Whether the syllable has internal structure or not is by no means a settled matter in generative phonology. This paper argues that the syllable has rich internal structure that may vary from language to language. Crucial evidence comes from phonological processes, such as partial reduplication, that target sub-strings of the syllable. In the case of Fuzhou, careful analysis of sub-syllabic processes provides a convincing argument for a highly articulated structure of the syllable.

1. Introduction

In recent years, several studies have focused on the syllable in various Chinese dialects, drawing data from phonological processes that target sub-syllabic constituents, such as speech error and partial reduplication. Analyses of such processes have proved fruitful in showing the syllable structure of a particular dialect, and consequently, cross-dialectal variation in syllable structure. Implicit in such work is the assumption that if a phonological process targets the string \(xyz\), then \(xyz\) is a constituent. In this paper, I continue this line of research by considering the properties of two sub-syllabic processes in Fuzhou, namely rhyme alternation and partial reduplication, in the hope of elucidating the structure of the Fuzhou syllable. I show that the sub-syllabic processes in Fuzhou provide amazingly lucid evidence for the structure of the syllable shown in (1).

\[
\begin{align*}
\sigma \\
O & \quad R \\
C & \quad G_m \\
N & \quad V \\
C_o & \quad G_s \\
\end{align*}
\]

In other words, if we were to take the constituency test seriously, a moraic or “flat” structure of the syllable fails to account for the phonological properties of the Fuzhou facts (see Section 4).

As the structure in (1) shows, the Fuzhou syllable may contain up to five segments. No single syllable has all five segments; so the maximum size of the syllable is four segments. Some of the syllable types are shown below (Yuan et al., 1989):
In this paper, we will examine the properties of sub-syllabic processes to determine the constituency of the five segments \( C_i \), \( G_m \), \( V \), \( C_f \) and \( G_o \).

The paper is organized as follows. In Section 2, I examine the alternating rhymes and establish that the nuclear vowel does not form a constituent with the medical glide and the off-glide. In Section 3, I first discuss l-words, and show that the off-glide forms a constituent with the final consonant. Then, I discuss other partially reduplicated words, and show that the rime contains all segments except the initial consonant. In Section 4, I consider and reject two alternative analyses that do not admit syllabic constituency. In Section 5, I examine the language game of La-mi, which exhibits properties that appear to be incompatible with those found in language-internal evidence of partial reduplication. I argue that game language phonology need not be point-to-point identical with the phonology of the language on which the language game is based (cf. Bagemihl, 1989; Ito et al., 1996). Section 6 is the conclusion.

2. Rhyme Alternation

Fuzhou rhymes are correlated with tones and change as a result of tone sandhi. On the surface, Fuzhou has seven citation tones, as follows (Liang, 1982):

\[
\begin{array}{ll}
(3) & \text{a. } 44 & \text{A. } 53 \\
& 31 & \\
& 213 & \text{C. } 242 \\
& 13 & \text{D. } 55 \\
\end{array}
\]

(3a–d) are derived from classical Chinese yin tones, and (3A–D) from their yang counterparts. In addition, Fuzhou has two tones, 11 and 35, that occur only in sandhi environments. These two tones and (3a, A, b, D) are the so-called “tight” tones, and (3c, C, d) are their corresponding “loose” tones. The exact articulatory meaning of the tight and loose rhymes need not concern us here. What is significant is that the tonal dichotomy correlates with two groups of rhymes, which, for lack of a better term, we may...
refer to as tight rhymes and loose rhymes—terms that are used in Chinese linguistics literature.

Liang (1982) classifies Fuzhou rhymes into three types, all of which exhibit some form of alternation conditioned by tone. Types B and C follow.

(4) a. **tight** loose tight loose tight loose
   
   i ei u ou y øy
   iŋ eiŋ uŋ ouŋ yŋ øŋ
   iʔ eiʔ uʔ ouʔ yʔ øʔ

   b. **tight** loose tight loose tight loose
   
   øy γy
   eiŋ aŋ ouŋ auŋ øŋ γŋ
   eiʔ aʔ ouʔ auʔ øʔ γʔ

Note that in (4a), the tight rhymes contain simple vowels, and their loose counterparts contain diphthongs.

Fuzhou rhyme alternation is not purely phonological. The same phonological string, say *ou*, appears with tight as well as loose tones. The data have been discussed quite extensively in the literature (see, for example, Chao, 1931, 1934; Yuan et al., 1989; Wang, 1967; Yip, 1980; Wright, 1983; Chan, 1985, 1997; Liang, 1982; Li et al., 1979; Zhan, 1981; Li et al., 1995; and Jiang-King, 1996), and various analyses have been put forth. Two analyses are possible, depending on whether we take the tight or loose rhymes as underlying. Traditional analyses within Chinese linguistics typically take the rhymes in citation form as basic. In the case of Fuzhou, the tight rhymes are underlying, from which the loose rhymes are derived. Yuan et al. (1989) capture the rhyme alternation as follows:

(5) a. i-, u-, y- are lowered and diphthongized to ei-, ou-, øy-
   
   b. øy-, ou-, ei- are lowered (and/or backed) to γy-, au-, a-

Similar analyses have been proposed by Chao (1934) and Chan (1985, 1997).

Alternatively, we can take the loose rhymes as basic, and derive the tight rhymes accordingly (see Yip, 1980; Wright, 1983). I will not discuss the merits of the two competing analyses; the interested reader can consult Chan (1985) and Jiang-King (1996), which discuss in great detail various proposals that have been put forth. For our purpose, it is sufficient to point out that rhyme alternation affects only the nuclear vowel, not the off-glide. This point is clearly exhibited in Type C data (4b). In Type B data (4a), the tight rhymes contain simple, high vowels, with their corresponding loose rhymes containing diphthongs. If we assume that the high vowels are linked
not only to the nuclear position, but to the coda (Co) position as well (cf. Bao, 1990; Chan, 1990), we will have the coda structure (6):

(6) \[
\begin{array}{c}
R \\
N \\
Co \\
[+\text{high}] \\
\eta/\eta'
\end{array}
\]

The high vowels are in effect diphthongized, and the tight rhymes in (4a) can be recast as follows:

(7) ii uu yy
iiŋ uuŋ yyŋ
iiʔ uuʔ yyʔ

Given this structure, rhyme alternation affects the nuclear [+high] vowel, not the coda link, i.e. the glide.4 We formulate the rule of rhyme alternation in the following schema:

(8) \[
\begin{array}{c}
N \\
\rightarrow \\
V
\end{array} \rightarrow \begin{array}{c}
N \\
V'
\end{array}
\]

where \( V \) is the vowel of the basic rhyme, and \( V' \) is the vowel of the derived rhyme.5 The exact formulation of the rule depends on the theoretical assumptions that a particular analysis makes. We will not attempt it here.

Type A data demonstrate that the nuclear vowel is not only independent of the off-glide, it is also independent of the medical glide \( G_m \). The data are listed below (Liang, 1982):

(9) tight loose tight loose tight loose tight loose tight loose
a a aŋ aŋ a? aʔ ai ai au au
ɛ a ɛ? aʔ ɛu au
œ œ œ? œʔ
o o oʔ oʔ
ia ia iaŋ iaŋ ia? iaʔ
ie ie iɛ iɛŋ iɛʔ iɛʔ iɛu iɛu
yo yo ɣo ѱo ɣoʔ ɣoʔ
ua ua uaŋ uaŋ uaʔ uaʔ uai uai
uo uo uoŋ uoŋ uoʔ uoʔ ui uoi6
Note that the tight vowels \( a/e, a/o, a/l/e?, \) and \( au/eu \) are neutralized into their respective loose rhymes \( a, o, a/l/e? \) and \( au/eu \). According to Liang (1982), the rhyme \( a/l/e? \) shows no alternation and is only used in a few onomatopoeic words.

As can be seen from the data, the rhyme alternation of Type A is not as radical as that of Types B and C. The alternations are as follows:

\[
\begin{align*}
(a) & \quad a \rightarrow a \\
& \quad e \rightarrow a \\
& \quad o \rightarrow o \\
(b) & \quad e \rightarrow e \\
& \quad o \rightarrow o \\
\end{align*}
\]

Type A alternation exhibits the same lowering and/or backing processes seen in Types B and C alternations. It is worth pointing out that only the nuclear vowels of the rhymes are involved in the alternation, not the medical glides. Since the nuclear vowel encodes the most sonorous segment of the syllable, we can apply rule (8) to derive all cases of rhyme alternation in Fuzhou. We therefore obtain the partial structure for the Fuzhou syllable shown in (11).

\[
(11) \quad N \\
\quad C_i \quad G_m \quad V \quad G_s \quad C_i
\]

We now proceed to examine partial reduplication from the same dialect.

3. **Partial Reduplication in Fuzhou**

3.1. *Replace(X) as Diagnostic Tool*

To focus our attention on the syllabic constituency that partial reduplication helps resolve, we will ignore the technical details of partial reduplication, and will instead make use of the rule schema Replace \((X)\), where \( X \) is the string of source materials not found in the copies – these “missing” materials are replaced by \( X \) in partially reduplicated words. The basic idea is related to the constituency hypothesis alluded to earlier: if a partially-reduplicated word satisfies Replace \((X)\), then \( X \) is a constituent. To further explicate the role of Replace(X), consider the hypothetical form shown in (12).

\[
(12) \quad taŋ \rightarrow tei-laŋ
\]

The partially reduplicated form *tei-laŋ* is derived from the source syllable *taŋ*. Ignoring the fine techical details of reduplication theories, we can derive
this disyllabic form in two steps. First, the source is copied to yield \textit{taŋ-taŋ}; and then the rime of the first syllable is replaced with \textit{ei}, and the initial of the second syllable is replaced with \textit{l}, to yield \textit{tei-laŋ} (cf. Steriade, 1988; Bao, 1990). We will use the rule schema Replace(X) to express the phonological relation between a source syllable and each syllable of a derived, partially-reduplicated word. We say that the form \textit{tei-laŋ} has the properties Replace(\textit{ei}) and Replace(\textit{l}). In exposition it is often convenient to use the vocabulary of generative phonology: Replace(X) applies to copies from a given source to generate the partially reduplication form. Since we are not concerned with the technical details of reduplication, the expression “Replace(X) applies to form F” has the same meaning as the expression “Form F has the property Replace(X).” I stipulate condition (13).³

\begin{equation}
(13) \text{Replace(X) applies once to teach syllable of an l-word.}
\end{equation}

In other words, from the source syllable \textit{taŋ}, we can derive the well-formed \textit{ta laŋ}, but not \textit{*ta lai}. In the ill-formed form, the second syllable \textit{lai} can be derived by applying Replace(X) twice: Replace(\textit{l}) and Replace(\textit{i}), in violation of the condition stated in (13).

The schema Replace(X) essentially follows the analysis of Chinese-based language games (cf. Section 5) proposed in Bao (1990), within the general theory reduplication put forth in Steriade (1988). It has been used as a diagnostic of syllabic constituency in a number of recent studies; see Lin (1989), Bao (1995, 1996, 1997), Chan (1990, 1997), and Chung (1997).

### 3.2. L-Words

L-words are fossilized, disyllabic expressions found in many dialects of Chinese, with different phonological properties (see, for example, Xu, 1981; Li, 1991; and Zhang, 1993). Formally, the second syllable of an l-word has \textit{l} as the onset, hence the term l-word. These words are not productive, and their origin is rather obscure. They often lack standard written form. Historically, the fossilized l-words may be the modern reflexes of consonant clusters of the form \textit{Cl-} in classical Chinese (cf. Chan, 1984; Xiang, 1993). One specimen from Fuzhou is shown below (Liang, 1982):

\begin{equation}
(14) \text{pe 31} > \text{pe 31 la 31} \quad \text{‘to sway’}
\end{equation}

Careful analysis of the phonological properties of l-words may shed light on the structure of the syllable. As we will see shortly, the l-words share the same phonological properties as other types of partially reduplicated words in Fuzhou.
Liang (1982) collects some 200 l-words, and classifies them into fourteen types in accordance with the segmental makeup of the base syllable. I classify them into four groups. They are listed below:

(15) a. \( C_i V(G_o)(C_f) > C_i V-IV(G_o)(C_f) \)
   
   paŋ 213 > pa laŋ 'to turn'
   
   p’ɔŋ 213 > p’ɔ laŋ 'to expand'
   
   taŋ 53 > ta laŋ 'to shine on'
   
   miŋ 44 > mi liŋ 'to hide'
   
   tau 213 > ta lau (< ta lau) 'to hang'
   
   teu 31 > te leu 'to droop'
   
   ta 31 > ta la 'to entangle'
   
   mo 44 > mo lo 'to protrude'

b. \( V(G_o)(C_i) > V-lV(G_o)(C_i) \)
   
   ou? 13 > o lou? 'to fold'
   
   au 44 > a lau 'to dent'
   
   øe? 13 > øe le? 'to throw up'
   
   o 44 > o lo 'to stick'

c. \( C_{iG_m} VG_o C_f > C_{iG_m} V-lG_m VG_o C_f \)
   
   tsiaŋ 53 > tsia liŋ 'to splash'
   
   ts’uo 55 > ts’uo luə? 'to startle'
   
   k’ieu 53 > k’ie lieu 'to shrink'
   
   tuo 213 > tuo luəi (< tuo luəi) 'to grab unto'
   
   hai 44 > hai lia 'to crack'
   
   ts’uo 44 > ts’uo luəo 'to screw'

d. \( G_{m} VG_o C_f > G_{m} V-lG_m VG_o G_f \)
   
   ua? 13 > ua luəi (< ua luəi) 'to poke out'
   
   lia? 13 > lia lia? (< lia lia?) 'quickly'
   
   ua 44 > ua luai 'not straight'
   
   uo 44 > uo luo 'together'

Liang (1982) observes that the first syllable of an l-word invariably ends in a vowel: and the second syllable begins with the lateral l. The merger of the two syllables – by taking the initial of the first syllable (including the so-called “zero-initial”) and the rhyme of second (including \( G_m \) and tone) – gives the source syllable from which the l-word is derived and with which it is synonymous. Some of the source syllables, shown on the left side of the arrow in (15), may not be used in isolation. Obviously, l-words are examples of partial reduplication.
We now proceed to analyze the Fuzhou l-words with the help of the rule schema Replace(X). Following Liang (1982), we take the source syllable as the base, which is copied to yield a string of two copies. The second syllable may be derived by a rule such as Replace(C_i), defined in (16):

(16) Replace(C_i): Replace C_i with l in the second syllable

This rule targets C_i only, without affecting G_m, suggesting that G_m is not a secondary articulation on C_i (i.e. G_i \neq G_m). The separation of C_i and G_m is corroborated by segmental deletion data from Fuzhou. In Fuzhou, the initial consonant of the second syllable of a disyllabic phrase often undergoes phonological change, which Tao (1930) terms “categorical transformation.” Among the eight categorical transformations that Tao (1930) enumerated is the deletion of the initial velar segments – the category of velar segments is transformed to the category of the zero initial. The data in (17) are cited from Chen et al. (1981) and Liang (1986).

(17) a. mi 31 kouŋ 44 → mi 21 ouŋ 44 'rice jar'
kau 44 k’au 213 → kau 53 au 213 'hook'
tsai 31 xiŋ 53 → tsai 21 iŋ 53 'paper type'
b. k’ai 44 kuaŋ 44 → k’ai 44 uŋ 44 'switch'
pa 53 kia 242 → pa 53 ia 242 'climb down'

Note that the medial glide is not deleted with the proceeding velar (cf. (17b)).

Consider now how the first syllable of an l-word may be derived. As exhibited by the data, it loses both the off-glide and the final consonant, suggesting that the two elements form a constituent. Given the coda structure in (18),

(18) \[
    \begin{array}{c}
    \text{Co} \\
    \text{C}_0 \\
    \text{C}_i \\
    \end{array}
\]

We can derive the first syllable with Delete(Co), defined below.

(19) Delete(Co): Delete Coda in the first syllable.

Delete(Co) is a more specific version of Replace(Co). The forms in (15) can be derived as follows:
The constituency of $G_0$ and $C_f$ has been proposed by Wright (1983) for some rhymes in Fuzhou and by Pulleyblank (1984) for Late Middle Chinese. The Fuzhou l-words support this constituency.

From the Fuzhou l-word data, we can safely draw two conclusions. First, $G_m$ is not a secondary articulation on $C_i$; second, $G_0$ and $C_f$ form a constituent. These are compatible with rhyme alternation. We revise the partial structure of the Fuzhou syllable, shown in (11), as follows:

\[ (21) \]

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\[ (21) \]

Other partial reduplication data will further enrich the structure, as we shall see in the next section.

3.3. Disyllabic Reduplication in Fuzhou

There are two types of partial reduplication in Fuzhou. In one type, one of the reduplicated syllables acquires a new initial segment; in the other, it acquires a new rhyme. I will call the former Type A, the latter Type B. We will discuss Type A first. The data are shown in (22) and (23) (all data are taken from Zhen (1983); similar data can be found in Chen (1967)).
296 BAO ZHIMING

(22) a. k‘u 44 > k‘u 44 lu 44 ‘to tighten’  
k‘i 44 > k‘i 44 li 44 ‘to rest on’  
sa 53 > sa 31 la 53 ‘to put a ring on’  
b. me? 55 > me 31 le? 55 ‘to deflate’  
kuŋ 31 > ku 31 luŋ 31 ‘to roll’  
c. tau 213 > ta 11 lau 213 ‘to cover’  
etu 31 > te 31 leu 31 ‘to shiver’  
d. t‘ou? 13 > t‘u 11 lou? 13 ‘to poke’  
ts‘ouŋ 242 > ts‘u 11 louŋ 242 ‘to wring’  
t‘oin 213 > t‘a 11 laiŋ 213 ‘to stiffen’

(23) a. pieu 44 > pie 44 lieu 44 ‘to shoot out’  
nia? 13 > nia 11 liu? 13 ‘to blink’  
b. ts‘uo 44 > ts‘uo 44 luo 44 ‘to turn’  
c. tuei 242 > tuo 11 luei 242 ‘to fall’  
tuo 213 > tuo 11 luo 213 ‘to cling to’  
kuaŋ 53 > kua 31 luŋ 53 ‘to circle’

The words in (22) do not contain a medial glide; those in (23) do. We observe that, of a partially reduplicated word, the first syllable is always light, without the off-glide and the final consonant of the source syllable (22b, c, d); and the second syllable acquires the new initial segment /l/. What is important for us is that the medial glide of the source is retained in both syllables, as can be seen in (23). To derive the data, we can use the two rules in (24):

 b. Replace(C_i): Replace the initial of the second syllable with /l/.

Such constituent-sensitive properties show that G_o and C_i form a constituent, i.e. the coda. Since it survives Replace(C_i) in the second syllable, the medial glide can not be the secondary articulation on the initial segment. The derivation of t’aiŋ 213 (22d) and kuaŋ 53 (23c) follows (tones are omitted):
This partial reduplication pattern lends empirical support for the partial structure of (21).

Now consider the Type B data in (26). This type of reduplication attributes brief, casual, or non-durative property to the meaning of the verb.

(26) a. ma 242 > mi 53 ma 242 'to sell
   se 31 > si 53 se 31 'to wash'
   ke 31 > ki 53 ke 31 'to untie a knot'
   ka 44 > ki 44 ka 44 'to cut with scissors'

   b. tøy? 13 > ti 53 tøy? 13 'to cover with lid'
   sa? 55 > si 31 sa? 55 'to boil'
   p’a? 13 > p’i 53 p’a? 13 'to pat'

   c. liaŋ 53 > li 44 liaŋ 53 'to line-dry'
   t’iŋ 213 > t’iŋ 53 t’iŋ 213 'to mend'
   kiaŋ 53 > kiaŋ 44 kiaŋ 53 'to walk'
   ts’ia? 13 > ts’i 53 ts’ia? 13 'to slide in'

   d. kuŋ 31 > kuŋ 53 kuŋ 31 'to roll up'
   p’uo? 55 > p’iu? 31 p’uo? 55 'to sun-dry'

We observe that while the second syllable remains unchanged, the first syllable retains the initial segment of the source and obtains a new rime. According to Zhen (1983, 36), if the original syllable ends in a nasal, the new rime is either i or iŋ (cf. (26c, d)); the retention of nasality is optional. If it ends in a vowel or glottal stop it is invariably i. The tone pattern is summarized below.
The second syllable retains the source tone. The pattern differs from that of the first type of partial reduplication, and from that of the l-words as well. Note that the tones of the first syllable are the so-called tight tones, correlated with the tight rhymes $i$ and $iŋ$.

An interesting segmental property is that the first syllable, which acquires the new rime $i$, does not keep the medial glide of the original syllable ($p’uo? 55 > p’i 31 p’uo? 55$). The absence of -u- can not be attributed to Fuzhou phonotactics, since -ui (-uei) is an actual tight rhyme in Fuzhou, as in $pui 44$ ‘cup’ and $p’ui 53$ ‘skin’.13 It is therefore a direct result of -uo- being replaced together by the new rhyme $i$. This shows that $G_m$, $V$, $G_o$, and $C_f$ form a constituent, which we shall call rime (R). Assuming that the new rime is $i$, we can derive the partial reduplication data with a rule such as (28):

(28) Replace(R): Replace the rime with $i$ in the first copy.

The resultant string is further modified to derive the effect of tone sandhi and optional nasal retention. (29) shows two sample derivations (irrelevant details are omitted from the structure):

(29) Base: \[
\begin{array}{c}
R \\
\text{t} \, \circ \, \text{y} \, ? \\
\text{l} \, \text{i} \, \text{a} \, \text{n} \\
\end{array}
\]

Copy: \[
\begin{array}{c}
R \, R \, R \, R \\
\text{t} \, \circ \, \text{y} \, ? \\
\text{t} \, \circ \, \text{y} \, ? \\
\text{l} \, \text{i} \, \text{a} \, \text{n} \\
\text{l} \, \text{i} \, \text{a} \, \text{n} \\
\end{array}
\]

Replace(R): \[
\begin{array}{c}
R \, R \, R \, R \\
\text{t} \, \text{i} \\
\text{t} \, \circ \, \text{y} \, ? \\
\text{l} \, \text{i} \\
\text{l} \, \text{i} \, \text{a} \, \text{n} \\
\end{array}
\]

Tone Sandhi: \[
\begin{array}{c}
ti \, 53 \\
t\, \circ \, \text{y} \, ? \, 13 \\
\text{l} \, \text{i} \\
\text{li} \, 44 \\
\text{lia} \, 53 \\
\end{array}
\]

The tone sandhi rule is not given, since it is of marginal interest for our purpose.

The two patterns of partial reduplication complement each other in an interesting fashion. Three properties are noteworthy. First, $G_m$, $V$, $G_o$, and $C_f$ form a constituent, i.e. the rime R. Second, $G_o$ and $C_f$ form the constituent
of coda (Co), a structure also motivated by the l-word data of the same dialect, which we examined in Section 3. Third, the medial glide G\textsubscript{m} is not a secondary articulation on the initial segment C\textsubscript{i}. But, given our analysis of Fuzhou rhyme alternation in Section 2, G\textsubscript{m} is not part of the nucleus either. Instead, it forms the constituent Rime with the nucleus and coda. When we take into consideration all available sub-syllabic properties, we conclude that the Fuzhou syllable has the structure shown in (30).

\[(30)\] completes the partial structure in (21).

The optional retention of the nasal coda is interesting, especially in contrast with the obligatory replacement of the glottal stop (cf. (26c)). In modern Fuzhou, the glottal stop has two sources: from classical Fuzhou *-ʔ and *-k. As a result, rhymes with glottal stop exhibit different segmental phonology (Liang, 1982; Chan, 1985, 1990, 1997). Chan (1990) argues that the glottal stop, at least the glottal stop derived from *-k, occupies the nuclear position in Fuzhou. However, since we have concluded that the off-glide G\textsubscript{o} is in the coda, this will make it impossible to place the glottal stop in the nuclear position in rhymes such as eiʔ and ouʔ. One interpretation of Chan’s view is to say that the glottal stop is not a full segment, but a glottal feature, say [constricted glottis] of Halle and Stevens (1971), on the nuclear vowel, whether simple or diphthongal. This has been suggested for Southern Min (cf. Li, 1989; and Yip, 1994). So when the vowel or diphthong is replaced, the glottal stop (or feature) disappears. Given this treatment, the behavior of the syllable-final glottal stop is compatible with Replace(R), as formulated in (28), or with any sub-syllabic operation that targets the nuclear vowel.

The optional retention of the velar nasal is more problematic for an analysis that places it in the coda position. We would expect it to be replaced, obligatorily, by Replace(R). In addition, the data show that G\textsubscript{m} and G\textsubscript{o} are replaced together with the nuclear vowel, as is evidenced in forms like ti 53 tiʔyʔ 13 (< tiʔyʔ 12) (cf. (26b)), and p’i 31 p’uoʔ 555 (< p’uoʔ 555) (cf. (26d)). But treating G\textsubscript{m}, V and G\textsubscript{o} as a constituent, say N, does not do justice to the other properties of Fuzhou partial reduplication that we have seen. One solution of the nasal retention problem is to treat nasality
as a morphemic feature, as Lin (1989) has argued for Taiwanese. Replacing the segments making up the rime need not affect the nasal feature, giving rise to the optional retention of nasality in reduplicated words. This account is quite plausible, given the fact that the Fuzhou syllable-final nasal, which is velar in isolation, nasalizes, and becomes homorganic with, the onset of the following syllable in a disyllabic phrase, a phenomenon that is not found in most other Chinese dialects (cf. Chen, 1967). The data below are cited from Liang (1986).

(31) a. souŋ 213 puŋ 53 → soum 44 muaŋ 53  ‘abacus’
b. hʊŋ 44 t’ai 44 → hun 44 nai 44  ‘typhoon’
c. tyŋ 44 suŋ 53 → tyn 44 nuŋ 53  ‘mid-month’

Although we do not know exactly what the conditioning environment is, this kind of sound change is nevertheless consistent with the view that the syllable-final velar nasal is in fact a morphemic feature. It assumes the place of articulation of the following onset in a disyllabic phrase, and by default becomes velar in phrase-final position.

4. ALTERNATIVE ANALYSES

Our analysis of the Fuzhou partial reduplication data leads us to postulate a hierarchical structure of the syllable. In this section I will consider two analyses – one based on moraic representation and the other on copy-and-association – that do not assume hierarchical structure of the syllable, and reject them as inadequate. The moraic analysis, based on the prosodic theory proposed by McCarthy and Prince (1986), would in fact lead us to conclude that G₀ and Ci form a constituent, i.e. a mora.

4.1. The Moraic Analysis

The syllable in Chinese in general, and Fuzhou in particular, has been analyzed as bimoraic (cf. Wright, 1983; Duanmu, 1990; Yip, 1992). Given the standard moraic representation (McCarthy and Prince, 1986, 1993b; Hayes, 1989), the initial consonant Ci and the medial glide G₀ are non-moraic and link directly to the syllable. The moraic structures of all syllable types in Fuzhou are shown below.

(32) a. \[\text{\begin{array}{c}
\sigma \\
\mu \\
\mu \\
C_i \\
V \\
G_0 \\
C_f
\end{array}}\]
b. \[\text{\begin{array}{c}
\sigma \\
\mu \\
\mu \\
C_i \\
G_m \\
V \\
G_0
\end{array}}\]
The nuclear vowel V occupies one mora position; Gₘ and Cᵢ link to a separate mora.

We observe that, details aside, the first syllable of an l-word, or a partially-reduplicated, disyllabic word is of the shape CᵢV or CᵢGₘV. We can treat it either as monomoraic, with V being the only moraic element, or as biomoraic, with the structure in (32d). We have two possible templates for partial reduplication in Fuzhou, namely, σₘ−σₘ or σₘ−σₘ. For l-words, these templates are as follows:

(33) a. \[ \sigma \mu \] b. \[ \sigma \mu \mu \]

The second syllable is pre-associated with l. These two structures have different consequences for the analysis of the l-word data. Given structure (33a), the forms in (15) can be derived in the following steps:

(34) a. Melody Copying: \[ p\text{a}i\eta \] \[ p\text{ai}\eta \]

Association:

Output: \[ p\text{a} \] \[ l\text{ai}\eta \]

b. Melody Copying: \[ k'\text{i}e\text{u} \] \[ k'\text{i}e\text{u} \]

Association:

Output: \[ k'\text{i}e \] \[ l\text{ie}u \]

However, we need to further stipulate that the monomoraic syllable in the l-word template may not have a branching mora. Otherwise, the ill-formed structures in (35) will be derived:
The stipulation is *ad hoc*. To adequately account for the facts, $G_o$ and $C_f$ need to link to the same mora in the biomoraic syllable, and fail to link in the monomoraic syllable; see derivation (34a).

The $\sigma_{\mu\mu}$-$\sigma_{\mu\mu}$ template of (33b) is equally problematic. To produce the desired forms, we need to stipulate that the nuclear vowel link to both moras in the first biomoraic syllable, and the off-glide $G_o$ and the final consonant $C_f$ be stranded in the final outcome:

But there is no principled motivation for such a stipulation. Moreover, a $\sigma_{\mu\mu}$-$\sigma_{\mu\mu}$ template fails to accommodate Type B partial reduplication in Fuzhou. Recall that Type B partial reduplication is of the form $C_i$-Base, with $C_i$ copied from the base (see Section 3.3). Given the $\sigma_{\mu\mu}$-$\sigma_{\mu\mu}$ template of (37a), the base $p`uo?55$ will yield the wrong form $*p`ui p`uo?55$, shown in (37b):

The correct form can be derived only when the medial glide -$u-$ does not link to the syllable node. This stipulation is *ad hoc*. The analytical quandary encountered here is a direct consequence of the poorly articulated struc-
ture of the syllable in moraic theories, in which mora is a unit of weight, not of constituency.\(^{17}\)

I conclude that moraic representation fails to provide an adequate account of the properties of Fuzhou partial reduplication.\(^{18}\)

4.2. Copy-and-Association

The second analysis I will consider is based on the copy-and-association theory of reduplication proposed by Marantz (1982), Yip (1982), and Clements (1985). In this theory, we can derive the l-words by assuming the template in (38):

\[(38) \quad \text{L-Word Template: CGV CGVGC} \]

The melodies are copied, and then associated to the template, left to right. The derivation in (34) can be recast as in (39):

\[(39) \quad \text{Melody Copying: p'aiŋ p'aiŋ k'ieu k'ieu} \]
\[\begin{align*}
\text{Association:} & \quad | \quad | \\
& \quad | \quad | \\
& \quad | \quad | \\
& \quad | \quad | \\
& p \quad a \quad i \quad n \quad k'ie \quad iu \quad k'ie \quad iu
\end{align*}\]
\[\text{Output: p'aiŋ laiŋ k'ie lieu}\]

The pre-associated l takes precedence over the copied melodies (cf. Yip, 1982). The unassociated segments are discarded, or stray-erased.

Within the copy-and-association theory, and any theory that does not recognize sub-syllabic constituency (cf. Clements and Keyser, 1983), the fact that Go and Ci are left without CV slots to associate to does not indicate their constituency; it is just an outcome of templatic satisfaction and directionality of association. Although such analysis weakens the conclusion that Ga and Ci form a constituent in Fuzhou, it does not provide a sufficient constraint on possible forms of templates in partial reduplication. The hypothetical template in (40) is just as plausible as the template in (38).

\[(40) \quad \text{GV CGVGC} \]
\[\begin{align*}
\text{GV CGVGC} & \quad | \\
& \quad | \\
& p \quad a \quad i \quad n \quad k'ie \quad iu
\end{align*}\]

303
This template yields hypothetical l-words shown below:

(41)  
- pain > ia lian  
- tuo > uo luo  
- mai > a lai  
- xa > a la

An extensive search in Chinese linguistics literature on Fuzhou and neighboring dialects fails to yield partially reduplicated words of this type. And it is not found cross-linguistically (cf. Wilbur, 1973; Marantz, 1982; and Steriade, 1988). The template and match theory makes no prediction concerning possible forms of (partial) reduplication.

5. LA-MI

The Fuzhou-based language game La-mi has been discussed quite extensively in the recent literature that includes, among others, Yip (1982), Lin (1989), Bao (1990), Duanmu (1990), Chan (1990), and Chiang (1992). These studies are based on the original work of Chao (1931). In this section, instead of reviewing the fine points of various analyses that have been put forward, I will focus on the structure of this language game. The basic data are as follows (Chao, 1931):

(42)  
- a. ma > la-mi  
  hɔ > lɔ-hi  
  b. ak > lɔk-il (> -eik)  
  muk > lu-mik  
  c. tai > lai-ti (> -tei)  
  tɔɔɔ > lɔy-tçi (> lɔy-tçei)  
  d. paik > laik-pik (> leik-peik)  
  hein > lein-hiŋ  
  e. pwɔ > lwɔ-pi  
  ηwɔ > lwɔ-ŋi (> -ŋei)  
  f. hwɔk > lwɔk-hik (> -heik)  
  syɔŋ > lyɔŋ-siŋ  
  kwɔŋ > lwɔŋ-kiŋ  
  g. twai > lwai-ti (> -tei)  
  tɕieu > lieu-tči  
  tɕ’wei > lwei-tɕ’i  
  ‘mother’  
  ‘good’  
  ‘duck’  
  ‘not have’  
  ‘vegetable’  
  ‘wine’  
  ‘eight’  
  ‘to return’  
  ‘cup’  
  ‘to sleep’  
  ‘to lack’  
  ‘often’  
  ‘light’  
  ‘big’  
  ‘wine’  
  ‘to urge’
From the data, we can see that the monosyllabic source is split into two syllables. The first syllable acquires \( l \), and the second syllable acquires a new vowel, \( i \) for the tight tones, and \( ei \) for the loose tones. What we can conclude is that \( l \) replaces only the initial consonant \( C_i \), not the medical glide \( G_m \), which is consistent with the syllable structure in (30). The second syllable is the focus of our concern here: the new vowel \( i \) replaces not only the nuclear vowel (cf. (42a, b)), but also the off-glide (cf. (42c, d)), the medial glide (cf. (42e,f)), or both (cf. (42g)). The final consonant is spared. We summarize the properties of La-mi below:

(43) a. \( C_i \) of the first syllable is replaced with \( l \).
   
   b. \( G_m VG_0 \) of the second syllable are replaced with \( i \).

The La-mi data are interesting, especially in light of the properties of other partial reduplication data that we have discussed in Section 3. At first glance, La-mi appears to motivate the structure shown in (44).

(44)

(44), of course, is incompatible with (30), which is motivated by language-internal evidence of similar phonological derivation. It appears that the sub-syllable processes do not give us a clear, unambiguous structure of the Fuzhou syllable. To explain away the problem that the La-mi data present for the structure in (30), we can either reject Replace(X) as a viable constituency test, or attempt formulations of Replace(X) that are compatible with the structure in (30). I will consider these “patch-up” solutions in turn.

The first solution starts with the observation that what gets us in the analytical quandary is the constituency hypothesis: if a phonological process targets \( xyz \), then \( xyz \) is a constituent. We may stipulate that the phonological process of partial reduplication targets a contiguous string of segments. In other words, \( xyz \) is not necessarily a constituent. This solution has its problems, the most serious of which is over-generation: not all contiguous segments can undergo partial reduplication. And, in partial reduplication of the Fuzhou type, and in game languages like La-mi, we observe the following generalization (cf. Chao, 1931; Yip, 1982; Li, 1985; Lin, 1989; Bao, 1990; and Chiang, 1992).
If Replace(Rime) replaces $G_m$, then Replace(Onset) replaces only $C_i$.

Of course, if Replace(Rime) does not replace $G_m$, Replace(Onset) is not so restricted. This generalization follows from the structure in (30) or (44). It becomes mysterious if Replace(X), our rule schema for partial reduplication, targets a contiguous string. The derivation in (46) is expected, given the contiguity hypothesis:

(46) $\text{twan} \rightarrow \text{twan-twan} \rightarrow \text{lan-ti}$

The form $\text{lan-ti}$ is not found in the type of partial reduplication data we have examined. For a principled understanding of the phenomenon, we need a well-articulated structure of the syllable.

Chan (1997) proposes a different analysis of La-mi. In her analysis, the new rime $i$ replaces only the nuclear vowel, simple or diphthongal. Expressed in our terms, the second syllable has the property Replace(VG$_o$), rather than Replace($G_m$VG$_o$), as in (43b). The medial glide $G_m$ is subsequently deleted after the application of Replace(VG$_o$). As an illustration, consider the derivation of the forms $\text{lwak-heik}$ (42f) and $\text{lwai-tei}$ (42g) displayed in (47).

(47) Source: hwak twai
Copy: hwak-hwak twai-twai
Replace(C$_i$) and Replace(VG$_o$): lwak-hwik lwai-twi
$G_m$ Deletion: lwak-hik lwai-ti
Rhyme Alternation: lwak-heik lwai-tei

$G_m$ deletion is part of La-mi phonology, but not of the phonology of Fuzhou. The last step is due to tone sandhi. Chan’s analysis motivates the structure shown below.

(48) $\sigma$

However, the structure is still different from (30).
To make La-mi data compatible with (30), we need to take Chan’s analysis a step further by saying that the second syllable of a La-mi word has the property Replace(R), which targets $G_nVG_Cf$, and the retention of $C_f$ is a requirement specific to La-mi. The derivations in (47) can be recast as follows.

(49) Source: hw $ightarrow$ hwak-twai
    Copy: hwak-hwak-twai
    Replace($C_i$) and Replace(R): lwuk-hii lwai-tii
    $C_f$ Retention: lwuk-hik lwai-tii
    Rhyme Alternation: lwuk-heik lwai-tei

We will not attempt the formulation of rules that retain $C_f$ after Replace(R). It is worth noting that the phonology of a language game need not be identical with the phonology of the language on which the game is based. This is not only true of La-mi, but also of other Chinese-based language games. The syllable $kiŋ$, for example, is not permissible in Mandarin, yet occurs in $leï-kïŋ$ (>$liŋ$ ‘other’), a form in the Mandarin-based language game Mey-ka (cf. Chao, 1934). This phenomenon is common in language games cross-linguistically (cf. Bagemihl, 1989; Ito et al., 1996). By allowing unique phonological processes in the formation of La-mi, we can readily account for the properties of La-mi with the syllable structure in (30). La-mi is a special case of partial reduplication in Fuzhou.

6. CONCLUSION

In the preceding sections I have examined rhyme alternation, l-words, disyllabic, and partially reduplicated words in Fuzhou, as well as the Fuzhou-based game language of La-mi. In one way or another, the data deal with sub-syllabic processes. The general properties of the data and their consequences for the structure of the Fuzhou syllable are summarized below.

(50) a. Rhyme alternation:
    i. Only the nuclear vowel is affected.
    ii. Syllable structure compatible with data (cf. (11)):

\[
\begin{array}{cccc}
\text{N} & \text{C}_i & G_m & V & G_o & C_f \\
\end{array}
\]
b. L-words:
   i. The off-glide and the final consonant are deleted in the first syllable.
   ii. The initial consonant is replaced by \( l \) in the second syllable.
   iii. Syllable structure motivated (cf. (21)):

   \[
   \begin{aligned}
   &C_i \quad G_m \\
   &\quad V \quad G_0 \\
   &\quad Co
   \end{aligned}
   \]

c. Partially reduplicated words and La-mi
   i. Type A: Initial consonant is replaced by \( l \) in the second syllable.
   ii. Type B: The string \( G_m VG_C_i \) is replaced by \( i \) in the first syllable; syllable-final \(-\eta\) is optionally retained.
   iii. La-mi: The initial consonant is replaced by \( l \) in the first syllable.
      The string \( G_m VG \) is replaced by \( i \) in the second syllable.
   iv. Syllable structure motivated (cf. (30)):

   \[
   \begin{aligned}
   &\sigma \\
   &O \quad R \\
   &\quad N \quad Co \\
   &\quad C_i \quad G_m \\
   &\quad V \quad G_0 \\
   &\quad C_i
   \end{aligned}
   \]

The phenomena we have examined share remarkably similar properties: new rimes contain \( i \), and new initials are invariably \( l \). This is not surprising. Except for rhyme alternation, (50b, c) are derived in similar fashion, and they motivate the same structure of the Fuzhou syllable. Although at first glance La-mi appears problematic, the data can be made compatible with the syllable structure (50c–iv) with additional phonological processes that are unique to the formation of La-mi.

Notes

* I am grateful for anonymous reviewers’ close reading and insightful critiques of earlier versions of this paper. One reviewer’s constructive criticism is especially important in improving the quality of this paper. All errors of fact and interpretation are my own.

The abbreviations are: σ, syllable; O, onset; R, rime; N, nucleus; Co, onset; Ci, initial consonant; Gm, medial glide; V, vowel; Go, post-nuclear off-glide; and Cf, the final consonant.

The fourth type, Type D, consists of syllabic nasals that exhibit no alternation.

This treatment of the tight vowels is consistent with the general tendency of diphthongization: typically, only long vowels diphthongize (Hayes 1990). Here we assume that diphthongization affects only the first "half" of a tight vowel. For discussions on the issue of diphthongization, see Hayes (1990).

I am grateful to one JEAL reviewer on this point.

The Types B and C data do not offer any compelling evidence for the constituency of V and Go, as pointed out by two anonymous reviewers. Both reviewers argue that rhyme alternation can target the most sonorous segment of the syllable, which is the segment associated with the nucleus. The rule in (8) formally encodes their intuition.

This rhyme, which is the hui rhyme in the classification of traditional philology, has many transcriptions for modern Fuzhou. Some of the transcriptions are shown below:

<table>
<thead>
<tr>
<th>Tight</th>
<th>Loose</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>ui</td>
<td>uoi</td>
<td>Li et al. (1979), Li et al. (1995)</td>
</tr>
<tr>
<td>uei</td>
<td>uei</td>
<td>Yuan et al. (1989), Hanyu (1989)</td>
</tr>
<tr>
<td>uui</td>
<td>uoi</td>
<td>Zhang (1981)</td>
</tr>
<tr>
<td>uoi</td>
<td>uei</td>
<td>Liang (1982)</td>
</tr>
<tr>
<td>uei</td>
<td>uei</td>
<td>Tao (1930)</td>
</tr>
</tbody>
</table>

Here I follow Li et al. (1979) and Li et al. (1995). The difference is largely notational. Y.-Z. Liang transcribes the rhyme as uoi/uoi in Liang (1982), but as ui/uei in Li et al. (1979) and Li et al. (1995). The difference between ui and uei (or u and u) is phonetically negligible and phonologically insignificant. It is crucial for our purpose that ui is part of the Fuzhou rhyme inventory; see Section 3. Whether or not it undergoes tight-loose alternation does not concern us.

The allophonic changes noted in the data in (9) are so small that most scholars do not consider them as alternating rhymes at all. In works such as Chao (1931, 1934), Yuan et al. (1989), Wright (1983), and Chan (1985), the loose rhymes in (9) are ignored; only Types B and C are accepted as alternating rhymes.

In the framework of Optimality Theory (cf. Prince and Smolensky, 1993), Replace(X) and the condition in (13) can be formulated as constraints on the output of Gen. See footnote 18 for further comments on Optimality Theory.

Only the source tone is given; the two tones of an l-word are the same as the tone of the source syllable, modulo the effect of tone sandhi. The second tone does not undergo tone sandhi; the first tone is subject to the following sandhi rules:

<table>
<thead>
<tr>
<th>i</th>
<th>44, 53, 31, 55 &gt; 31</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>213, 242, 13          &gt; 11</td>
</tr>
</tbody>
</table>

The tones 44, 53, 31 and 55 are used with the tight rhymes, and 213, 242, and 13 with loose rhymes. The sandhi tones 31 and 11, which are used with tight rhymes, may induce loose rhymes to change to their tight counterparts. 11 is also transcribed as 21. See Section 2 on the rhyme alternation seen here.

There is a slight difference in transcription between Liang (1982) and Zhen (1983). I use the segmental transcription of the sources. The tone patterns of the partial reduplication data shown in (22) and (23) are as follows:

<table>
<thead>
<tr>
<th>i</th>
<th>Original Tone</th>
<th>Tone of First Copy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>44, 31</td>
<td>same</td>
</tr>
<tr>
<td></td>
<td>53, 55</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>213, 242, 13</td>
<td>11</td>
</tr>
</tbody>
</table>
The second syllable retains the original tone. The sandhi pattern differs from that of l-words in the same dialect (see Section 3.2). The change in the vocalic quality of the rhymes is due to tone sandhi; see Section 2.

11 According to Liang’s (1982) transcription, tau 213 should be tau 213, 213 being a loose tone; see (9). Since vocalic qualities are not important for our concern, I will stick to the transcription of the sources.

12 If we take the tight rhymes as underlying, the forms t’ou? 13 (< t’u? 13 ) and ts’ouŋ 242 (< ts’uŋ 242 ), should be listed under (22b). The vowel /u/ surfaces as [ou], conditioned by the loose tones 13 and 242. In this paper, we remain neutral on the alternating rhymes, and the forms are classified on the basis of surface realization. This classification does not affect our argument.

13 These words are transcribed as puei 44 and p’uei 53 respectively in Yuan et al. (1989). It should be clarified that they are not the “loose” counterparts of pai 44 and p’ui 53. The loose alternant for the rhyme of -ui- is -uoi-; see footnote 6.

14 The syllable-initial sound change exemplified in (31), and that in (17), are first noted in Tao (1930). According to Tao, they take place when the two syllables have “close grammatical connections.” Exactly what these connections are is not clear; see Li et al. (1979), Zhao (1980), and Chen et al. (1981) for interesting discussions of the complexity of the Fuzhou sound change.

15 If we treat -ʔ and -η as morphemic (or floating) features, C_i is not a slot in the Fuzhou syllabic template, so the coda consists of G_o only. Since the segmental status of syllable-final -ʔ and -η is of marginal interest to our central concern, we will continue to consider -ʔ and -η as full segments.

16 We will ignore the optional retention of the velar nasal in Type B partial reduplication (cf. (26c)); see Section 3.3.

17 I thank one anonymous reviewer for pointing out to me the relevance of Type B partial reduplication against moraic representation.

The same reviewer also points out that argument against moraic theories works only when we assume the syllable structures in (32). If we allow the medial glide G_n to link to the first mora of a biomoraic syllable, the problems we have identified will not arise. While this is true, we have to stipulate that, given the syllable structures shown in (i), the medial glide G_n must link to the first mora in l-words, but must not link to the first mora in Type B partial reduplication, as illustrated in (ii) and (iii).
One reviewer points out that the Fuzhou data we have examined can be easily accommodated within the framework of Optimality Theory (cf. Prince and Smolensky, 1993), without assuming sub-syllabic constituency. There is no doubt that the Fuzhou facts can in principle be accounted for through the interaction of ranked constraints. Rule schemas such as Replace(X) can be easily translated into Optimality-theoretic constraints. In the case of l-words, we can formulate a constraint, or a set of ranked constraints, to ensure that the first syllable is a core syllable (i.e. CV), and that l emerges as the default onset in the second syllable, along the line of argument of McCarthy and Prince (1986, 1993a, b) and Alderete et al. (1997). The issue here is not constraint interaction, but the formulation of the required constraints. If we cannot refer to sub-syllabic constituents in the formal statement of constraints, an OT account of the Fuzhou facts will face the same difficulty as any mora-based theory of reduplication. Pre-theoretically, the non-existent form "p’ui 31 p’uo? 55 (p’uo? 55) is just as optimal as the actual form p’i 31 p’uo? 55 (< p’uo? 55) (cf. (26d)), since none of the component syllables violates constraints that govern well-formed syllables and rhyme-tone co-occurrence. By introducing sub-syllabic constituents into phonological representation, the required constraints can be formulated with enhanced formal perspicuity and predictive force.

Tones are omitted. The forms in parentheses are surface forms, due to rhyme alternation; see Section 2. The analysis adopted here follows Bao (1990) and Chan (1990). In modern Fuzhou, -k is unreleased, and is often glottalized (cf. Chan, 1990). It is possible to treat -k as a floating feature, analogous to the treatment of the glottal stop in Southern Mi (cf. Li, 1989; Lin, 1989; Yip, 1992). I will not pursue the matter further, since it is of marginal interest to our argument.

I am grateful for one reviewer’s insightful comments, which greatly improved the argument presented in this section.

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