]lei[M]tsi[MH]]	[Ek[H]si[M]kang[H]]
tonal suffix.:	----------	----------
surface:	[ts'E[H]lei[M]tsi[MH]]	[Ek[H]si[M]kang[H]]

Recall that in the form [sik[H] si[L] fung[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 (43).

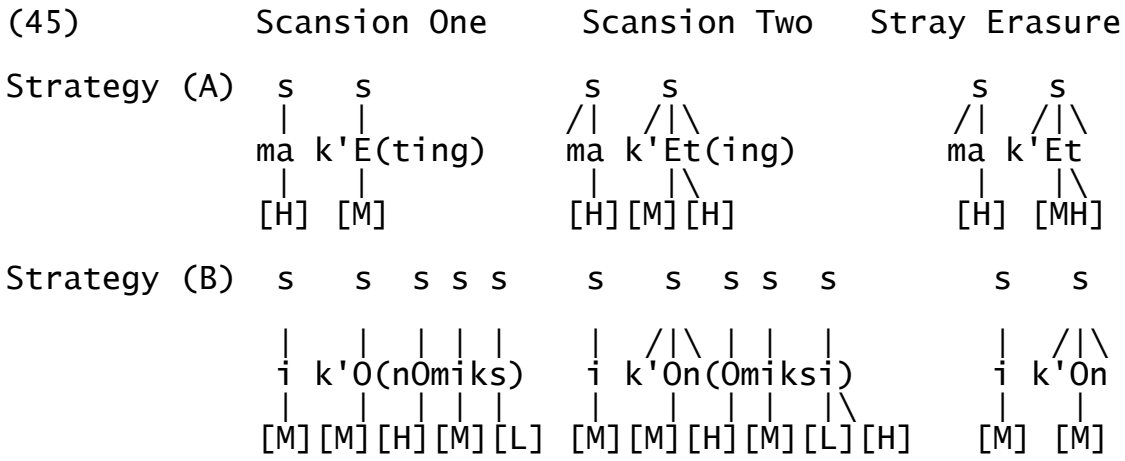
I now posit the following derivation for [economics] -> [i[M] k'On[M]]:

(44) input: [economics]
Scansion One: ?[i[M]k'O[M]na[H]mik[M]s[L]]
Scansion Two: [i[M]k'On[M](a[H]mik[M]si[L][H]])
Stray Erasure: [i[M]k'On[M]]
surface [i[M]k'On[M]]

Note that this analysis is fully consistent with the hypothesis that syllable nodes are provided on Scansion One, and that Truncation Strategy (A) does not provide syllable nodes beyond the first two: evidence from pitch contrasts have supported the hypothesis that tones are only perceived on syllabic segments as Scansion One proceeds. Therefore, as Truncation Strategy (A) applies, only the first two syllabic segments are provided with tones. Consequently, the tonal suffix associates from the right edge to the leftmost available TBU, crucially by-passing all melodic material that has not yet been deleted through

Stray Erasure:

(45)



In (45), Truncation Strategy (A) applies on Scansion One, whereas prosodization and tonal suffixation apply on Scansion Two, the suffix docking to the rightmost available TBU. Finally, Stray Erasure deletes unprosodized melodic material, and the tonal suffix survives. Now contrast Strategy (A) with Strategy (B). Here, truncation applies on Scansion Two, crucially, after syllable nodes have been provided for the full underlying form. As suffixation proceeds, the [H] tone docks to the rightmost available TBU. Stray Erasure consequently deletes all unprosodized melodic material, including the [H] suffix.

4.4 Maximizing Syllable Construction: Evidence for

Note that the /n/ in the Cantonese truncated form of [economics] syllabifies with the preceding syllable coda. This suggests that syllable structure is constructed maximally on Scansion Two. Observe the following forms:

(46) a. [chemistry] -> [k'Em]
[marketing] -> [ma k'Et]
[political science] -> [pou lit]

b. [composition] -> [k'Am p'ou]
[insurance] -> [in sO]
[psychology] -> [sai k'O]

In all the above forms, the onset of the leftmost deleted English syllable surfaces as the coda of the rightmost retained syllable, but only when the segment in question is an acceptable coda. In (46a), the /m/ from [chemistry], 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, the forms in (46b), 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] -> [rE si] (I assume the /r/ is either a misprint in Zhang's data, or is in free variation with /l/). The contrastive syllabification metrics are exemplified in (38).

(47)

English syllabification:

```
      s   s  s        s   s  s   s
     /|\ /| /|\      /|\ /| /|  /|\
      mar ke ting     com po si
tion
```

Cantonese syllabification:

```
      s   s          s    s
     /|\ /|\        /|\  /|\
   [ma:k'Et]      [k' m p'ou]
```

(note that postvocalic, pre-consonantal /r/ is perceived as vowel length)

As Cantonese speakers do not perceive syllable boundaries in the acoustic input, they must provide their own syllable structure. As stated in Section 0, Cantonese has 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, which results in an unsyllabified segmental string, and subsequently 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 idea that Scansion Two Cantonese loanword phonolgy is distinct from the native phonology, in that Scansion Two processes do not exist in the native phonology, but instead are available through Universal Grammar.

4.5 Indigenous Truncation Strategies

While Cantonese does have indigenous forms which undergo truncation, this truncation strategy operates on the level of the morpheme.

(48) [kong kong siu y ng pa si] -> [siu pa]
"public collective small style bus" "small-bu(s)"
(minibus)
[t'ai hak t'Ek lou] -> [t'ai t'Ek]
"undergound iron road" "ground-iron"

(subway)

[ngou yau t'O si] -> [yau t'O]

"milk oil toast" "oil-toa(st)"

(buttered toast)

(Both [pa si] and [t'O si] are loans themselves.)

Since Cantonese has no indigenous truncation strategy for polysyllabic morphemes, appeals to universal rules must be made on truncated loans. Therefore, the licensed monomorphemic segmental string is assigned prosodic structure maximally up to well-formedness.

It is instructive to contrast Cantonese truncation strategies with those of a language that does possess indigenous monomorphemic truncated forms. In Japanese, forms may be truncated to meet the following minimal requirements (Ito 1990):

(49) Minimal stem requirement: = F = [m m]

Minimal word requirement: > s

Examples are given in (50) (examples are from Mester (1990)).

(50) [Akira] -> [Aki-can]
[Ranko] -> [o-Ran]
[koono] -> [o-Koo-san]

Here, the stem reduces to fit a bimoraic template, yet requires affixal material in order to meet the minimal word requirement of bisyllabicity.

As Japanese morphology allows for polysyllabic morphemes, the same strategy is employed when polysyllabic loanwords are truncated: each loanword stem is allowed surface representation up to two moras in its Japanese realization, while each word requires surface representation of more than one syllable (Ito assumes that Japanese speakers divide stems and affixes of loanwords in accordance with indigenous strategies) (examples are from Ito 1990):

(51)

[permanent]	->	[paamaneNto]	->[paama]
			(*[paamaN])
[combination]	->	[koNbinaeeshon]	->[koNbi]
			(*[koNbiN])
[location]	->	[rokeeshoN]	->[roke]
			(*[rokee])

[demonstration] -> [demoNsutoreeshon]->[demo]
(*[demoN])

[guarantee] -> [gyaraNtee] ->[gyara]
(*[gyaraN])

("N" represents the moraic nasal)

The crucial observation is that syllables are not constructed maximally up to well-formedness in truncated loanwords. Were Japanese speakers employing this strategy, [permanent] would surface as *[paamaN], since [maN] is a well-formed Japanese syllable. As the indigenous Japanese prosodic phonology makes reference to subsyllabic prosodic structure in its indigenous truncation operations (i.e. it refers to the mora), this same strategy is naturally employed when loanwords are truncated. Therefore, when the Japanese minimal word requirement is minimally satisfied, no further melodic material is incorporated into the structure.

But as the indigenous Cantonese strategy of truncation operates solely on the morphemic level, appeals to universal principles must be made when non-native polysyllabic morphemes undergo truncation.

5. METRICAL STRUCTURE: THE ROLE OF THE BINARY FOOT

5.1 Evidence from Truncation

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

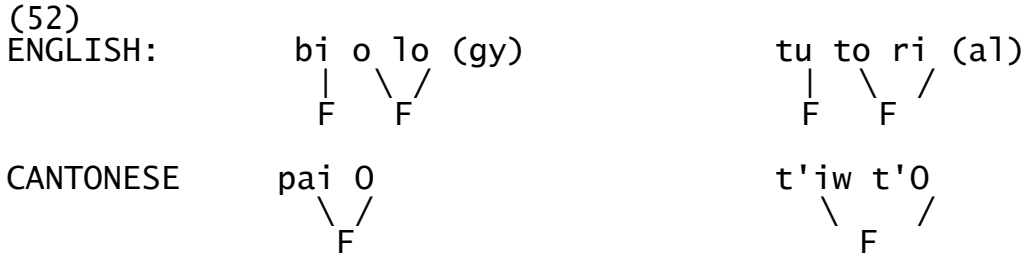
Now recall that truncation Strategy (B) applies on Scansion One. I have already shown that this truncation strategy requires a certain amount of prosodic structure, namely, syllable nodes, to be supplied at this stage of the derivation, as Scansion One truncation requires a full syllable count to have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

Further recall that truncation normally reduces a form to bisyllabicity. I now suggest that still more prosodic structure is perceived at the Perceptual Level of the loanword phonology. I propose that a binary foot template is supplied at the right 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. 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 can not proceed from English foot construction.

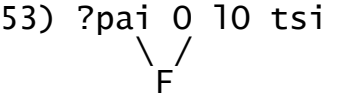
(52)



If Cantonese speakers had access to English metrical structure, [biology] and [tutorial] would surface in Cantonese either as [pai] and [t'iw], or perhaps as [pai O lou] and [t'iw t'O li], as such forms contain complete English metrical constituents. The forms actually employed

by Cantonese, [pai O] and [t'iw t'O], do not contain English metrical constituents. Note further that appeals to morphological structure cannot be made when characterizing truncation strategies. While the bisyllabic bio- possesses morphemic status in English, forms like [ing lit] (from [english literature]) and [tiu t'O] (from [tutorial]) do not. Obviously, neither can appeals to native English truncation strategies be made (cf. [tiu t'O]). 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 is the only reasonable explanation for the truncation facts. 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:

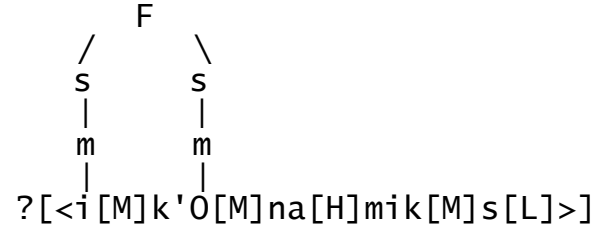
(53) ?pai O lO tsi ?t'iu t'O li



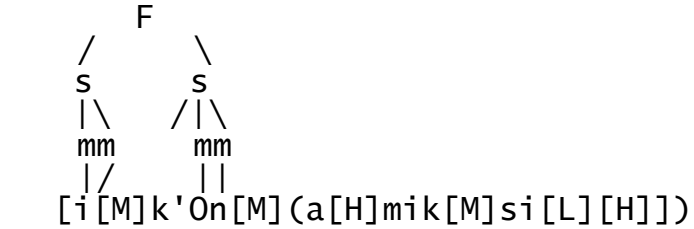
We can now assume the following derivation of a truncated form like [i k'On]:

(54) input: [economics]

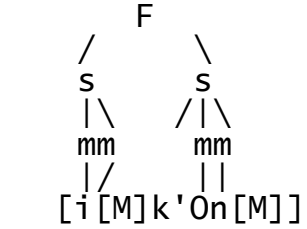
Scansion One:



Scansion Two:



Stray Erasure:



surface: [i[M] k'On[M]]

5.2 C-Liquid Clusters: Further Evidence for the Binary Foot Template, and Syllable Node Provision On Scansion One

We will now consider further data which support the

hypothesis that syllable nodes and a binary foot are provided on Scansion One. 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]	->	[kei[L] lim[H]]
	[fluke]	->	[fu[L] luk[H]]
	#[blonde]	->	[pi[L] lAn[H]]
b)	#[printer]	->	[p'En[H] t'a[MH]
	[broker]	->	[puk[H] k'a[MH]]
	[professor]	->	[pou[M] fa[H] sa[MH]]
	#[proton]	->	[pow[H] t'an[MH]]
	[place]	->	[p'ey[H] si[MH]]
	#[price]	->	[p'ai[H] si[MH]]
	#[blender]	->	[pEn[H] ta[MH]]
	[freezer]	->	[fi[H] sa[MH]

We observe liquid deletion in polysyllabic English forms. Otherwise, in monosyllabic English forms, the

liquid is preserved, and a vowel is epenthesized. 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] -> [pAt[2] lan[5] tei[35]] is uninteresting for the present analysis, as its pronunciation is based on the characters employed in the Mandarin English loanword. The only true exception of which I am aware is [clutch] -> [kik lik tsi], 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 the Scansion One: epenthesis
polysyllabic on the Scansion One: deletion

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

The behavior of C-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 prosodization strategy is employed for C-liquid clusters. If the output of Scansion One is monosyllabic, the liquid is salvaged, and a vowel is epenthesized 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'En ta] (from [print]/[printer]) confirm 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).

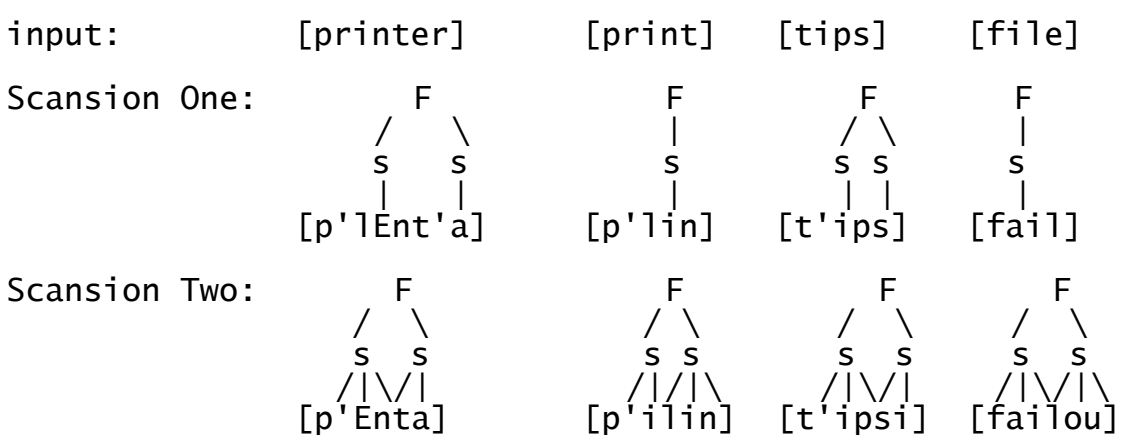
The Cantonese form for [floorshow] ([fO[H] sou[H]]) possesses some interesting properties. We have already seen that the tonal pattern for this form shows that it is composed of two PCA domains, indicating that Scansion One

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 by 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 C-liquid prosodization 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: vocalic sonority peaks, as well as phonetically salient consonants which are otherwise unsyllabifiable. (See Dell and Elmedlaoui (1985) for a similar approach to syllabification in Imdlawn Tashlhiyt Berber.) For example, post-vocalic /s/'s salience is most likely due to both its duration and its sibilance. When this segment is perceived post-vocalically, and is either pre-consonantal or form-final, it is perceived syllabically by Cantonese speakers, and hence provided with syllable nodes on Scansion One. In

(57) are some derivations.

(57)



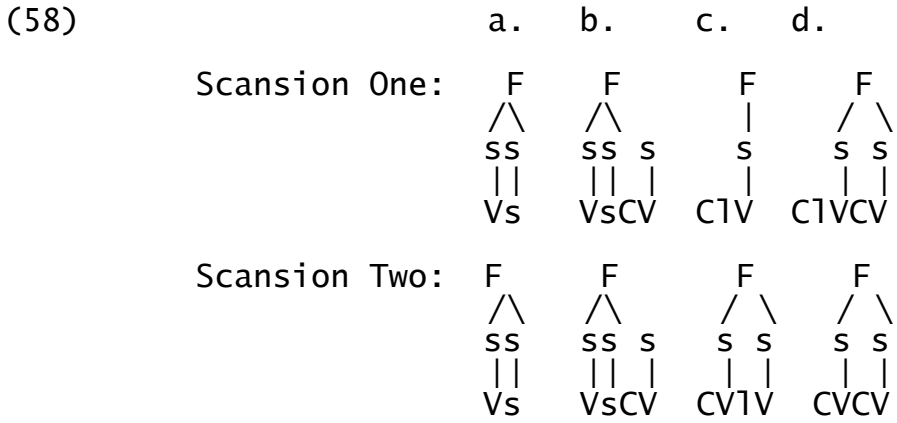
On Scansion One, feature matrices are provided, as well as syllable nodes for sonority peaks and phonetically salient segments that are otherwise unsyllabifiable. A binary foot template is provided, seeking to associate with syllable nodes. As Scansion Two proceeds, prosodization strategies apply, constrained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

Note that unsyllabifiable /s/ and /l/ exhibit distinct behavior in the following way: /s/ is always perceived

syllabically, and is thus always 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/, 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. The presumed derivations are schematized in (58).

(58)



In (58a), both V and /s/ are perceived syllabically. As the template is filled, no relevant template-triggered operations apply on Scansion Two. In (58b), three syllabic

segments are perceived on Scansion One. Assuming truncation is unavailable, the form will surface as trisyllabic. In (58c), a single syllabic element is perceived during Scansion One. Now, the liquid may be salvaged by epenthesizing a vowel, thus filling the template. In (58d), two syllabic segments are perceived on Scansion One. As the template has already been filled, the liquid deletes.

5.3 Further Exemplification

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

(59)
a. [forecast] -> [fO[H] k'a[H] si[MH]]
b. [high-class] -> [hai[H] k'a[H] si[MH]]
c. [wide-angle] -> [wai[H] Eng[H] kou[MH]]
d. [passport] -> [pa[H] si[L] p'Ot[H]]

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 (cf. [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 hypothesizes 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 realized in a derived syllable in, despite the fact that the output exceeds preferred bisyllabicity (cf. [floorshow] -> [fO[H] sou[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 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 and. At the Operative Level, on Scansion Two, loanword phonological processes apply to the output of Scansion One as prosodization proceeds, constrained when possible by a preference for bisyllabicity. Therefore, as [forecast], [high-class], and [passport] are perceived as trisyllabic

on Scansion One, and truncation is unavailable for these forms, 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 thus 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 supports 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 (1990) also argues for the existence of metrical structure in Cantonese. However, she argues that the foot to which Cantonese phonology makes reference is actually 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 re-analyzes the form-final pitch rise as a type of weight-marker, which results in a weak-strong pattern, thus achieving iambicity.

Note that under Yip's analysis, truncated forms such as [economics] -> [[i[M]k'On[M]], [sociology] -> [sou[M]si[M], and [physics chemistry biology] -> [fi[H]k'Em[H]pai[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 a boundary tone which indicates the end of the loan form (before truncation). Forms which undergo Truncation Strategy (B) thus suggest that most loans are 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 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 (60) (Whitaker 1955/6, Kao 1971).

(60)

[pak[L]]	(white)	->	[pak[L]pak[LH]tei[L]] (rather white)
		->	[pak[LH]pak[L] (very white)
[man[M]]	(slow)	->	[man[L]man[LH]tei[L]] (rather slow)
		->	[man[MH]man[M] (very slow)
[sai[M]]	(small)	->	[sai[M]sai[MH]tei[L]] (rather small)
		->	[sai[MH]sai[M] (very small)

(Observe the superficial violation of the tonal inventory here ([LH]), unlike in loans, where [H]

suffixation triggers the raising of tautosyllabic [L] to [M], to accord with the native contour tone inventory.)

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

(61)

[tok[L]yat[H]tok[L]]	->	[tok[LH]tok[L]]
(measure one measure)		(to measure (once))
kwang[M]yat[H]kwang[M]]	->	[kwang[MH]kwang[M]]
(stroll one stroll)		(to walk around (for a while))
t'iu[M]yat[H]t'iu[M]]	->	[tiu[MH]tiu[M]]
(jump one jump)		(to jump (once))

In these forms, the segmental material associated with [yat[H]] ("one") deletes, while the tonal material presumably re-associates to its left, resulting in a 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. [pai[HM]] -> a[M]pai[H]] ("The Lame"), [fei[M]] -> [a[M] fei[LH]] ("The Fat"). Furthermore, when hypocoristic tonal suffixation applies to disyllabic forms, a--prefixation does not apply (e.g. [wong[L] mou[L]] -> [wang[L] mou[LH]] ("The Yellow-Haired One"), [mang[L] pei[L]] -> [mang[L] pei[LH]] ("Deformed Nose"). This phenomenon is found in several other lexical classes, usually referring to humans (Whitaker 1955/6): familial relationships ([po[H]] -> [a[M] po[H]] ("grandmother"), the numerical order of children or servants ([ng[L]] -> [a[M]ng[LH]] ("no. five"), but [sap[L]sei[M]] -> [sap[L]sei[MH]] ("no. fourteen"), but also pet names ([wu[HM]] -> a[M]wu[H]] ("Blackie"). Thus the output in Cantonese hypocorisitics is always bisyllabic.

The only apparent exceptions to bisyllabicity in potentially bisyllabic loanwords are [physics] -> [fi[H]], and [chemistry] -> [k'Em[H]]. However, recall that the natural science cluster ([physics chemistry biology] -> [fi[H] k'Em[H] pai[M]]) does indeed abide by minimality, as does the Cantonese form for [biology], when it stands on its own ([pai[M] O[H]]).

[fi[H]] and [k'Em[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 lexicalization has taken place, as the surface forms would be identical in any case. Given the opacity of these derivations, we may assume that a re-analysis has taken place, and the truncated forms have become lexicalized. Therefore, when standing alone, they need not be bisyllablic, as they are underived forms.

However, [-pai[M]] (from [fi[H] k'Em[H] pai[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 [pai[M] O[H]] surfaces.

5.5 Exceptions to Bisyllabicity

We have provided several lines of evidence indicating that the binary foot exerts pressure on loanwords to achieve bisyllabicity. However, bisyllabicity is forfeited under certain conditions:

1) If a monosyllabic input can be fully accommodated, bisyllabicity is forfeited: [card] -> [kat], [game] -> [kEm].

2) If the input is provided with more than two syllable nodes on the first scansion, and truncation is unavailable, bisyllabicity is forfeited: [office] -> [Ofisi], [professor] -> [poufasa].

3) If a monosyllabic input posseses consonant strings which contain unanalyzable elements, bisyllabicity is forfeited: [band] -> pEn], [sink] -> [sing].

4) If the truncated status of a form is opaque, bisyllabicity is forfeited when this form stands alone: [physics] -> [fi[H], [chemistry] -> [k'Em[H] (from [fi[H]k'Em[H]pai[M]).

5.6 Left - To - Right Syllabification

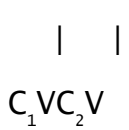
As prosodization proceeds on Scansion Two, there is a preference for syllables to close in loanwords. As already discussed, the Cantonese syllable will close if the corresponding English post-vocalic segment is an acceptable Cantonese coda. When only one consonant is present intervocalically, this segment will naturally syllabify to its right in accordance with the Onset Condition (avoid $_{s}$[V... (Ito 1986)). However, under fairly regular circumstances, we observe gemination of this intervocalic segment.

(62) a. [copy] -> [k'Ap p'i]
[shutter] -> [sAt t'a]
[letter] -> [lEt t'a]
[guitar] -> [kit t'a]
[vanilla] -> [wAn lE la]
b. [market] -> [ma k'Et]
[soda] -> [sO ta]
[motor] -> [mO ta]
[major] -> [mE tsa]

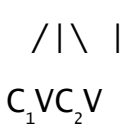
Yip (1990) notes that the generalization is as follows: only short English vowels (62a) tend to trigger

gemination of the intervocalic consonant (note that post-vocalic /r/ is perceived as vowel length (cf. [market] -> [ma k'Et]). This result is not surprising when we recall the shape of the Cantonese syllable ((C)VX), and the principle of maximizing 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. Therefore, intervocalic consonants will syllabify to their left if the preceding vowel is short, since the resulting syllable will be a maximally well-formed one:

(63) a. Scansion One:



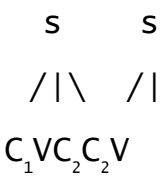
b. Scansion Two:



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

an onset:

(64)



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:

(65)

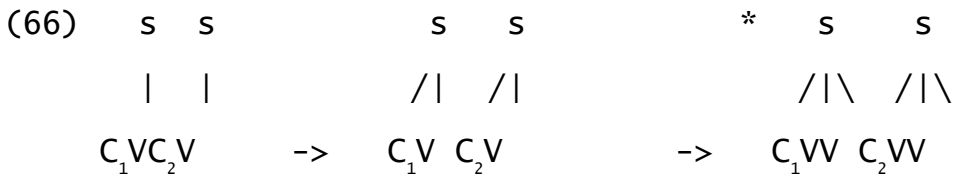
Of course, gemination only applies when the intervocalic segment may serve as an appropriate coda in Cantonese. When this segment can not serve as a coda, no gemination is observed: [essay] -> [E sei]. This observation requires no stipulations concerning the principles of maximizing syllable structure.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

Furthermore, as the Onset Condition does not play a

role in the indigenous Cantonese phonology, I conclude that evidence from Cantonese loanword phonology supports the claim that onsets are universally preferred.

Note that gemination can only be motivated if left-to-right syllabification is assumed. Were syllabification right-to-left, a consonant which follows a short vowel would initially syllabify to its right in accordance with the Onset Condition. But instead of copying to provide a coda for the preceding syllable, the pre-consonantal vowel would lengthen, to fill the empty mora. Assuming syllabification proceeds right-to-left, we would predict the following:

(66)



According to Yip's (1990) analysis, syllabification is argued to proceed right-to-left in Cantonese loanword phonology.

Yip provides three arguments for this assumption (note that Yip (1990) does not assume a level-ordered approach to loanword phonology, and in fact is primarily concerned with providing evidence for universally unmarked settings for

prosodic parameters):

1) C-liquid clusters. Yip argues that the behavior of liquids in C-liquid clusters supports an analysis in which right-to-left syllabification is hypothesized. Recall that liquids are retained by a process of epenthesizing a vowel to their left, but only if the output is bisyllabic. Otherwise, they delete.

In the form [place] -> [p'ey si], the unsyllabifiable /s/ acquires a degenerate syllable, and consequently triggers epenthesis. The behavior of /l/ is dependent upon a full syllable count. Thus, degenerate syllables assigned to the right edge of the form count towards the strategy employed for C-liquid clusters. Therefore, syllabification must proceed right-to-left.

2) Vowel copying. Epenthetic vowels normally acquire features from surrounding segments. Yip notes that the vocalic features of rightward vowels may shape the melodic content of epenthetic segments.

(67) a. [break] -> [pik lik]
[cream] -> [kei lim]
b. [file] -> [fai lou]
[film] -> [fei l m]

Yip concludes that only right-to-left syllabification can account for these facts, as material to the right of the initially feature-less epenthetic vowel shape its melodic content.

3) Final Clusters: Yip stipulates that syllable nodes are provided for all unsyllabifiable segments, except stops. Syllable structure is assumed constructed maximally. Assuming right-to-left syllabification can therefore account for the fact that the post-consonantal /t/ in [cast] ->
[k'a si] is not realized, as it is a stop, and therefore by stipulation does not receive a degenerate syllable. The post-consonantal /m/ in [film] -> [fei l m], on the other hand, is realized, as a vowel is epenthesized to its left, the /l/ being incorporated as an onset.

Left-to-right syllabification fails, as the /s/ of [cast] would be assigned a degenerate syllable, thus triggering epenthesis to its right. At this point, the /t/ maybe incorporated as a coda, resulting in the illicit *[k'a sit].

I will now present my counter-arguments to the hypothesis that syllabification in Cantonese loanword phonology proceeds right-to-left. First, recall that I have presented evidence that the loanword phonology

possesses two levels, manifested as two ordered scansions across incoming forms. A level-ordered loanword phonology hypothesis may account for apparent rightward-triggered phenomena in a straightforward manner, while still assuming left-to-right prosodization.

Consider Yip's first argument, which concerns the form [place] -> [p'ey si]. First, I assume that before C-liquid cluster strategies apply, the form has undergone a full preliminary left-to-right scansion. This Perceptual Level of the loanword phonology constructs syllable nodes for two elements of the input: /e/, and /s/. On Scansion Two, phonological operations apply, and the liquid deletes, as the output to Scansion One is bisyllabic. Therefore, rightward material may influence the derivation not because syllabification proceeds right-to-left, but because the Perceptual Level of the loanword phonology has already provided a preliminary representation of the entire form.

The same reasoning may be employed in regards to Yip's second argument for right-to-left syllabification. As the full form has been provided with a preliminary, "raw" representation on Scansion One, it follows as a natural consequence that epenthesized segments may be influenced by vocalic elements to their right.

Now consider Yip's third argument, which stipulates

that syllable nodes are not provided for unsyllabifiable stops. As noted in Section 3.2, English consonant clusters are treated differently depending on where they fall in the syllable.

(68)		Onset cluster	Coda cluster
a.	plosive//sonorant	[pleat]-> #[p'i[M] lit[H]]	[band]-> [pEn[M]]
		[clean]-> #[ki[M] lin[H]]	[friend]-> [fEn[H]]
b.	fricative//sonorant	[fluke]-> [fu[L] luk[H]]	[length]-> #[lEn[H]]
		[flea]-> #[fu[L] li[H]]	
c.	fricative//plosive	----------	[lift]-> [lip[H]]
			[shaft]-> [sAp[H]]

(68a) shows that plosive-sonorant onset clusters trigger epenthesis, whereas sonorant-plosive coda clusters are simplified. (68b) shows that fricative-sonorant onset clusters also trigger epenthesis, whereas sonorant-fricative coda clusters are simplified. Finally, in (68c) fricative-plosive coda clusters are simplified (but cf. [soft] -> [sO 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, 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 VO strings, as the native phonotactics of Cantonese (indeed, of every language) permit such strings. However, in non-native VCO strings, the acoustic quality of the initial C 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 unanalyzable. To illustrate, when the form [band] is encountered, the post-vocalic /n/ is represented without difficulty. However, the /d/ cannot be analyzed, 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 analyze its formant transitions. The /d/ is consequently unanalyzable, 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 now must 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.

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

(69) [film] -> [fei[H] lAm[MH]]
#[kiln] -> [k'i[H] lon[MH]]

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

(70)	a.	*[fei lou]	*[k'i lou]
	b.	*[feim]	*[k'in]
	c.	*[fei]	*[k'i]

In (70a) the nasal has deleted, and the /l/ has triggered epenthesis. In (70b) the liquid has deleted, and the nasal closes the syllable. In (70c) 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 epenthesized, and bisyllabicity is achieved.

Unlike Yip's analysis, I make no ad hoc stipulations regarding syllable node provision for unsyllabifiable stops. Instead, as Cantonese speakers are ill-equipped to perceive such segments, they are never represented.

Given that all of Yip's arguments for right-to-left syllabification may be accounted for by assuming a level-ordered loanword phonology, and given that I have presented several independent lines of evidence for such an account, I conclude that syllabification in Cantonese loanword phonology proceeds left-to-right.

6. THE FINAL MODEL

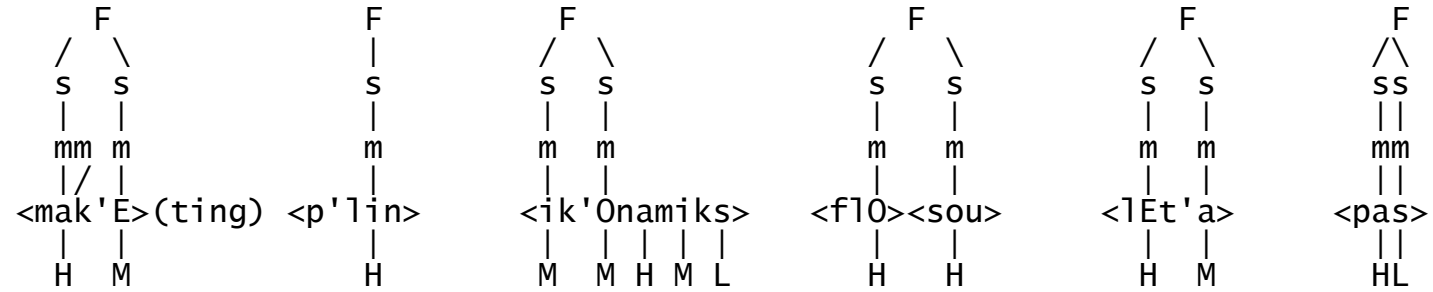
In this section, I provide sample derivations of English loanwords in Cantonese, assuming a level-ordered theory of loanword phonology.

(71)

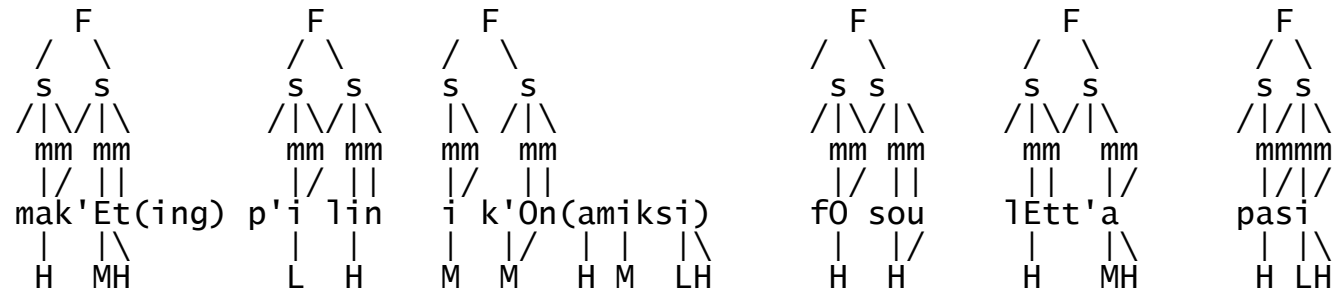
INPUT:

a.	b.	c.	d.	e.	f.
[marketing]	[print]	[economics]	[floorshow]	[letter]	[bus]

SCANSION ONE:

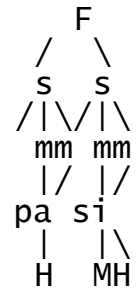


SCANSION TWO:



STRAY ERASURE:

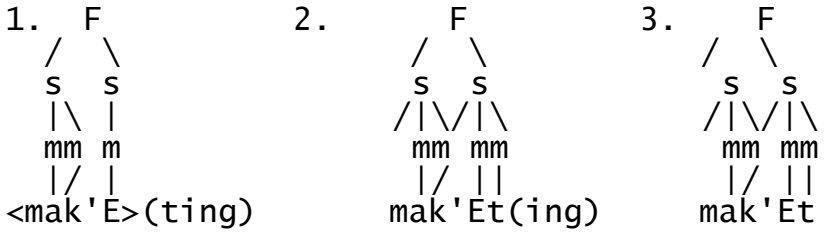
LATE RULES:



SURFACE:

a. [ma[H] k'Et[MH]]
b. [p'i[L] lin[H]]
c. [i[M] k'On[M]]
d. [fO[H] sou[H]]
e. [lEt[H] t'a[MH]]
f. [pa[H] si[MH]]

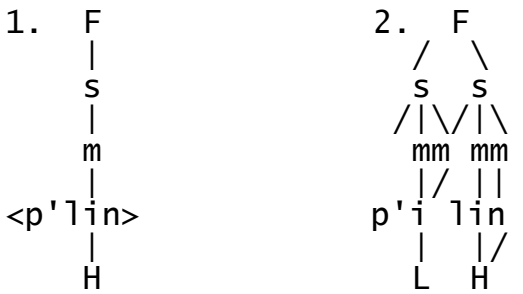
(71a) Input: [marketing]



On Scansion One, segments are perceived, and a foot template is provided, which triggers truncation. Therefore, syllable nodes are provided only for the first two segments which are perceived as possessing syllabicity. A PCA domain is established across the licensed domain, and tones are perceived accordingly. As Scansion Two procceeds, native SSCs hold, and the template is filled up to maximiality. The boundary tone attaches form-finally. Finally, Stray Erasure deletes all unlicensed material from the representation.

output: [ma[H] k'Et[MH]]

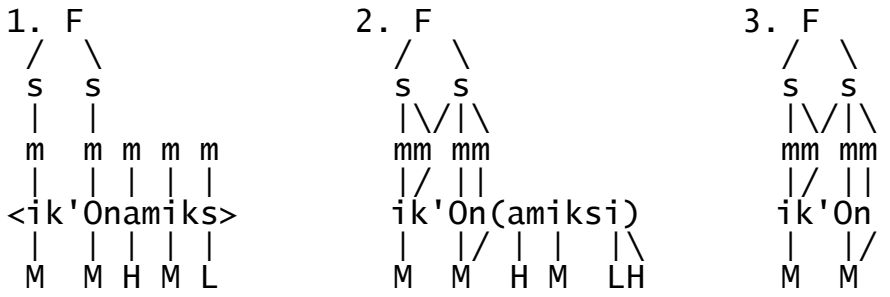
(71b) Input: [print]



On Scansion One, segments are isolated and provided with native feature matrices. A single syllable node is provided for the segment perceived as possessing syllabicity. A [H] tone is perceived. Due to its position in the input, the final obstruent lacks sufficient phonetic salience to be perceived, and is thus never represented. A foot template is provided. As Scansion Two proceeds, native SSCs hold. The liquid is retained, as the form achieves preferred bisyllabicity, filling the template. This syllable is low [L] in tone. As the final syllable surfaces with a [H] tone, the boundary tone does not attach.

Output: [p'i[L] lin[H]]

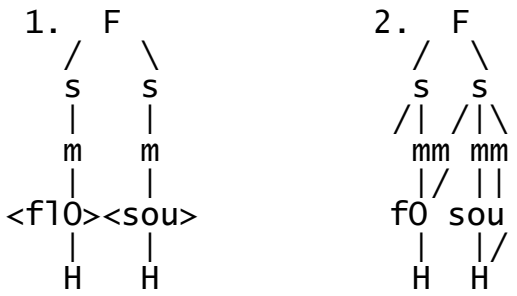
(71c) Input: [economics]



On Scansion One, native segments are provided. A PCA domain is established in which five sonority peaks are perceived, the first two being provided with a foot template, syllable nodes, and tones. On the Scansion Two, native SSCs hold, and syllabification is completed. The boundary tone attaches. Finally, the unlicenced residue deletes before the form surfaces.

output: [i[M] k'On[M]]

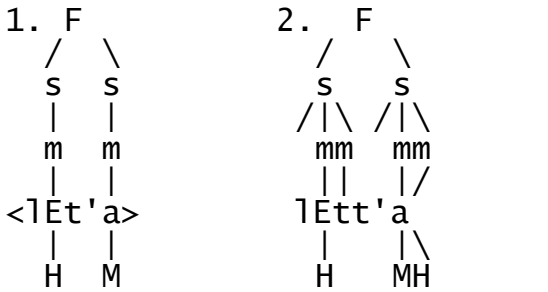
(71d) Input: [floorshow]



Cantonese speakers employ their knowledge of English morphology and establish two PCA domains. On Scansion One, segments are perceived, and the two sonority peaks are provided with syllable nodes. Each syllabic segment receives a [H] tone within its PCA domain. A foot template is provided. On Scansion Two, full syllabification proceeds. The liquid deletes, as the template has already been filled. The boundary tone does not attach.

Output: [fO[H] sou[H]]

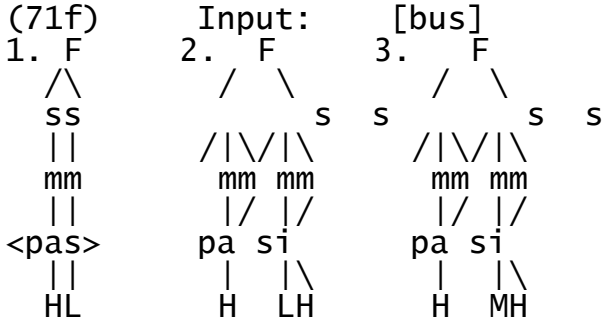
(71e) Input: [letter]



On Scansion One, segments are perceived, and a single PCA domain is established, in which two sonority peaks are perceived, and moras and syllable nodes are provided. Pitch patterns become tonal patterns. A foot is constructed.

On Scansion Two, native SSCs hold, as full syllabification proceeds. The short initial vowel leaves room for the /t/ to be incorporated into this syllable. The /t/ then spreads to provide an onset for the second syllable, and the boundary tone attaches.

Output: [lEt[H] t'a[MH]]



Two syllables are perceived on Scansion One, one of which is the phonetically salient /s/. [H] and [L] tones are perceived, and a template is provided.

On Scansion Two, SSCs hold as the template is filled. An epenthetic vowel repairs the degenerate syllable, triggering tone reassocaition. The boundary tone attaches.

Late rules apply, raising [L] to [M].

Output: [pa[H] si[MH]]

The level-ordered theory of loanword phonology

presented herein accounts for all major patterns observed in the Cantonese corpus of data. There are, to be sure, forms which do not surface as predicted. Most of these have been noted. The generalizations made do hold for the large majority of data, and thus unpredicted forms can indeed be characterized as exceptional in behavior.

7. CONCLUSION

I have provided evidence that Cantonese loanword phonology posseses two distinct ordered 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 the non-linguistic acoustic input into unprosodized 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 "raw" segmental representation for incoming forms.

The second level of the loanword phonology applies to the output of the Perceptual Level. During this stage,

loanwords undergo prosodization, and thus native constraints on prosodic structure subsequently hold. I have provided evidence from segmental phenomena, in conjunction with the Perceptual Uniformity Hypothesis, arguing for this Operative Level of the loanword phonology. Furthermore, as the rules employed at this level are peculiar to the loanword phonology, and, crucially, do not exist in the native phonology, they are presumably available through Universal Grammar.

The analysis of truncated forms has provided strong supporting evidence for a theory of level-ordered 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.

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

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