0. INTRODUCTION

In loanword phonology we seek to uncover the processes by which speakers possessing one phonological system perceive, apply native representational constraints on, and ultimately produce forms which have been generated by a different phonological system. We are interested in how speakers instantiate segmental and prosodic structure on an input which may or may not abide by native rules. Crucial to this assumed strategy is the idea that loanwords do not come equipped with their own phonological representation. For any phonetic string, it is only native speakers for whom a fully articulated phonological structure is present; the input to loanword phonology is merely a superficial non-linguistic acoustic signal. Thus 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 represented, and ultimately produced in a distinct manner in each language it enters.
In this article, I provide evidence from segmental, prosodic, and tonal operations applied to English loanwords indicating that Cantonese speakers have no access to the phonological representation of incoming loanwords. We will see that the input to the Cantonese loanword phonology indeed consists solely of a superficial acoustic signal, lacking all phonological representation.

The loanword phonology will be shown to possess two distinct levels. The first level of loanword phonology consists primarily of a parsing of the input signal into segment-sized chunks, for which native feature matrices which most closely approximate 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 concerned with providing a preliminary, "raw" linguistic representation to the perceived non-linguistic input, we may refer to it as the Perceptual Level of the loanword phonology.

It is only when native phonotactic constraints hold for the incoming form that the raw segmental material may undergo phonological processes, so that it may be 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.

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

<table>
<thead>
<tr>
<th></th>
<th>English</th>
<th>Cantonese</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>break</td>
<td>[pik lik]</td>
</tr>
<tr>
<td></td>
<td>print</td>
<td>[p'i lin]</td>
</tr>
<tr>
<td></td>
<td>cream</td>
<td>[kei lim]</td>
</tr>
<tr>
<td>b)</td>
<td>printer</td>
<td>[p'En t'a]</td>
</tr>
<tr>
<td></td>
<td>broker</td>
<td>[puk k'a]</td>
</tr>
<tr>
<td></td>
<td>freezer</td>
<td>[fi sa]</td>
</tr>
</tbody>
</table>

(E = , aspiration is indicated by inverse commas)

All the English forms in (1) possess form-initial consonant-liquid clusters. However, in their Cantonese manifestations, only in the forms in (1a) has the liquid been preserved, through epenthesisizing a vowel (Cantonese disallows consonant clusters). In (1b), the liquid is not present in the Cantonese form. We might want to say that only in the (a) examples is the liquid perceived by Cantonese speakers. However, such a hypothesis quickly becomes untenable when considering near-minimal pairs (e.g. print -> [p'i lin]/printer -> [p'En t'a]), and once the proper generalization is made: the liquid is salvaged if the resulting output is bisyllabic. In forms whose output would exceed bisyllabicity, the liquid deletes, and the output is, again, bisyllabic. Alternatively, we might hypothesize that it
is the prosodic shape of the input which conditions the processes affecting consonant-liquid clusters: only in monosyllabic inputs are C-liquid clusters fully salvaged. Otherwise, the liquid deletes. While I will be arguing for the former analysis, the crucial point is that, either way, the liquid must first be perceived in order for the correct strategy to apply. Once perceived, further phonological processes may apply, conditioned by prosodic constraints on the form, resulting in the attested surface forms. Thus we may hypothesize the existence of a Perceptual Level of the loanword phonology as distinct from a further level, the Operative Level. While the Perceptual Level is concerned with providing preliminary segmental and prosodic structure to the acoustic signal, it is only at the Operative Level that language specific phonotactic and prosodic constraints trigger particular segmental processes on the form, so that the output may conform to language-specific surface constraints and preferences.

As we will see, the processes which apply at the Operative Level of the Cantonese loanword phonology do not exist in native phonological derivations. Rather, they are processes which are peculiar to the loanword phonology, applying so that non-native forms may be 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 property common with native phonological processes is that the same language specific constraints exert an influence on the output of both systems.

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

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

Maddieson (1985) has argued for the existence of phonetic cues to syllabification; that vowels are universally of shorter duration in closed syllables. While such a generalization may be
noteworthy to the phonetician, it is doubtful that the naive
listener would notice, let alone exploit such information. I
will thus assume that Cantonese speakers do not have access to
English prosodic representation, but instead provide syllable
structure for the output of the Perceptual Level of the loanword
phonology in accordance with indigenous prosodic constraints and
preferences. Indeed, as will be seen, there exist dichotomies
between English versus Cantonese syllabification strategies.

Analyzing how Cantonese speakers incorporate loanwords whose
segmental make-up (the input to the Perceptual Level) cannot be
fully accommodated by the Cantonese phonological system
(constraints at the Operative Level) may 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
practically no native processes of epenthesis, syncope, or
resyllabification; every monosyllabic morpheme almost always
surfaces fully intact. However, the Operative Level of the
loanword phonology will be shown to require rules triggering
these processes, as well as rules triggering segmental processes,
not a part of the native phonology, as exemplified in (1). 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. I will provide evidence from the loanword phonology and the native phonology which indicate that Cantonese makes reference to the binary foot, reanalyzing data first discussed in Yip (1990).

Characterizing the Cantonese system of loanword incorporation purely in terms of the phonology will result in an incomplete understanding of the forces at work in loanword phonology. As will be seen, speakers' explicit knowledge of the various grammatical levels of the lending language (e.g. syntax, morphology) can and do exert an influence on their phonological instantiations. For example, 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.

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 syllable structure constraints (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.

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 forms 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 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 ("#”). 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 article, however, is to provide evidence that the input to the Cantonese loanword phonology is not a phonological representation. 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. In the interest of clarity, however, I provide the following diagram, in order to indicate the hypothesized forces at work within the loanword phonology. This diagram should be kept in mind as data is presented.
The input to the loanword phonology is a non-linguistic acoustic signal. At the Perceptual level, the native segment inventory constrains the representation of perceived segments. It is only as the Operative Level of the loanword
phonology proceeds that perceived segments may undergo true phonological operations, triggered by native phonotactic constraints, and provided by universal grammar.

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

1. CANTONESE PHONOTACTICS

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

1.1 Segmentals, and Syllable Structure

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

(3)  p  t  ts  k  k'
     p' t' ts' k' k''
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 (4).

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

(4) shows that all consonantal segments, as well as the glides and /h/, are possible onsets. Acceptable codas are listed in (5).

(5) p t k
m n ng
w y

(5) shows that only the unaspirated plosives, nasals and glides may close syllables in Cantonese. The Cantonese phonetic vowel inventory is presented in (6).
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 (San 1990), as all syllables possess either codas or long vowels (*CV). Vowel length, as it is predictable, will not be indicated, except in those instances where discussion directly centers on syllable weight.

One of seven tones is lexically associated with every syllable.

(7)  
55 ([H])  53 ([HM])
33 ([M])  35 ([MH])
22 ([L])  24 ([LM])
21
Tones are presented with traditional notation, where an increase in numerical value corresponds to an increase in pitch. 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.

The lexical contour tones will play an extremely limited role in the present discussion, acting only to constrain the form superficial contours may take. Thus the only tonemes which play an active role in the present analysis are [L], [M], and [H].

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

(8)       L       M       H
          /   \      /   \      /   \      /   \
 TBU  TBU  TBU  TBU  TBU  TBU  TBU

In (8), long level tones are represented as single melodic elements associated with two tone-bearing units
2. SEGMENTAL CONSTRAINTS AND OPERATIONS

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

As we will now see, constraints on segment 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 segment inventory. When confronted with a segment whose feature matrix in English does not exist in Cantonese, Cantonese speakers will represent and produce the native segment which most closely approximates the input in articulatory and/or acoustic properties.

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

(9)

Perceptual Uniformity Hypothesis:

At the Perceptual Level, the native segment inventory constrains segmental representation in a uniform fashion, regardless of string position.

It should be noted that the Perceptual Uniformity Hypothesis makes no reference to allophonic rules acting within the lending language, as will be exemplified momentarily. We will henceforth assume the Perceptual Uniformity Hypothesis, unless empirical evidence 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 contrast. Some examples are given in (10).

(10) | Input  | Perceptual Level |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ball</td>
<td>[pO]</td>
</tr>
<tr>
<td>game</td>
<td>[kEm]</td>
</tr>
<tr>
<td>b. salad</td>
<td>[sa lot]</td>
</tr>
<tr>
<td>sideboard</td>
<td>[sai put]</td>
</tr>
<tr>
<td>c. stick</td>
<td>[si tik]</td>
</tr>
</tbody>
</table>

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

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

(11) | Input  | Perceptual Level |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. bearing</td>
<td>[pE ling]</td>
</tr>
<tr>
<td>b. warrant</td>
<td>[wO loen]</td>
</tr>
</tbody>
</table>
(11) shows that pre-vocalic English /r/ is perceived as /l/ by Cantonese speakers.

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

(12) | input | Perceptual Level |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. pair</td>
<td>-&gt; [p'E]</td>
</tr>
<tr>
<td>b. mark</td>
<td>-&gt; [mak]</td>
</tr>
</tbody>
</table>

In the forms in (12), we observe that /r/s 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 /S/. Cantonese, on the other hand, does not possess the palato-alveolar voiceless fricative. As Cantonese speakers are thus ill-equipped to fully accommodate English /S/, they perceive the segment as /s/, which is the Cantonese segment closest in phonetic quality to the input:

(13) | input | Perceptual Level |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>show</td>
<td>-&gt; [sou]</td>
</tr>
</tbody>
</table>
sharp  ->  [sap]
shaft  ->  [sAp]

(13) shows that English /S/ is perceived as /s/ in Cantonese.

Similarly, both /z/ and /Z/, while present in English, are absent from Cantonese. Both these segments are therefore represented as /s/.

(14)  size  ->  [sai si]
cashmere -> [k'E si mE]

(Zhang in fact transcribes cashmere with the voiceless palato-alveolar fricative, however)

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
In (15), English aspirated voiceless plosives are perceived as such by Cantonese speakers. English unaspirated voiceless plosives are also fully accommodated. Cantonese lacks the voiced labio-dental fricative /v/. Therefore, when encountering this segment, Cantonese represent, and subsequently produce the native segment which most closely approximates /v/'s acoustic properties: /w/.

(16) 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 native phonotactics constrain the surface forms which loanwords may take. Thus, at the Operative Level of the loanword phonology 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 the 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. We may formally state this constraint in terms of Aperture Theory (Steriade (1991)): only A₀ positions (as well as vowels) are allowed syllable-finally: A₀[s]. I assume that at the output of the Perceptual Level, before native SSCs hold, Cantonese speakers indeed represent English fricatives and affricates as such, although always
voiceless. It is only at the Operative Level, when SSCs hold, that a phonological process of occlusivization will apply to fricatives and affricates that have been assigned to coda positions in Cantonese. The process may be stated informally as follows: C -> [-cont] / __]s. Examples are in (17).

(17) input Operative input Operative Level Level

(output) (output)

film -> [fei lAm] shaft -> [sAp]
floorshow -> [fO sou] lift -> [lip]

(17) shows that when fricative /f/ is assigned to 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:

(18) 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 /s/ is perceived as the native feature bundle which most closely approximates it: /s/. At the Operative Level, SSCs 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. Additionally, Yip (1990) points out that occlusivization primarily applies to coda continuants when they are followed by a stop. She argues for a process of segment merger in such environments, place of articulation surviving from the fricative, manner of articulation surviving from the stop. She notes that fricatives in non-branching codas normally undergo epenthesis, thus bus -> [pa si] (*[pat]).

We have already noted the fact that Cantonese disallows released stops in coda position. While form-final unreleased stops are in free variation with released stops in English, Cantonese forms do not reflect this low level contrast. Given the Perceptual Uniformity Hypothesis, I assume that the output of the Perceptual Level may contain released stops wherever in the segmental string they arise,
the release presumably perceived as aspiration (aspirated stops exist in Cantonese, and therefore may be represented by Cantonese speakers). However, at the Operative Level, as SSCs hold, a phonological process results in the loss of aspiration in segments surfacing in coda position. Universal grammar presumably supplies a rule of the following form: \( C \rightarrow [-s.g.] / \_ \_ \_ \)\(_s\). Such a rule falls out from the fact that Cantonese only allows \( A_0 \) positions to close syllables. Derivations are in (19).

(19) input: cut mark
Perceptual Level: [k'At(')] [mak(')]
Operative Level: [k'At] [mak]

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

I have already discussed the Perceptual Level processes affecting the form valve \( \rightarrow [wa lou] \), i.e. /v/ \( \rightarrow /w/ \). The Operative Level of the loanword phonology exerts a further influence on this form. The input to the Operative Level of the loanword phonology possesses two instances of the high glide ([wa lw]). As SSCs hold at the Operative Level, the first /w/ may be syllabified as an onset, as the
following low vowel exceeds /w/ in sonority. However, as the second /w/ is encountered, we witness a process of epenthesys (/w/ -> [ou]).

2.3 The Treatment of /l/ and /s/

We have already observed a positive constraint that allows solely A₀ positions to close syllables in Cantonese. As /l/ is thus 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:

\[
\begin{array}{ll}
\text{input} & \text{Operative Level} \\
\text{a. coil} & [k'Oi lou] \\
\text{b. file} & [fai lou] \\
\text{c. valve} & \rightarrow [wa lou]
\end{array}
\]

Again, I assume that the output of the Perceptual Level possesses no vowel to /l/’s right; each segment of the input is represented as faithfully as the Cantonese segment inventory will permit. According to the Perceptual Uniformity Hypothesis, the initial perception of the acoustic signal should not be constrained by anything other than the segment inventory of Cantonese. Surely, as no post-liquid vocalic segment exists in the incoming acoustic signal, Cantonese speakers do not perceive such a segment.
It is only during the Operative Level, when SSCs hold, that /l/ is provided with an epenthetic segment so that it may be realized in the Cantonese incarnation of the form, in conformity with native SSCs. As only A₀s are allowable syllable-finally, a vowel must be epenthesized to the lateral's right. This rule of epenthesis is thus a phonological process peculiar to the Operative Level of the loanword phonology. Significantly, no such process exists in the native phonology.

All /s/s (and segments perceived as /s/, i.e. /S/, /z/, and presumably /Z/) 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]. Again, as /s/ is not an A₀, a vowel must be epenthesized when this segment would otherwise surface in coda position. The one exception I am aware of is gross -> [10].

(21) input Operative Level

a. tips -> [tip si]
waste -> [wAi si]
bus -> [pa si]

b. stamp -> [si tam]
store -> [si tO]
In (21a) and (21b), /s/ triggers epenthesis in onset and coda position respectively. The epenthetic segment is always /i/.

3. THE ANALYSIS OF PITCH CONTRASTS: STRESS - TO - TONE

Stress languages tend to possess a loose correlation between the degree of stressing and pitch height, as determined by $F_0$ of the vocalic elements of the speech signal. For example, in English unmarked intonation, syllables receiving primary stress tend to be higher in pitch than other syllables. The phonetic phenomenon of pitch 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.

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

In (22a) a monosyllabic English word enters Cantonese receiving a high [H] tone, whereas in (22b), 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.

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 conform to Cantonese SSCs. According to one method, the feature matrix
which is supplied for the second offending consonant is deleted from the representation, truncating the branching structure to a non-branching one: \( [C_1C_2V\ldots] \rightarrow [C_1V\ldots] \).

According to the other method, epenthesis is applied to break up a consonant cluster: \( [..CC\ldots] \rightarrow [..CVC\ldots] \).

Below, we will formally 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 provided with a low [L] tone. Examples follow.

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

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

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

(24) input: stamp stick
Perceptual Level: [s tAm[H]] [s tik[H]]
Operative Level:
1. epenthesis [si tAm[H]] [si tik[H]]
2. tone insertion [si[L]tAm[H]] [si[L]tik[H]]
surface: [si[L]tAm[H]] [si[L]tik[H]]

3.3 Morphemic Tone
Within the loanword phonology, all final syllables that are not perceived as possessing a [H] tone surface with a pitch rise. I will assume along with Whitaker (1955/56) that this tone possesses independent morphemic status, indicating a state of intimacy and/or familiarity between the speaker and the referent in question:

(25)  (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.

(26) 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 (26a) 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. I assume that in such forms, the [H] suffix may attach vacuously.

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

(27)  [L] -> [M] / [___[H]]

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

Finally, note that tonal suffixation applies after
surface constraints on prosodization have triggered the necessary Operative processes. 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 argue 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 (28).

(28) 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 (28) receives primary stress, whereas the second syllable receives secondary stress. Nonetheless, Cantonese speakers are employing [H] tones on both syllables. Therefore, we can tentatively conclude that Cantonese speakers establish a strict domain in which relative pitch contrasts are analyzed:
(29) PCA Domain: <English free morpheme>

(29) indicates that Cantonese speakers' explicit knowledge of English morphology is, at least under certain circumstances, influencing their phonological analysis of the phonetic 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:

(30)

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]]

(to save space, tones perceived at the Perceptual Level are linearly arranged following the syllable boundaries which come to exist at the Operative
Phonological tone is represented in terms of relative pitch contrasts, not absolute pitch contrasts. Therefore, each PCA domain will be independent of all others. Despite the fact that the syllables within the forms _dockyard_ and _floorshow_ contrast in pitch, this contrast exists only beyond the PCA domain, and so it plays no observable role in the cases at hand.

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

(31)  #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 (31), despite identical stress patterns to the forms in (28), the PCA domain is obviously the full form, as tone is perceived relative to this full form. Presumably, as the forms in (31) are not composed of two free English roots, Cantonese speakers establish a single PCA domain at the Perceptual Level, and perceive tone
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 \textit{sideboard} \(\rightarrow\) *[sai[M] put[M]], or \textit{buffet} \(\rightarrow\) *[pou[L] fei[MH]]. This explains why monosyllabic English forms always receive \([H]\) tones in Cantonese:

\[
\begin{align*}
\text{jam} & \rightarrow \ [<\text{tsEm}[H]>] \rightarrow \ [\text{tsEm}[H]] \\
\text{sink} & \rightarrow \ [<\text{sing}[H]>] \rightarrow \ [\text{sing}[H]] \\
\text{game} & \rightarrow \ [<\text{kEm}[H]>] \rightarrow \ [\text{kEm}[H]] \\
\text{gin} & \rightarrow \ [<\text{tsin}[H]>] \rightarrow \ [\text{tsin}[H]]
\end{align*}
\]

In the form \textit{saxophone} \(\rightarrow\) [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 realized with a \([L]\) tone. As the \([i]\) in /si/ is often devoiced in the input, this syllable is quite possibly
phonetically indistinct from coda /s/, and hence is supplied with a [L] tone, after epenthesis has been triggered. Finally, note that if this analysis is correct, this form provides evidence that tonal suffixation follows lexical word-building operations, as the second syllable derived from the first "free" morpheme surfaces without the high [H] suffix (cf. *[sik[H] si[MH] fung[H]]). The forms telephone -> [tik[H] l0t[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.

(33)  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 are realized with [L] tones. According to the analysis presented here, this tonal contrast is due to the fact that the Operative Level of the loanword phonology possesses a late, post-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 raises [L] to [M], so that the superficial tonal pattern abides by native contour tone constraints.

Furthermore, observe that each stressed element of the free-root 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 attaches vacuously. 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 provided for derived rimes 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 MULTIPLE SCANSIONS IN LOANWORD PHONOLOGY: THE ANALYSIS OF TRUNCATED FORMS

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

In this section, I provide evidence from truncated English loanwords in Cantonese which clearly supports the existence of these two levels of the loanword phonology. We will see that the tonal pattern of truncated forms requires that we hypothesize the application of two ordered scansion 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:

\[
\begin{align*}
\text{Scansion One} & = \text{Perceptual Level} \\
\text{Scansion Two} & = \text{Operative Level}
\end{align*}
\]

As I will now be 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.

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 truncation process will be formalized in Section 5.

(35) 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 (35a) with those in (35b), where the full form is realized.

In (35a), 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 (though healthy) set of tone options that Cantonese possesses.

(36)

<table>
<thead>
<tr>
<th>input</th>
<th>Scansion One</th>
<th>Scansion Two</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
<td>economics</td>
<td>ik'Onamiks</td>
<td>ik'On</td>
<td>i[M]k'On[M]</td>
</tr>
<tr>
<td></td>
<td>M   M H M</td>
<td>M   M</td>
<td></td>
</tr>
</tbody>
</table>

The Perceptual Level representation of the form for economics has exhausted the set of tonal contrasts Cantonese allows; [H] is perceived on primary stressed syllabic elements, and thus only [M] remains (recall that [L] is reserved for epenthesized vowels). Therefore, the pitch distinction between secondary stressed syllables and non-stressed syllables cannot be represented by Cantonese speakers, and thus all such syllables are provided with [M] tones. Therefore, syllables receiving secondary stress are
not tonologically distinguished from unstressed syllables in a PCA domain containing a fully stressed element. However, such a contrast can be distinguished in a PCA domain that does not possess a fully stressed element, as there is no greater pitch contrast to trigger neutralization:

(37)    (a)       (b)

   economics     economics

   PCA domain:   [<s s s s>]     [<s s s>]
                 [<ik'Onamics>]   [<ik'On>]

   tones perceived: [s s s s]               [s s]
                   | | | |                   | |
                   [M][M][H][M]        [H][M]

                   [ik'O na mics]       [ik'On]
                   | | | |                   | |
                   [M][M][H][M]        [H][M]

   (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]]:

(38) input:
The Cantonese tones present in these forms are not based on the pitch of the two surviving English syllables when pronounced in isolation: \([i \, k'\text{a:n}], [s\, o\, w \, s\, i]\). Had Cantonese speakers employed this strategy, the following forms would surface:

\[(39) \quad \text{economics} \quad \rightarrow \quad *[i[H] \, k'\text{On}[M]] \\
\text{sociology} \quad \rightarrow \quad *[sou[H] \, si[M]] \]

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 the contrast between secondarily- and non-stressed elements.

It is apparent then, that as English forms enter Cantonese, they are preliminarily scanned in their entirety. Then, in at least one lexical class, syllables beyond an initial left-to-right binary foot may be deleted. Syllable deletion crucially follows the establishment of a PCA domain. In other words, the Perceptual Level of the loanword phonology is manifested as a preliminary scansion across the entire form. It is only after this preliminary scansion that the Operative Level phonology is reached.

The natural science cluster (\textit{physics chemistry biology}) displays a slightly different pattern:

(40) physics chemistry biology $\rightarrow$ [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 (41).
There is evidence beyond stress-to-tone perception supporting this analysis. Observe that, unlike most other forms, those in (39) 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 (39).

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

(42)  composition    ->  [k'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 providing it with a [H] tone. This falls out naturally if the PCA domain includes only the syllables surfacing in the Cantonese form:

(43)  input:    composition
         Scansion One:    [k'Am[H] p'ou[M]](sison)
         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 provided with a [H] tone. Note specifically that tone provision is indeed a result of relative pitch contrasts, and not absolute pitch contrasts. As truncation proceeds on Scansion One, no ternary pitch contrast exists to neutralize this contrast.

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 (39), the boundary tone is not deleted along with segmental material. This indicates that it attaches after truncation.

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

Cantonese speakers apparently may apply truncation at the earliest stages of the derivation, i.e., upon reception
of the acoustic input on Scansion One. As pitch is perceived solely in relation to those pitches present in the representation, the tonal patterns in (38) can be accounted for only if we assume that Cantonese speakers are attending only to the first two perceived pitches of the acoustic input, subsequent material not undergoing any phonological analysis, being treated as "noise".

I have thus far provided evidence that Scansion One provides melodic representation for the incoming acoustic signal, only implicitly assuming the construction of some preliminary prosodic structure. However, I have just presented evidence that truncation may apply as Scansion One proceeds. Therefore, it must be the case that a certain amount of prosodic structure, namely syllable nodes and moras, 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. (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 \textit{economics} $\rightarrow$ \textit{i[M] k'On[M]}, which have been argued to have undergone both Scansion One and Scansion Two processes before
truncation applies.

The two strategies are schematized in (44).

(44) 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

(44) 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 (39) and (42). Cantonese speakers seemingly employ either of these strategies on an optional basis, though this optionality holds only between forms, and not within them.

There is a strikingly similar interaction between truncation and suffixation in the native 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). An additional example comes from distinct truncation strategies of statistics. While undergraduate psychology majors at the University of Pennsylvania truncate this form to stat, elsewhere it is truncated to stats. The distinct derivations proceed exactly as those for math/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 scansion 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 Tonal Suffixation

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

(45) [cherry] -> [ts'EH leim + tsi[MH]]  
[X-ray] -> [Ek[H] si[L] + kwong[H]]

In the forms in (45), the first two syllables are derived from English, whereas the third is a native Cantonese morpheme ([tsi[MH]], meaning 'seed' or 'son', and [kwong[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]leim[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.

(46)
input: cherry X
Scansion One: [ts'EH leim[M]] [Ek[H]s]
Scansion Two: [Ek[H]si[L]]
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 (45).

I now posit the following derivation for \textit{economics} $\rightarrow$ [i[M] k'On[M]]:

\begin{align*}
(47) \text{input:} \quad \text{economics} \\
\text{Scansion One:} \quad [i[M]k'O[M]na[H]mik[M]s] \\
\text{Scansion Two:} \quad [i[M]k'On[M](a[H]mik[M]si[L][H])] \\
\text{Stray Erasure:} \quad [i[M]k'On[M]] \\
\text{surface} \quad [i[M]k'On[M]]
\end{align*}

4.4 Maximizing Syllable Construction: Evidence for Universal Strategies

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

(48) 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 Cantonese syllable, but only when the segment in question is an acceptable coda. In (44a), 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 (44b), 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 strategies are exemplified in (45).
As Cantonese speakers have no access to the phonological and prosodic representation of the input, they presumably do not perceive syllable boundaries in the preliminary acoustic signal (cf. Maddieson 1985), and thus must provide their own syllable structure. As stated in Section 0, Cantonese has virtually no indigenous processes of epenthesis, syncope, or resyllabification. And so in their treatment of certain loanwords, Cantonese speakers are employing rules of syllable construction which they could not have learned during the initial acquisition process. They are scanning the acoustic signal, supplying feature matrices, and are constructing syllables maximally up to well-formedness. Cantonese speakers are thus appealing to a universal strategy as syllabification of loanwords proceeds. These facts reinforce the claim that Scansion Two Cantonese loanword phonology is distinct from the native phonology, in that Scansion Two processes, while constrained by the identical phonotactics which exist in the native phonology, do not themselves exist in the native phonology, but
instead are available through universal grammar. Furthermore, native phonotactic constraints indeed appear to hold not at the earliest stages of the loanword phonology (on Scansion One), but instead hold later in the derivation (on Scansion Two).

5. METRICAL STRUCTURE: THE ROLE OF THE BINARY FOOT

5.1 Evidence from Truncation

McCarthy 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 its phonology, for example, the mora, the syllable, the foot.

Now recall that truncation Strategy (B) applies on Scansion One. I have already argued 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 bisyllabic form. I now suggest that still more prosodic structure is present at the Perceptual Level of the loanword phonology. I propose that a binary foot template is supplied at the left edge of a form as Scansion One proceeds. I will argue below that the native Cantonese
phonology possesses this metrical constituent. Therefore, its presence at the Perceptual Level of the loanword phonology may follow as a natural consequence: while syllabification of loanwords requires processes peculiar to the loanword phonology, template provision, which does not require reference to melodic material, may apply at the earliest stages of the loanword phonology, i.e. at the Perceptual Level. The binary foot will be shown to act as a template, pressuring forms to achieve bisyllabicity.

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

(50)

ENGLISH: bi o lo (gy) tu to ri (al)

|   \ /   |   \ /   |
| F   F   | F   F   |

CANTONESE pai O t'iw t'O

\ / \ / \
F F F

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:

(51) pai O lo tsi t'iu t'O li
    \ / \ \ /
    F    F

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

(52) input: economics

Scansion One: F
        /
       /\ s s
      /   | m m
     |    |

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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. As already discussed in the introductory section, English liquids sometimes delete when occurring in a consonant cluster. Elsewhere, they are salvaged by epenthesis:
To repeat the observation made in the introduction, we observe liquid deletion in polysyllabic English forms. Otherwise, in monosyllabic English forms, the liquid is preserved, and a vowel is epenthesized. Thus in both cases the output is bisyllabic. These data suggest that the binary foot exerts an influence in Cantonese in that a segment which normally undergoes deletion in loanwords is preserved in one instance: just in case the resulting form is bisyllabic, i.e. consists of one binary foot. The form *brandy* -> [pAt[L] lan[H] tei[MH]] is uninteresting for the present analysis, as its pronunciation is based on the
characters employed in the Mandarin English loanword. The only true exceptions of which I am aware is clutch -> [kik lik tsi], and spring -> [si pit ling], 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:

(54) monosyllabic on Scansion One: epenthesis
    polysyllabic on 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) confirms that segments perceived at the Perceptual Level (Scansion One) may undergo phonological rules -- in this case, deletion -- as prosodic structure is supplied at the Operative Level (Scansion Two).

The Cantonese form for floorshow ([*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 syllabic identity, and provides a binary foot template for the incoming form. I propose that on Scansion One, syllable nodes are provided for the most salient components of the phonetic input, i.e. those segments which are perceived as syllabic: vocalic sonority peaks, as well as phonetically salient consonants which are otherwise unsyllabifiable. For example, post-vocalic /s/'s salience is most likely due to both its duration and its sibilance. When this segment is perceived post-vocally, and is either pre-consonantal or form-final, it is perceived syllabically by Cantonese speakers, and hence provided with a syllable node on Scansion One. In (55) are some derivations.

(55)

<table>
<thead>
<tr>
<th>input:</th>
<th>printer</th>
<th>print</th>
<th>tips</th>
<th>file</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scansion One:</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>/ \</td>
<td>/ \</td>
<td>/ \</td>
<td>/ \</td>
</tr>
<tr>
<td></td>
<td>s s</td>
<td>s s s</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td></td>
<td>[p'1Ent'a]</td>
<td>[p'lin]</td>
<td>[t'ips]</td>
<td>[fail]</td>
</tr>
<tr>
<td>Scansion Two:</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

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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 when not pre-vocalic, and is thus retained and salvaged by epenthesys. /l/, on the other hand, triggers epenthesys conditionally: only if the resulting output will fill the binary foot template.

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

5.3 Further Exemplification

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

(56) 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, as in forecast. Indeed, the tonal pattern for this form indicates that two PCA domains have been established, as both members of the compound are perceived with [H] tones on their stressed syllable.

Furthermore, the theory outlined here 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 (56a,b,c), despite the
fact that the output exceeds preferred bisyllabic (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. At the Operative 
Level, on Scansion Two, loanword phonological processes 
apply to the output of Scansion One, constrained when 
possible by a preference for bisyllabic. Therefore, as 
forecast, high-class, and passport are perceived as 
trisyllabic on Scansion One, the output of the Operative 
Level is indeed trisyllabic. Note in particular that the 
/l/ from -class has been deleted; as bisyllabic has 
already been forfeited on Scansion One, there is no 
motivation to salvage this segment, and it deletes from the 
representation.

5.4 Native Evidence for the Binary Foot

I have provided several lines of evidence which 
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 quasi-iambicity. Note that such an iamb is still quantity-insensitive, as all syllables in Cantonese are presumed superficially bimoraic, and thus the iamb to which Cantonese refers must be regarded as unprecedented as a type (Hayes 1991).

Under Yip's analysis, truncated forms such as economics
-> [[i[M]k'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 the boundary tone (before truncation). Forms which undergo Truncation Strategy (B) thus suggest that most loans are quasi-iambic in quality as an artifact of the preference for bisyllabicity, in conjunction with [H] tone suffixation, and not to an overt preference for iambicity.

There is evidence from the native phonology to suggest that the tonal rise is not due to a preference for iambicity, but instead possesses productive morphemic status in Cantonese, and further, surfaces in forms that are not iambic in quality. Cantonese adjectival reduplication is accompanied by tonal suffixation. When the tonal suffix attaches to the second copy, the resulting form possesses the meaning 'rather adj.'. The tonal suffix may instead attach to the first copy however, resulting in a 'quasi-trochaic' metrical structure (i.e high - non-high, corresponding to a strong - weak pattern). Here, the resulting form possesses the meaning 'very adj.'. Examples are in (57) (Whitaker 1955/6, Kao 1971).
Further evidence against a metrical motivation for the pitch rise is available from verbal reduplication/truncation, resulting in a bisyllabic surface form.

(58)

(measure one measure)   (to measure (once))

(stroll one stroll)   (to walk around (for a while))
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 'quasi-trochaic' pattern.

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

Further evidence for the binary foot comes from Cantonese hypocoristics. Hypocoristics (Yip 1990b), in which a high tonal suffix attaches to a monosyllabic name, are always prefixed by a- (e.g. [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 minimal bisyllabicity, as does the Cantonese form for biology, when it stands in isolation ([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 cannot attain bisyllabicity, as they are underived.
monosyllables.

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.

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

5.4 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 $[V...$ (Ito 1986)). However, under fairly regular
circumstances, we observe gemination of this intervocalic segment.

(59) 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 (59a) tend to trigger gemination of the intervocalic consonant. This result is not surprising when we recall the shape of the Cantonese syllable ((C)VX), and the principle of 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. As Yip concludes, intervocalic consonants will syllabify to their left if the
preceding vowel is short, since the resulting syllable will be a maximally well-formed one:

\[(60)\]
\[
\begin{array}{c}
\text{a. Scansion One:}
\end{array}
\]
\[
\begin{array}{c}
\text{s} \quad s \\
\mid \mid \\
C_1V C_2V
\end{array}
\]

\[
\begin{array}{c}
\text{b. Scansion Two:}
\end{array}
\]
\[
\begin{array}{c}
\text{s} \quad s \\
\mid \mid \mid \\
C_1V C_2V
\end{array}
\]

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

\[(61)\]
\[
\begin{array}{c}
s \quad s \\
\mid \mid \mid \mid \\
C_1V C_2C_2V
\end{array}
\]

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:
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 an active 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:
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 the multiple scansions hypothesis proposed herein):

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. However, in spring -> [si pit ling], the /l/ is presumably syllabified before the /s/ is encountered, and thus a trisyllabic output is obtained.

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, but that leftward vowels do not.

(64) a. break -> [pik lik]
    cream -> [kei lim]

b. file -> [fai lou]
    film -> [fei lAm]

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. Leftward material, as it has not yet been encountered, plays no role in determining the shape of the epenthetic segment.

3) Final Clusters: Yip hypothesizes that syllable nodes are provided for all unsyllabifiable segments, except stops, which are too low in sonority. 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 does not receive a degenerate syllable. The post-consonantal /m/ in *film* -> [fei lAm], 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/ may be incorporated as a coda, resulting in the unattested *[k'a sit].

I will now present my counter-arguments to Yip's 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 scansion across incoming forms. The multiple scansion hypothesis for loanword phonology 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. As for spring -> [si pit ling], this form appears to be a counter-example to the conclusion drawn herein regarding left-to-right syllabification, but only if we assume a single scansion is performed within the loanword phonology. Assuming the multiple scansions hypothesis supported herein, this form indeed counterexemplifies the assumed strategy for consonant-liquid cluster simplification, but presents no problem for left-to-right syllabification. The form clutch -> [kik lik tsi], similarly poses no problem for left-to-right syllabification along with multiple scansions, but does counterexemplify Yip's assumed syllabification strategy: as /u/ is encountered, the leftward /l/ should now delete, as bisyllabicity has already been achieved: clutch -> *[kik tsi].

Yip's second argument for right-to-left syllabification in fact possesses some empirical problems. First, epenthetic vowels in forms like film -> [fei lAm], and file -> [fai lou] appear to be influenced by dark [l], whose backness is manifested in the back rounded epenthetic vowel. Additionally, the labial consonant to the epenthetic segment's right may bear on the issue. The same argumentation may be employed for a form like fluke -> [fu
luk], where both (or either) a rightward labial vowel and (or) a leftward labial consonant may be influencing the shape of the epenthetic vowel. Almost every other instance of epenthesis is triggered by /s/, and is uniformly the high front vowel, perhaps due to leftward /s/’s coronality. It thus cannot be safely concluded that only rightward segments influence the shape of epenthetic segments. Assuming the multiple scansions hypothesis presented herein, both rightward and leftward segments may theoretically influence epenthetic vowel quality. Indeed, this hypothesis is consistent with the facts.

Now consider Yip's third argument, which hypothesizes 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.

(65) Onset cluster Coda cluster

a. plosive//sonorant
pleat-> band->
#{p'i[M] lit[H]} [pEn[M]]
clean-> friend->
#{k'i[M] lin[H]} [fEn[H]]

b. fricative//sonorant
fluke-> length->
[fu[L] luk[H]] #{lEn[H]}
"flea->"
(65a) shows that plosive-sonorant onset clusters trigger epenthesis, whereas sonorant-plosive coda clusters are simplified. (65b) shows that fricative-sonorant onset clusters also trigger epenthesis, whereas sonorant-fricative coda clusters are simplified. Finally, in (65c) fricative-plosive coda clusters are simplified (but cf. soft -> [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, and in fact is often debuccalized, 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:

(66) 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.

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

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

Unlike Yip's analysis, I make no 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 multiple scansions in 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 the multiple scansions theory of loanword phonology presented herein.
INPUT:

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

SCANSION ONE:

```
F  F  F  F  F  F  F
/ \ | / \ / \ / \ /
 s s s s s s s s
/ \ | | \ | \ | \ |
mm m mm m mm m mm mm
| | | / | | | / |
<mak'E>(ting) <p'lin> <ik'Onamiks> <flO><sou> <lEt'a> <pas>
H M H H M M H M H M H
```

SCANSION TWO:

```
F  F  F  F  F  F  F
/ \ / \ / \ / \ / \ /
 s s s s s s s s
/ / | / | / | / |
mm mm mm mm mm mm mm mm
/ | | | | | | | |
mak'Et(ing) p'i lin i k'On(amiksi) fo sou lEt't'a pasi
H MH L HH M M H M LH H HH H MH H LH
```

STRAY ERASURE:

```
F  F
/ \ / \ / \ /
 s s s s
/ / | / |
```

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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]]

(68a)  Input:  marketing

1.  F  2.  F  3.  F

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 syllabicly. A PCA domain is established across the licensed domain, and tones are perceived accordingly. As Scansion Two proceeds, native SSCs hold, and the template is filled up to maximality. The boundary tone attaches form-finally. Finally, Stray Erasure deletes all unlicensed material from the representation.

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

(68b) Input: print

1. F  2. F
   |   / \ 
  s  s s 
  |  /|\ /|\ 
 m  m m m 
  |  / |  |
 <p'lin>  p' i lin
  |  |  |
 H  L H

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 provided with a low [L] tone. As the final
syllable surfaces with a [H] tone, the boundary tone attaches vacuously.

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

(68c) Input: economics

1. F          2. F          3. F
   / \                    / \                    / \ 
  s s                    s s                    s s
 /\                     |\                    |\     
m m m m m               mm mm                 mm mm
     \                     \                     \   
<ik'Onamiks>  ik'On(amiksi)  ik'On
     \ | |                  | / | |            | / | |
    M M H M                M M H M LH            M M

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, all being provided with syllable nodes, all but the last with 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]]

(68d) Input: floorshow

1. F          2. F
   / \                    / \ 
  s s                    s s 
 /\                     |\ /\ 
m m                   mm mm
     \                     \     
     \                     \   
    M M H M                M M

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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, SSCs hold. The liquid deletes, as the template has already been filled. The boundary tone attaches vacuously.

Output: \([fO[H] sou[H]]\)

(68e) Input: letter

1. F          2. F
   / \          / \ 
  s s          s s
   | |          /|\ /|\ 
 m mm         mm mm
   | |          ||  |/
<let'a>  let't'a
   | |          | |  |
 H M          H MH

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

On Scansion Two, native SSCs hold. 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]]

(68f) Input: bus

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>2. F</td>
<td>3. F</td>
</tr>
</tbody>
</table>

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

On Scansion Two, SSCs hold as the template is filled. An epenthetic vowel repairs the degenerate syllable, and a [L] tone is provided. The boundary tone attaches.

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

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

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

The second level of the loanword phonology applies to the output of the Perceptual Level. During this stage, native constraints hold on prosodic structure. I have provided evidence from segmental 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 bi-leveled loanword phonology, enabling us to phonologically isolate the Perceptual and Operative Levels as a series of ordered scansion which forms undergo. Scansion One has been shown to correspond to the Perceptual Level, while Scansion Two has been shown to correspond to the Operative Level. It is left to further research to explore the possibility that such a strategy is employed beyond the domain of loanword phonology.

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

References


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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 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.
Multiple Scansions in Loanword Phonology: Evidence from Cantonese

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