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Chengdu Reduplication: An Optimality Theoretic Analysis*

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This paper examines four reduplication patterns in Chengdu that involve special tone sandhi (i.e. AA, AAB, ABB and AABB) and proposes an Optimality Theoretic (OT) analysis to account for the reduplicant size, the reduplicant placement, and tone sandhi of these patterns. For reduplicant size, the monosyllabic reduplicant size in AA, AAB, and ABB and the disyllabic size in AABB are shown to be governed by different alignment constraints that contribute to the variant reduplicant sizes. For reduplicant placements, it is shown that though the reduplicant in AABB appears to be infixal, it is actually a suffix (just as the other patterns), whose movement into the base is forced by a linearity constraint that requires the input segmental sequence to be preserved in the output. Finally, for tone sandhi, it is shown that the special tonal alternations in the four reduplication patterns are the combinational effect of general tone sandhi and a floating high tone, which usually docks on the left edge of the reduplicant.

Key words: Chengdu, floating high tone, Optimality Theory, reduplication, special tone sandhi

1. Introduction

Chengdu is a southwestern Mandarin dialect spoken in Sichuan Province, China. It has four common patterns of reduplication, AA, ABB, AAB, and AABB, whose tonal alternations differ from those observed in general (non-reduplicative) tone sandhi. Within the output-oriented framework of Optimality Theory (McCarthy & Prince 1993; Prince & Smolensky 2004), this paper examines the reduplicant size, the reduplicant placement, and tone sandhi in the four patterns. For reduplicant size, the paper argues that the monosyllabic reduplicant size in AA, AAB, and ABB and the disyllabic size in AABB are due to the different nature of the reduplicants in the two groups of patterns; while the reduplicant of the former three patterns is stem-internal, that of the latter is stem-external. Stem-internal and -external reduplicants are subject to different alignment constraints, leading to the different reduplicant sizes. For reduplicant placements, despite the fact that the reduplicant in AABB appears to be infixal, it is actually a suffix (as are the other three patterns), whose movement into

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the base is triggered by a linearity constraint that requires the input segmental sequence to be preserved in the output. Finally, for tone sandhi, it is shown that although the tonal alternations observed in the different reduplication patterns are distinct from one another, they are all accompanied by a floating high tone that contributes greatly to the special tonal alternations. The floating high tone aims to dock on the left edge of the reduplicant; however, it may fail to be realized on the designated tone-bearing unit if it is preceded by another high tone within the stem, which is an OCP effect that targets stem-internal morpheme boundaries.

The remainder of this paper is organized as follows. Section 2 presents data and generalizations of tone sandhi in the four reduplication patterns in Chengdu, followed by an Optimality Theoretic analysis proposed in §3. Section 4 concludes the paper.

2. Tone sandhi in reduplication

This section presents data and generalizations of tone sandhi in the four reduplication patterns. As knowledge of general (non-reduplicative) tone sandhi is prerequisite, a brief introduction to general tone sandhi is given in §2.1, before the presentation of reduplication data in §2.2.

2.1 General tone sandhi in Chengdu

Chengdu has four lexical tones: *yinping* 45, *yangping* 31, *shangsheng* 55, and *qusheng* 13. Given the four-tone system, there are 16 (4 × 4) bi-tonal combinations in Chengdu, among which 12 undergo tone sandhi. These tonal alternations are illustrated in (1).

(1) Tonal combinations that undergo tone sandhi

	Input	Output	Example
a.	45.45	45.**44**	*tɕin tʰiɛn* 'today'
b.	31.45	31.**44**	*tso tʰiɛn* 'yesterday'
c.	13.45	13.**44**	*miɛn pau* 'bread'
d.	55.45	55.**44**	*tsʰau ku* 'straw mushroom'
e.	45.55	45.**53**	*tsʰau səu* 'wonton'
f.	31.55	31.**53**	*tʰaŋ ko* 'candy'
g.	13.55	13.**53**	*fu mu* 'parents'
h.	55.55	55.**53**	*tso səu* 'left hand'
i.	45.13	45.**11**	*tsoŋ tɕiau* 'religion'
j	31.13	31.**11**	*ɕi kuan* 'habit'
k.	13.13	13.**11**	*sɨ tɕiɛi* 'world'
l.	55.13	55.**11**	*tsau fan* 'breakfast'

Key: tones are separated by '.'; tones that undergo general tone sandhi are in boldface.

Tone sandhi as illustrated in (1) can be captured by the three derivational rules in (2).

(2) General tone sandhi (TS) rules

a. 45 → 44/ T ___

b. 55 → 53 / __]

c. 13 → 11/ T __

Key: T = any tone; ‘]’ = phrase final boundary

Three things are worth noting. First, as far as general tone sandhi is concerned, Chengdu belongs to a left prominent language, as opposed to right prominent languages such as Beijing Mandarin and Taiwanese, since in Chengdu, when general tone sandhi occurs, it is usually the tone on the left that stays intact and the one on the right that changes. It is also of interest to note that no rising tone occurs at the right edge of the string after tone sandhi. Second, Chengdu verbs are free from tone sandhi. For example, while nouns with an underlying /45.45/ sequence, such as *tɕin*45 *t*^{h}*iɛn*45 ‘today’, would undergo tone sandhi and change to *tɕin*45 *t*^{h}*iɛn***44**, verbs with the same underlying tonal sequence, such as *ts*^{h}*uei*45 *foŋ*45 ‘to go for a blow’, would remain unchanged. This suggests that there is a tone sandhi boundary (marked by ||) between the verb part (v) and its following element (such as object (o) or complement (c)) (i.e. *ts*^{h}*uei*(v)45 || *foŋ*(o)45 ‘to go for a blow’), prohibiting tonal alternations from taking place in the bi-tonal window containing the v part and a following syllable. More examples are given in (3).

(3)

Input		Output		
		Non-verb		Verb
/45.45/	a.	45.**44** (e.g. *tɕin t*^{h}*iɛn* ‘today’)	a′.	45.||45 (e.g. *ts*^{h}*uei foŋ* ‘to go for a blow’)
/13.45/	b.	13.**44** (e.g. *miɛn pau* ‘bread’)	b′.	13.||45 (e.g. *ts*^{h}*aŋ ko* ‘to sing’)
/55.45/	c.	55.**44** (e.g. *ts*^{h}*au ku* ‘straw mushroom’)	c′.	55.||45 (e.g. *tɕ*^{h}*i foŋ* ‘wind springs up’)
/13.13.31/	d.	13.**11**.31 (e.g. *sən tan tɕiɛ* ‘Christmas’)	d′.	13.||13.31 (e.g. *xua ti t*^{h}*u* ‘to wet the bed’)
/55.45.45/	e.	55.**44.44** (e.g. *suei ɕiɛn xua* ‘daffodil’)	e′.	55.||45.**44** (e.g. *ta kuan sɨ* ‘to sue’)
/45.13.45/	f.	45.**11.44** (e.g. *san tsɨ tɕin* ‘the Three Character Classic (San Zi Jing)’)	f′.	45.||13.**44** (e.g. *k*^{h}*ai ie ts*^{h}*e* ‘to burn the midnight oil’)

Finally, *shangsheng* in Chengdu has two allotones, 53 and 55, where the former occurs in the final position of the word (1e–h) and the latter elsewhere (e.g. 1d, h, l). As such, in the citation form (where *shangsheng* stands alone), it is 53 that surfaces (e.g. *ts*^{h}*au*53 ‘grass’). In the literature, the citation form of *shangsheng* in Chengdu is usually assumed to be the underlying form (Liang & Huang 1998; Lin 2006). Nonetheless, Lin (2014) convincingly argues that the 55 variant is underlying while the 53 variant is derived. As Lin points out, the fact that the citation form of *shangsheng* is 53 does not necessarily mean its underlying tone must also be 53, since a citation tone can be different from its underlying tone (Bao 1999:83; Chiang 1998:82, 2002:562; Ting 1982, 1989). According to Lin, if the underlying tone of *shangsheng* were 53, it would have to undergo tone sandhi before another tone to yield the correct output (e.g. /*tso*53.*səu*53/ → [*tso***55**.*səu*53] ‘left hand’), which is different from tone sandhi in *yinping* and *qusheng* where the left tone is preserved. Moreover, Lin points out that considering 55 as the underlying tone better explains the lack of tone sandhi in verbs. As is shown in (3), there is a boundary standing between the v part and its following element, blocking tone sandhi in the ditonal sequence containing the v part and a following syllable. If 53 were considered as underlying, it would be hard to explain why it would undergo tone sandhi even though it is followed by a boundary (e.g. /*tɕ*^{h}*i*53 ‖ *foŋ*45/ → [*tɕ*^{h}*i***55** ‖ *foŋ*45] ‘wind springs up’). On the other hand, considering 55 as underlying correctly predicts that the v does not change before the boundary (e.g. /*tɕ*^{h}*i*55 ‖ *foŋ*45/ → [*tɕ*^{h}*i*55 ‖ *foŋ*45] ‘wind springs up’). Therefore, the present paper follows Lin in assuming the underlying tone of *shangsheng* to be 55.

2.2 Tone sandhi in AA, AAB, ABB, and AABB reduplication

This section presents data and generalizations of Chengdu reduplication. Chengdu has four common patterns of reduplication. They are AA reduplication, ABB reduplication, AAB reduplication, and AABB reduplication, as exemplified in (4). (**T** $^{<\mathrm{T}}$ in the examples refers to sandhi tone $^{<\text{citation tone}}$; **T** in the examples refers to sandhi tones that are different from general tone sandhi.)

(4) AA reduplication

	Root	Reduplicated form
ai.	*tau*45	*tau*45.*tau***55**
	刀 ‘knife’	刀刀 ‘small knife’
aii.	*ɕiaŋ*45	*ɕiaŋ*45.*ɕiaŋ***55**
	箱 ‘trunk’	箱箱 ‘trunk’
bi.	*ts*^{h}*oŋ*31	*ts*^{h}*oŋ*31.*ts*^{h}*oŋ***55**
	蟲 ‘worm’	蟲蟲 ‘small worm’
bii.	*xo*31	*xo*31.*xo***55**
	盒 ‘box’	盒盒 ‘box’
ci.	*toŋ*13	*toŋ*13.*toŋ***55**
	洞 ‘hole’	洞洞 ‘small hole’
cii.	*paŋ*13	*paŋ*13.*paŋ***55**
	棒 ‘stick’	棒棒 ‘stick’
di.	*i***53**$^{<55}$	*i*55.*i***31**
	椅 ‘chair’	椅椅 ‘small chair’
dii.	*ts*^{h}*au***53**$^{<55}$	*ts*^{h}*au*55.*ts*^{h}*au***31**
	草 ‘grass’	草 ‘grass’

(5) AAB reduplication

	Root	Reduplicant
a.	t^{h}uei45.ts^{h}e**44**$^{<45}$	t^{h}uei45.t^{h}uei**55**.ts^{h}e**44**$^{<45}$
	推車 ‘trolley’	推推車 ‘trolley’
b.	tɕiɛn45.mau**11**$^{<13}$	tɕiɛn45.tɕiɛn**55**.mau**11**$^{<13}$
	尖帽 ‘pointed tall hat’	尖尖帽 ‘pointed tall hat’
c.	p^{h}o31.niaŋ31	p^{h}o31.p^{h}o**55**.niaŋ31
	婆娘 ‘wife’	婆婆娘 ‘husband’s mother’
d.	tsa13.nuei31	tsa13.tsa**55**.nuei31
	炸雷 ‘thunderclap’	炸炸雷 ‘thunderclap’
e.	tin55.saŋ**11**$^{<13}$	tin55.tin**31**.saŋ**11**$^{<13}$
	頂上 ‘top’	頂頂上 ‘the very top’
f.	ts^{h}au 55.yo31	ts^{h}au55. ts^{h}au**31**.yo31
	草藥 ‘herbal medicine’	草草藥 ‘herbal medicine’

(6) ABB reduplication

	Root	Reduplicant
a.	foŋ45.ts^{h}e**44**$^{<45}$	foŋ45.ts^{h}e**44**$^{<45}$.ts^{h}e**55**
	風車 ‘windmill’	風車車 ‘small windmill’
b.	tau45.tɕiɛn**44**$^{<45}$	tau45.tɕiɛn**44**$^{<45}$.tɕiɛn**55**
	刀尖 ‘tip of the knife’	刀尖尖 ‘the very tip of the knife’
c.	suei55.k^{h}ən**44**$^{<45}$	suei55.k^{h}ən**44**$^{<45}$.k^{h}ən**55**
	水坑 ‘puddle’	水坑坑 ‘small puddle’
d.	ts^{h}oŋ45.pe31	ts^{h}oŋ45.pe31.pe**55**
	蔥白 ‘spring onion’	蔥白白 ‘spring onion’
e.	ts^{h}au55.p^{h}oŋ31	ts^{h}au55.p^{h}oŋ31.p^{h}oŋ**55**
	草棚 ‘thatch shack’	草棚棚 ‘thatch shack’
f.	yan31.tən**11**$^{<13}$	yan31.tən**11**$^{<13}$.tən**55**
	圓凳 ‘stool’	圓凳凳 ‘stool’
g.	niau13.kuan**11**$^{<13}$	niau13.kuan**11**$^{<13}$.kuan**55**
	尿罐 ‘chamber pot’	尿罐罐 ‘chamber pot’
h.	kau45.soŋ**53**$^{<55}$	kau45.soŋ55.soŋ**31**
	高聳 ‘tall’	高聳聳 ‘very tall’

(7) AABB reduplication

	Root	Reduplicant
a.	sɨ45.uən31	sɨ45.sɨ**55**.uən31.uən31
	斯文 ‘gentle’	斯斯文文 ‘very gentle’
b.	ze31.nau**11**$^{<13}$	ze31.ze**55**.nau**11**$^{<13}$.nau**11**$^{<13}$
	熱鬧 ‘lively’	熱熱鬧鬧 ‘very lively’
c.	tɕ^{h}yo31.o**44**$^{<45}$	tɕ^{h}yo31.tɕ^{h}yo**55**.o**44**$^{<45}$.o**44**$^{<45}$
	雀窩 ‘nest’	雀雀窩窩 ‘nest’

d.	*n/a*[1]	*tsʰaŋ*31.*tsʰaŋ*<u>**55**</u>.*tu*55.*tu*$\mathbf{53}^{<55}$
		腸腸肚肚 'internal organs'
d.	*ta*13.*faŋ*$\mathbf{44}^{<45}$	*ta*13.*ta*<u>**55**</u>.*faŋ*$\mathbf{44}^{<45}$.*faŋ*$\mathbf{44}^{<45}$
	大方 'generous'	大大方方 'very generous'
e.	*tsən*55.*tɕʰi*31	*tsən*55.*tsən*<u>**55**</u>.*tɕʰi* 31.*tɕʰi*31
	整齊 'tidy'	整整齊齊 'very tidy'

Tonal alternations in the four reduplication patterns are somewhat different from general tone sandhi (summarized in (2)). In the AA (=A_1A_2) pattern, which involves complete copying of the monosyllabic root, when the underlying tone of the root is /45/, /31/, or /13/, the second repeated portion A_2 will surface as a high level tone <u>**55**</u>. On the other hand, when the underlying tone of the root is /55/, the second repeated portion will surface as <u>**31**</u>. That is, 45.<u>**55**</u>, 31.<u>**55**</u>, 13.<u>**55**</u>, and 55.<u>**31**</u>. This tonal alternation differs from general tone sandhi. Had general tone sandhi taken place, the surface tonal combinations would have been 45.$\mathbf{44}^{<45}$, 31.31, 13.$\mathbf{11}^{<13}$, and 55.$\mathbf{53}^{<55}$, respectively.

The same special tonal alternations are also observed in the ditonal sequence at the left edge of the AAB pattern and at the right edge of the ABB pattern where repeated portions are observed. Tone sandhi in the remainder of the two patterns (i.e. the ditonal sequence at the right edge of AAB and that at the left edge of ABB), on the other hand, follows general tone sandhi. Take AAB $\textit{tɕiɛn}_1$.$\textit{tɕiɛn}_2$.*mau* $尖_1尖_2$帽 'pointed tall hat', for instance; the tonal change on the first ditonal sequence undergoes special tone sandhi, in which the second repeated portion $\textit{tɕiɛn}_2$ $尖_2$ surfaces as <u>**55**</u> following $\textit{tɕiɛn}_1$ $尖_1$45, and the second ditonal sequence undergoes general tone sandhi, in which *mau* 帽 /13/ surfaces as [**11**] after another tone (i.e. *tɕiɛn*45.*tɕiɛn*<u>**55**</u>.*mau*$\mathbf{11}^{<13}$). Take ABB *niau*.$\textit{kuan}_1$.$\textit{kuan}_2$ 尿$罐_1罐_2$ 'chamber pot' as another example; the tonal change on the second ditonal sequence undergoes special tone sandhi, in which the second repeated portion $\textit{kuan}_2$ $罐_2$ surfaces as <u>**55**</u> following $\textit{kuan}_1$ $罐_1$ /13/, and the first ditonal sequence undergoes general tone sandhi, in which $\textit{kuan}_1罐_1$ /13/ surfaces as [**11**] after another tone (i.e. *niau*13.*kuan*$\mathbf{11}^{<13}$.*kuan*<u>**55**</u>).

Tone sandhi in $A_1A_2B_1B_2$ reduplication is, however, different. In the pattern, the second tone A_2 always surfaces as <u>**55**</u>, no matter what its preceding tone is. As for the tonal behaviors in the rest of the syllables, they are derivable by applying the general tone sandhi rules in (2). For instance, in *tsən*55.*tsən*<u>**55**</u>.*tɕʰi*31.*tɕʰi*31 整整齊齊 'very tidy', the second tone surfaces with a <u>**55**</u> even though it follows another high level tone 55; the rest of the two tones remains unchanged following general tone sandhi.

In sum, tone sandhi in reduplication is characterized by special tonal alternations that are different from general tone sandhi, and may combine with general tone sandhi when the reduplicated form exceeds two syllables. In terms of special tone sandhi, AA, AAB, and ABB patterns share the same tonal alternations, which are different from AABB reduplication. Tone sandhi in the four patterns of reduplication are summarized in (8):[2]

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[1] Most of the AABB reduplicated forms have corresponding non-reduplicated disyllabic roots. *tsʰaŋ*31.*tsʰaŋ*<u>**55**</u>.*tu*55.*tu*$\mathbf{53}^{<55}$ 腸腸肚肚 'internal organs' is among one of the minority forms that have no corresponding root.

[2] Chengdu has three other reduplication patterns that are less productive; these are ABAB reduplication, ABAC reduplication, and ABCB reduplication. Please refer to the appendix for a brief discussion.

(8)

<table>
<tr><td rowspan="2">Reduplication pattern</td><td colspan="2">Tone sandhi</td></tr>
<tr><td>Special tone sandhi</td><td>General tone sandhi</td></tr>
<tr><td>a. AA</td><td rowspan="3">45.55, 31.55, 13.55, 55.31</td><td>n.a.</td></tr>
<tr><td>b. AAB</td><td rowspan="3">Following (2)</td></tr>
<tr><td>c. ABB</td></tr>
<tr><td>d. AABB</td><td>T.55</td></tr>
</table>

In addition to the tone sandhi phenomena of the four reduplication patterns, the issue with regard to which part of the repeated portion is the reduplicant and which is the base should be addressed. AA, AAB, and ABB all involve monosyllabic reduplication. For these patterns, the present paper assumes the monosyllabic reduplicant to be suffixal. That is, $A\text{-}\underline{A}$, $A\text{-}\underline{A}\text{-}B$, and $AB\text{-}\underline{B}$ (where the reduplicants are underlined). The assumption is based on the consensus that in reduplication, bases are more faithful to the input than their reduplicant counterparts are since the base, but not the reduplicant, is regulated by IO faithfulness constraint (i.e. input-base correspondence). In other words, the repeated portion that preserves the underlying tonal quality should be considered as the base. In AA reduplication, while the right tone is always different from the input tone (often surfacing as **55**), the left tone is always identical to the input tone. This suggests that the reduplicant is the second repeated portion, i.e. $A\text{-}\underline{A}$. In AAB reduplication and in ABB reduplication, just as in AA reduplication, while the second repeated portion always surfaces with a derived tone (usually surfacing as **55**), the first repeated portion tends to be the same as the input tone; therefore, the reduplicant is the second repeated portion, i.e. $A\text{-}\underline{A}\text{-}B$ and $AB\text{-}\underline{B}$. Notice that though the reduplicants in the patterns of AA, AAB, and ABB are all suffixal, the placements of the reduplicants are not entirely the same. In AA and ABB, the reduplicant is suffixed to the root final syllable and is placed to the right of the root; in AAB, on the other hand, the reduplicant is suffixed to the root initial syllable and is placed after it.

Unlike the other three patterns, AABB reduplication involves disyllabic reduplication. For the pattern, there are four possible ways to derive AABB from an AB root, as listed in (9):

(9) Possible reduplicant placements in AABB reduplication

a. $A_1\text{-}\underline{A_2B_1}\text{-}B_2$

b. $A_1\text{-}\underline{A_2}\text{-}B_1\text{-}\underline{B_2}$

c. $\underline{A_1}\text{-}A_2B_1\text{-}\underline{B_2}$

d. $\underline{A_1}\text{-}A_2\text{-}\underline{B_1}\text{-}B_2$

In AABB reduplication, the tone in the initial position is always identical to the input; therefore, the initial syllable should be the base. Thus, (c) and (d) are ruled out immediately. As for the first (a) and the second (b) options, they differ only in terms of the intervening part. In the first option, the base is intervened by the reduplicant, while in the second option, not only is the reduplicant intervened by part of the base (i.e. B_1), the base is also intervened by part of the reduplicant (i.e. A_2). Thus, in terms of Contiguity, the first option will only violate Contig-IB, which requires the portion of the base standing in correspondence to the input to form a contiguous string. On the other hand, the second option, in addition to violating Contig-IB, violates Contig-IR, which requires the portion of the reduplicant standing in correspondence to the input to form a contiguous string.[3] Thus, the first option, where the reduplicant appears as an infix to the root, should be the correct analysis. The reduplicant size and placement of the four reduplication patterns are summarized in (10).

(10)

Reduplication pattern	Reduplicant size	Reduplicant placement
a. A-A	monosyllabic	suffixed to root final syllable
b. A-A-B		suffixed to root initial syllable
c. AB-B		suffixed to root final syllable
d. A-AB-B	disyllabic	infixed after the root initial syllable

Before concluding this section, it is important to note that there is no clear semantic distinction among the four patterns. In Chengdu, reduplication can indicate diminutivity, intensity, or more commonly, no meaning change at all. Nonetheless, these functions are realized with different patterns. For instance, dimunitivity is realized not only in AA reduplication (as in *tsʰoŋ tsʰoŋ* 蟲蟲 'small worm' < *tsʰoŋ* 蟲 'worm'), but also in ABB reduplication (as in *suei .kʰən .kʰən* 水坑坑 'small puddle' < *suei .kʰən* 水坑 'puddle'); intensity is realized not only in AABB reduplication (as in *tsən. tsən.tɕʰi.tɕʰi* 整整齊齊 'very tidy' < *tsən. tɕʰi* 整齊 'tidy'), but also in ABB (as in *kau.soŋ.soŋ* 高聳聳 'very tall' < *kau.soŋ* 高聳 'tall') and in AAB (as in 頂頂上). Finally, the most common function (i.e. no meaning change) is observed in all the four reduplication patterns (as in AA *ɕiaŋ.ɕiaŋ* 箱箱 'trunk' < *ɕiaŋ* 箱 'trunk', AAB *tʰuei.tʰuei.tsʰe* 推推車 'trolley' < *tʰuei.tsʰe* 推車 'trolley', ABB *niau.kuan.kuan* 尿罐罐 'chamber pot' < *niau.kuan* 尿罐 'chamber pot', and AABB *tɕʰyo.tɕʰyo.o.o* 雀雀窩窩 'nest' < *tɕʰyo.o* 雀窩 'nest'). In other words, there is no clear semantic distinction among these reduplication patterns. Moreover, a pattern usually denotes more than one meaning. For example, AA reduplication can indicate diminutivity and may cause no meaning change, ABB reduplication can indicate diminutivity, intensity, or may cause no meaning change. Therefore, it is difficult to predict which root will undergo which pattern. For instance, it is not clear why *tsʰau.yo* 草藥 'herbal medicine' would reduplicate its first syllable (i.e. undergoing AAB reduplication) to form *tsʰau.tsʰau.yo* 草草藥 'herbal medicine', while *tsʰau.pʰoŋ* 草棚 'thatch shack' would reduplicate its second syllable (i.e. undergoing ABB reduplication) to form *tsʰau.pʰoŋ.pʰoŋ* 草棚棚 'thatch

[3] The Contig-IR constraint is adopted from Fitzgerald (2000).

shack', even though in both cases, reduplication does not result in meaning change.[4] Since the choice of which pattern to apply is not predictable, and since the mapping of the four patterns to specific semantic functions is not possible, this paper considers the choice of patterns and functions to be controlled by the root.[5] In other words, the reduplicants in different patterns are considered as allomorphic variants of the same functional affix and the alternations in the reduplicative morphemes (including variations in the reduplicant size and placement, as well as in tone sandhi) are considered as allomorphic.

3. An Optimality Theoretic analysis

This section proposes an analysis based on OT to account for the reduplicant size, the reduplicant placement, and tone sandhi in the reduplication patterns of AA, ABB, AAB, and AABB.

3.1 Reduplicant placement and size

Consider first the variations in the reduplicant size and placement. As mentioned above, because there is no systematic semantic functional distinction among the four reduplication patterns the reduplicative morphemes in the four patterns are considered as root controlled and the alternations in the size and placement of the reduplicants are allomorphic. The allomorphic alternations in size and placement of Chengdu reduplication can be accounted for by the morphoprosodic alignment (MPA) model, which was proposed by Kennedy (2008) to account for morphological alternations. According to MPA, reduplicative affixes may be stem-internal or stem-external; stem-internal affixes are separated from the base by a + boundary (i.e. $[\text{RED} + \text{base}]_{\text{stem}}$) while stem-external affixes are separated from the base by a # boundary (i.e. $[\text{RED} \# [\text{base}]_{\text{stem}}]$). Whether a reduplicant is stem-internal or -external is determined by the morphological component before phonological derivation. In the allomorphic system, the morphological position of a reduplicant inside or outside

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4 It is worth noting that syntactic categories also play no role in the selection of one reduplication pattern as opposed to another. Although AAB reduplication generally involves noun bases, the patterns of AA, ABB, and AABB can come from a variety of bases. For instance, a disyllabic noun, in addition to undergoing AAB reduplication (e.g. *pʰo.niaŋ* 婆娘 'wife' > *pʰo.pʰo.niaŋ* 婆婆娘 'husband's mother'), can also undergo ABB (e.g. *yan.tən* 圓凳 'stool' > *yan.tən.tən* 圓凳凳 'stool') or AABB reduplication (e.g. *nan.ny* 男女 'boy and girl' > *nan.nan.ny.ny* 男男女女 'boys and girls'). And a disyllabic adjective can undergo ABB reduplication (e.g. *kau.soŋ* 高聳 'tall' > *kau.soŋ.soŋ* 高聳聳 'very tall') as well as AABB reduplication (e.g. *ta.faŋ* 大方 'generous' > *ta.ta.faŋ.faŋ* 大大方方 'very generous').

5 In addition to accounting for allomorphic alternation (in which a single reduplicant has different phonological manifestations), the MPA model can also account for isomorphic alternations (in which different reduplicative affixes have different phonological realizations). As mentioned, in the morphoprosodic alignment (MPA) model, whether a reduplicant is stem-internal or -external is determined by the morphological component before phonological derivation. Isomorphic and allomorphic alternations only differ in what determines the morphological position of a reduplicant inside or outside the stem as well as its linear position as a prefix or suffix; such information is determined by the root in the allomorphic system but by the reduplicative affix in the isomorphic system.

the stem, as well as its linear position as a prefix or suffix, is determined by the root. In MPA, the phonological component may be sensitive and target degrees of morphological junctures through the two alignment constraints following, in which (11) applies to stem-internal affixes while (12) applies to stem-external ones. In addition to alignment constraints, markedness constraints can be sensitive to morphological junctures.

(11) Align + Syll: Stem-internal morphological boundaries occur at syllable boundaries. (Kennedy 2008:591)

(12) Align # Foot: Stem-external morphological boundaries occur at foot boundaries. (Kennedy 2008:591)

In Chengdu, since reduplicative morphemes are allomorphic, the reduplicant's position as prefix or suffix or as stem-internal or -external is encoded in the roots. Roots in Chengdu can be categorized into four groups: those that undergo AA reduplication, those that undergo AAB reduplication, those that undergo ABB reduplication, and those that undergo AABB reduplication. These roots are referred to hereafter as AA root, AAB root, ABB root, and AABB root, respectively. Based on MPA, we assume that a monosyllabic reduplicant is stem-internal while the disyllabic reduplicant is stem-external. The monosyllabic reduplicant is clearly a suffix and is assumed as such in the paper. Nonetheless, for the disyllabic reduplicant, though it appears to be an infix, due to the fact that it is stem-external, it is considered as a suffix, whose movement into the base will be shown below to be triggered by some linearity constraints. The four types of roots are encoded with the information in (13).

(13) a. AA root: e.g. *toŋ* 洞 'hole', *tau* 刀 'knife', *ɕiaŋ* 箱 'trunk', *tsʰoŋ* 蟲 'worm', *xo* 盒 'box', *paŋ* 棒 'stick', *i* 椅 'chair', *tsʰau* 草 'grass'
Encoding: e.g. [*toŋ*洞 + RED]$_{stem}$

b. AAB root: *tsʰau.yo* 草藥 'herbal medicine', *tʰuei.tsʰe* 推車 'trolley', *tɕiɛn.mau* 尖帽 'pointed tall hat', *pʰo.niaŋ* 婆娘 'wife', *tsa.nuei* 炸雷 'thunderclap', *tin.saŋ* 頂上 'top'
Encoding: e.g. [*tsʰau*草 + RED + *yo*藥]$_{stem}$

c. ABB root: *tsʰau.pʰoŋ* 草棚 'thatch shack', *foŋ.tsʰe* 風車 'windmill', *tau.tɕiɛn* 刀尖 'tip of the knife', *suei.kʰən* 水坑 'puddle', *tsʰoŋ.pe* 蔥白 'spring onion', *yan.tən* 圓凳 'stool', *niau.kuan* 尿罐 'chamber pot', *kau.soŋ* 高聳 'tall'
Encoding: e.g. [*tsʰau.pʰoŋ* 草棚 + RED]$_{stem}$

d. AABB root: *ta.faŋ* 大方 'generous', *sɨ.uən* 斯文 'gentle', *ze.nau* 熱鬧 'lively', *tɕʰyo.o* 雀窩 'nest', *tsən.tɕʰi* 整齊 'tidy'
Encoding: e.g. [$_{stem}$[*ta.faŋ*大方] # RED]

To account for the size of the reduplicant, the following constraints are necessary in addition to the two alignment constraints in (11) and (12).

(14) *Struc: No syllables are allowed.

(15) Max-BR: Every segment in the base has a correspondent in the reduplicant.

(16) Lin(M): The linear order of the morphemes in the input is kept in the output.

(17) Lin(S): The linear order of the segments in the input is kept in the output.

For AA roots, AAB roots, and ABB roots, since the reduplicants are stem-internal, they are subject to the Align + Syll constraint. Nonetheless, as illustrated in (18)–(20), the Align + Syll constraint alone cannot predict the monosyllabic size for the stem-internal reduplicant. The constraint only requires a stem-internal reduplicant to be minimally monosyllabic in size; it cannot guarantee the reduplicant to be exactly monosyllabic since a disyllabic reduplicant also satisfies the Align + Syll constraint. The selection of monosyllabic reduplicant for stem-internal reduplicant in AA, AAB, and ABB is actually achieved with the help of the size-penalizing constraint *Struc, which crucially ranks below Align + Syll and above Max-BR.

(18) ||Al + Syl >> *Struc >> Max-BR|| predicts that a stem-internal RED is monosyllabic
AA root *toŋ* 洞 'hole' → *toŋ.toŋ* 洞洞 'small hole'

toŋ + RED	Align # Foot	Align + Syll	*Struc	Max-BR
a. *toŋ* + (*toŋ. toŋ*)			***!	
☞ b. *toŋ* + *toŋ*			**	

(19) ||Al + Syl >> *Struc >> Max-BR|| predicts that a stem-internal RED is monosyllabic
ABB root *foŋ.ts*^{h}*e* 風車 'windmill' → *foŋ.ts*^{h}*e.ts*^{h}*e* 風車車 'windmill'

foŋ.ts^h*e* + RED	Align # Foot	Align + Syll	*Struc	Max-BR
a. *foŋ.ts*^{h}*e* + (*ts*^{h}*e. ts*^{h}*e*)			****!	
☞ b. *foŋ.ts*^{h}*e* + *ts*^{h}*e*			***	*

(20) ||Al + Syl >> *Struc >> Max-BR|| predicts that a stem-internal RED is monosyllabic
AAB root *ts*^{h}*au.yo* 草藥 'herbal medicine' → *ts*^{h}*au.ts*^{h}*au.yo* 草草藥 'herbal medicine'

ts^h*au* + RED + *yo*	Align # Foot	Align + Syll	*Struc	Max-BR
a. A.*ts*^{h}*au* + (*ts*^{h}*au ts*^{h}*au*) + *yo*			****!	
☞ b. *ts*^{h}*au* + *ts*^{h}*au* + *yo*			***	*

It is worth noting that the candidate that best satisfies the *Struc constraint in tableaux (18)–(20) is in fact a candidate without a reduplicant. Such a candidate violates Realize Morpheme (e.g. Kurisu 2001), which requires a morpheme to have some phonological exponent in the output. Realize Morpheme is undominated in Chengdu reduplication. For simplicity, this dominant constraint is omitted and output candidates that violate the constraint are not considered.[6]

[6] I am grateful to one of the reviewers for pointing out the importance of the Realize Morpheme constraint.

For AABB roots, since the reduplicants are stem-external, they are subject to the ALIGN # FOOT constraint. The align constraint ensures the reduplicant must be at least foot-sized. By assuming that a foot is disyllabic (i.e. with undominated FTBIN constraint, which requires feet to be binary under syllabic analysis), a reduplicant will be minimally di-syllabic.[7] As shown in (21), a monosyllabic reduplicant (21a) is ruled out by the ALIGN # FOOT constraint.

(21) ||AL # FT >> *STRUC >> MAX-BR|| predicts that a stem-external RED is disyllabic
AABB root *ta.faŋ* 大方 'generous' → *ta.<u>ta.faŋ</u>.faŋ* 大大方方 'very generous'

ta.faŋ # RED	ALIGN # FOOT	ALIGN + SYLL	*STRUC	MAX-BR
a. *ta.faŋ* # *<u>.faŋ</u>*	*!		***	*
b. *ta.faŋ.* # (*<u>ta.faŋ</u>*)			****	
c. *ta.* # (*<u>ta.faŋ</u>*) # *.faŋ*			****	

Although the alignment constraint correctly predicts the size of a stem-external reduplicant to be disyllabic, it fails to predict where the reduplicant should appear. The stem-external reduplicant does not surface as a suffix following the linearity of the morpheme in the input. Instead, it is infixed in the base. The intervention of the reduplicant into the base violates the LIN(M) constraint in (16), which requires the linear order of the morpheme in the input to be preserved in the output; nonetheless, it helps to preserve the segmental linearity of the input (i.e. A precedes B), satisfying LIN(S) in (17). This suggests that LIN(S) must dominate LIN(M), as illustrated in (22). In (22), candidate (a) violates LIN(S) because *ta* 大, which comes before *faŋ* 方 in the input, does not always precede *faŋ* 方 in the output. Candidate (b), on the other hand, violates LIN(M) because the reduplicant is infixed in the base rather than suffixed to the base, following the linear order of the morphemes specified in the input. Since LIN(S) outranks LIN(M), candidate (b) is correctly predicted as the optimal candidate.

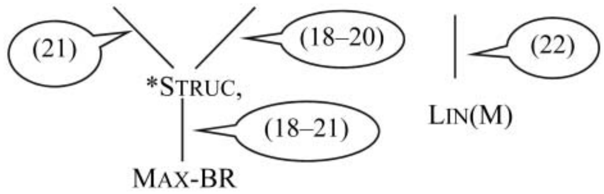
(22) ||LIN(S) > LIN(M)|| predicts the intervention of the RED into the base in AABB
AABB root *ta.faŋ* 大方 'generous' → *ta.<u>ta.faŋ</u>.faŋ* 大大方方 'very generous'

ta.faŋ # RED	LIN(S)	ALIGN # FOOT	ALIGN + SYLL	LIN(M)
a. *ta.faŋ.* # (*<u>ta.faŋ</u>*)	*!			
☞ b. *ta.* # (*<u>ta.faŋ</u>*) # *.faŋ*				*

The inclusion of LIN(S) and LIN (M) in the constraint ranking does not influence the prediction for stem-internal reduplicants since neither constraint is violated by the roots undergoing AA, ABB, and AAB reduplication. The final constraint ranking for the reduplicant size and placement is summarized in the Hasse diagram in (23), and is labeled with the example numbers of the tableaux that illustrate the ranking arguments.

[7] Stem-external reduplicants that are bigger than disyllabic will be penalized by *STRUC.

(23) Align # Foot, Align + Syll, Lin(S)



3.2 An Optimality Theoretic analysis of tone sandhi in reduplication

This section offers an OT analysis of tone sandhi in the four reduplication patterns. The tonal patterns of the four reduplication patterns to be accounted for are summarized in (24).

(24) a. The tonal pattern of AA (A-A) reduplication
The tone on the reduplicant is 55 when its corresponding tone in the base is 45, 31 or 13, and 31 when its corresponding tone in the base is 55.

b. The tonal pattern of ABB (AB-B) reduplication
  i. The tone on the reduplicant is 55 when its corresponding tone in the base is 45, 31, or 13, and 31 when its corresponding tone in the base is 55.
  ii. The tonal behavior on the non-reduplicant syllable is derivable by general tone sandhi.

c. The tonal pattern of AAB (A-A-B) reduplication
  i. The tone on the reduplicant is 55 when its corresponding tone in the base is 45, 31, or 13, and 31 when its corresponding tone in the base is 55.
  ii. The tonal behavior on the non-reduplicant syllable is derivable by general tone sandhi.

d. The tonal pattern of AABB (A-AB-B) reduplication
  i. The tone on the left of the reduplicant is 55.
  ii. The tonal behavior on the rest of the syllables is derivable by general tone sandhi.

Four generalizations can be observed from the above. (1) A high tone 55 tends to appear in the reduplicant. (2) The high tone 55 occurs on the reduplicant when it is monosyllabic (e.g. AB-B^{55}) and on the left edge of the reduplicant when it is disyllabic (e.g. A-A^{55}B-B). (3) With the exception of AABB, 55 is not allowed to occur when its corresponding tone in the base (which usually precedes the reduplicant) is 55. That is, *55.55 (e.g. *AB^{55}-B^{55}, compare with AB^{55}-B^{31}). (4) The rest of the syllables, if any, undergo general tone sandhi. The first three characteristics, which belong to special tone sandhi, will be accounted for in §3.2.1; the last characteristic, which belongs to general tone sandhi, will be accounted for in §3.2.2.

3.2.1 Optimality Theoretic analysis of special tone sandhi in reduplication

This section proposes an OT analysis of special tone sandhi in Chengdu reduplication.

Consider the first characteristic of special tone sandhi, in which a high level tone tends to appear in the reduplicant. The present paper assumes that the high tone realized on the reduplicant is a floating one that accompanies the morphological process of reduplication. Reduplication accompanying floating high tones is not unusual in Chinese dialects. It is also observed in dialects such as Beijing Mandarin, Taiwanese, and Dongshi Hakka, as illustrated in (25), where T highlights realization of an input floating tone in the output.[8] Interested readers are referred to Yip (1990) for a floating tone analysis regarding adjective reduplication in Beijing Mandarin, to Cheng (1973) and Zhang & Lai (2007, 2008) for a floating tone analysis pertaining to double reduplication in Taiwanese monosyllabic adjectives, and to Lin (2011) for a floating tone analysis within Dongshi Hakka special reduplication.

(25) Beijing Mandarin: *xau*21 'good' → *xau*21-*xau*.**55** (*tə*)
Taiwanese: *tĩ*55 'sweet' → *tĩ*3**5**-*tĩ***33**-*tĩ*55 'very sweet'
Dongshi Hakka: *vu*33.*kim*33 'black' → *vu*33.*kim*3**5**-*vu*33.*kim*33 'somewhat black'

Consider now the second characteristic of special tone sandhi. According to the second characteristic, the floating high tone falls on the reduplicant when it is monosyllabic and on the left edge of the reduplicant when it is disyllabic. Thus, it can be generalized that the floating high tone is realized on the left edge of the reduplicant. The constraints in (26) are proposed to account for realization of the floating high tone on the left edge of the reduplicant in Chengdu.

(26) a. *Float: No floating tones.
b. MaxFloat: All autosegments that are floating in the input have output correspondents.
c. Align (H, L, Red, L) (abbr. Align-HR-L): A high tone must be associated with the leftmost tone bearer of a reduplicant.
d. Max-T: All input tones have output correspondents.
e. Max-A: All input association lines have output correspondents.

The two constraints *Float and MaxFloat are adopted from Wolf (2007). *Float is violated if an underlying floating tone remains floating in the output; MaxFloat is violated if an underlying floating tone is deleted. Thus, an unrealized input floating tone would violate either *Float or MaxFloat. Align-HR-L, Max-T, and Max-A, on the other hand, are derived from Carleton &

[8] A possible alternative analysis is to consider the high tone that is realized in the reduplicant as the result of the emergence of the unmarked (TETU), since 55 is a relatively unmarked tone. However, a TETU analysis faces the problem of explaining why in $A_1A_2B_1B_2$ reduplication only A_2 surfaces as the unmarked tone. B_2, which forms part of the reduplicant, can surface as contour tones such as 31 (e.g. *tsən*55.-*tsən*55.*tɕʰi*31.-*tɕʰi*31 整整齊齊 'very tidy'), which is by no means unmarked. This is not a problem in the floating tone analysis. Since there is only one floating tone, according to one-to-one association, only one reduplicant can be associated with the floating tone; the other reduplicant gets its tonal melody from BR correspondence.

Myers (1994). When Align-HR-L is dominated by Max-T and Max-A, which respectively require input tones and association lines to be parsed, the alignment constraint will only affect the floating tones. This is because for tones that are underlyingly associated, any movement or deletion of high tones that are not aligned with the initial tone bearer to improve Align-HR-L will violate either Max-T or Max-A. On the other hand, a floating high tone is not associated with any tone bearer in the underlying representation; thus, the floating high tone is free to move without violating the two anti-deletion constraints. As Max-T and Max-A are never violated, and are dominant in Chengdu reduplication, for simplicity in the OT tableaux that follow we will not include the two constraints and will not consider output candidates that violate the two constraints.

As shown in (27), MaxFloat, *Float, and Align-HR-L together predict the realization of the floating high tone on the left edge of the reduplicant. Notice that since the lack of the realization of an input floating tone in the output would violate either *Float or MaxFloat, for simplicity, no distinction between the two will be made in the tableaux that follow. (In these tableaux, Ⓣ refers to the floating tone in the input; [**T**] refers to output tones that correspond to an input floating tone.)

(27) ||MaxFloat, *Float, Align-HR-L|| predicts that ㊿55 is realized on the left edge of RED

/45-RED, (55)/	*Float, MaxFloat	Align-TR-L
a. 45-**33**	*!	
b. [**55**]-**33**		*!
☞ c. 45-[**55**]		

We shall now turn to the third characteristic of Chengdu reduplication, that in AA, ABB, and AAB reduplication, when the base tone, which precedes the reduplicant, is 55, the floating high tone is not realized; instead, a **31** tone surfaces. This should be an OCP effect and could in principle be ruled out by *55-55, which prohibits adjacent 55 tones. Nonetheless, a sequence containing adjacent high level tones is actually legal in non-reduplicated forms (e.g. *suei*^{55}*.ko*^{55}*.tʰaŋ*^{31} 水果糖 'fruit drops'). As a matter of fact, the sequence is also tolerated in a reduplicated form as long as neither of the members in the sequence is a reduplicant (e.g. *səu*^{55}*.uan*^{55}*.uan*$^{\mathbf{31}}$ 手腕腕 'wrist'). In other words, 55.55 is impermissible only if one 55 comes from the floating tone. Thus, the OCP constraint should be modified as *55-[55], which would prohibit the 55.[55] sequence, but not the 55.55 sequence. The modified OCP constraint may seem ad hoc; however, it is actually equivalent to the [*55-55 & Dep-IO-A]$_{adj}$ constraint that conjoins the general *55-55 constraint and the Dep-IO-A constraint, which prohibits the addition of association lines, since realization of a floating tone in the output would induce the addition of a new association line and result in the violation of Dep-IO-A.[9]

[9] Alternatively, one of the reviewers suggested that *55-[55] may also be thought of as a new markedness constraint (i.e. $*_{N}$55-55) in the model of Comparative Markedness (McCarthy 2003), which only penalizes marked structure that is not present in the fully faithful candidate. Thus, $*_{N}$55-55 would only penalize 55.55 but not 55.[55], because only the former has one of the instances of 55, which is new in the sense that it is linked to a tone-bearing unit on the surface, but not underlyingly.

(28) *55-$\boxed{55}$: 55-$\boxed{55}$ sequence is prohibited.

(29) *55-$\boxed{55}$ prevents $\boxed{55}$ from occurring after 55

/55.55-RED, ㊺/	*55-$\boxed{55}$
☞ a. 55.55-**31**	
b. 55.55-$\boxed{\mathbf{55}}$	*!

*55-$\boxed{55}$ must dominate *FLOAT, MAXFLOAT to ensure that the floating tone will not be realized on a tone-bearing unit when the corresponding base tone preceding it is 55.

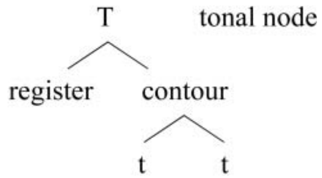
(30) ||*55-$\boxed{55}$ >> *FLOAT, MAXFLOAT|| predicts ㊺ will not be realized on a TBU after 55

/55-RED, ㊺/	*55-$\boxed{55}$	*FLOAT, MAXFLOAT
a. 55-$\boxed{\mathbf{55}}$	*!	
☞ b. 55-**31**		*

However, *55-$\boxed{55}$ cannot help predict why, when its corresponding base tone is 55, the reduplicant will surface as 31, but not the other possible tones in Chengdu, i.e. 13, 45, 11, 44, and 53.

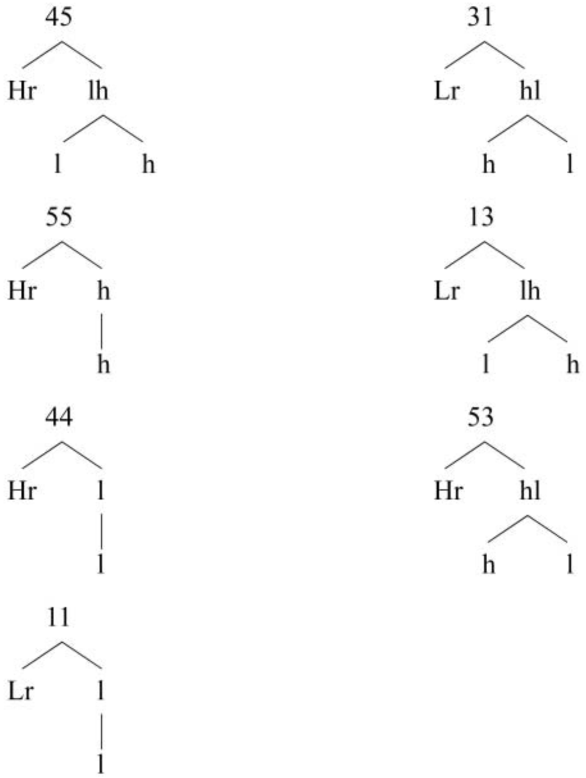
Following Bao (1999), this paper assumes that each tone should have an internal representation such as that in (31), in which tone segments are dominated by a node called Contour, which is a sister of the Register feature; both Contour and Register are dominated by a Tonal Node.

(31) Tonal geometry proposed in Bao (1999)



Therefore, in Chengdu, the tones, 45, 31, 55, 13, etc., belong to the tonal level. The high and low registers are represented as Hr and Lr, respectively. They belong to the register level. The tone segments are represented as h and l. The four lexical tones and the three derived tones in Chengdu are represented in (32).

(32) The internal structure of Chengdu tones



Therefore, the reason the reduplicant does not surface as 13 and 45 when preceded by 55 could be attributed to the rising contours in 13 and 45, which are universally marked and violate the *Rise constraint in (33). On the other hand, the fact that the reduplicant does not surface as 11 and 44 suggests that the reduplicant and the base preceding it (which carries 55) prefer to have different contours. This can be captured by the ¬BR-Con constraint in (34). Finally, the fact that the reduplicant does not surface as 53 suggests that the reduplicant and the base tend to have different registers. This is captured by the ¬BR-Reg constraint in (35). The prediction of 31 after 55 is illustrated in (36).

(33) *Rise: No rising contours.

(34) ¬BR-Con: The reduplicant and the base should have different contours.

(35) ¬BR-Reg: The reduplicant and the base should have different registers.

(36) *RISE, ¬BR-CON, and ¬BR-REG help predict 31 after 55

/55-RED, ⑮/	*RISE	*55-[55]	¬BR-CON	¬BR-REG
a. 55-**13**	*!			
b. 55-**45**	*!			
c. 55-**[55]**		*!		
d. 55-**11**			*!	
e. 55-**44**			*!	
f. 55-**53**				*!
☞ g. 55-**31**				

Notice that ¬BR-REG and ¬BR-CON are anti-faithfulness constraints holding between the reduplicant and the base, which might be strange at first glance since it is more natural for the reduplicant and the base to be identical. However, antifaithfulness between the reduplicant and the base is not unique to Chengdu. In some languages, there is a tendency to prevent total identity between the base and the reduplicant. Interested readers are referred to Kenstowicz (1986) and Yip (1995) for BR antifaithfulness in Javanese habitual repetitive reduplication, and to Hicks Kennard (2004:321) for BR antifaithfulness in Tawala durative reduplication.

¬BR-REG and ¬BR-CON must be outranked by *FLOAT and MAXFLOAT to ensure that when the base tone is not 55 (i.e. when *55-[55] is not violated), the reduplicant will surface with the floating tone even if it will cause the reduplicant and the base to have the same registers or contours, as illustrated in (37).

(37) ||*FLOAT, MAXFLOAT >> ¬BR-REG, ¬BR-CON|| ensures the realization of ⑮ when the base tone is not 55

/45-RED, ⑮/	*RISE	*55-[55]	*FLOAT, MAXFLOAT	¬BR-CON	¬BR-REG
a. 45-**13**	**!		*	*	
b. 45-**45**	**!		*	*	*
c. 45-**11**	*		*!		
d. 45-**44**	*		*!		*
e. 45-**53**	*		*!		*
f. 45-**31**	*		*!		
☞ g. 45-**[55]**	*				*

The 55-[55] sequence is not prohibited in AABB reduplication. In the pattern, the left tone of the reduplicant always surfaces as <u>55</u> regardless of whether its corresponding base tone is 13, 31, 45, or 55. Recall that reduplicants of AABB roots are stem-external, while those of the other roots are stem-internal; therefore, the fact that the 55-[55] sequence is tolerated in AABB but not in the rest of the patterns shows that the OCP constraint should be sensitive to morpheme boundaries as well. In particular, it should be sensitive to a stem-internal boundary but not a stem-external boundary. Therefore, the OCP constraint is modified as shown in (38).

(38) *55+[55]: The 55-[55] sequence cannot occur stem-internally.

As illustrated in (39) and (40), while the constraint correctly forbids the 55-55 sequence to occur in AA, ABB, and AAB reduplication whose reduplicant is stem-internal, it allows the sequence to occur freely in AABB reduplication because the reduplicant of AABB reduplication is stem-external.

(39) ||*55+[55] >> *Float, MaxFloat|| predicts that [55] does not occur after 55 when the RED is stem-internal

AA reduplication

/55+RED, (55)/	*55+[55]	*Float, MaxFloat
☞ a. 55+<u>**31**</u>		*
b. 55+**[55]**	*!	

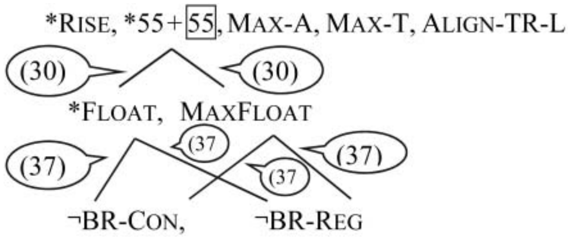
(40) ||*55+[55] >> *Float, MaxFloat|| predictsthat [55] can occur after 55 when the RED is stem-external

AABB reduplication

/55.31-RED, (55)/	*55+[55]	*Float, MaxFloat
a. 55#<u>**31**.31</u>#31		*!
☞ b. 55#<u>**[55]**.31</u>#31		

The final constraint rankings for the four reduplication patterns are summarized in (41):

(41)



3.2.2 An Optimality Theoretic analysis of general tone sandhi

This section proposes an OT analysis for general tone sandhi. Recall that Chengdu has four lexical tones, 45, 31, 55, and 13, and among those, 45 and 13 undergo tone sandhi in the non-initial position while 55 undergoes tone sandhi phrase in the final position. This section starts by analyzing the pairings of the underlying tones and their corresponding sandhi tones; that is, 45~**44**, 55~**53** and 13~**11**, which are summarized in more detail in (42).

(42)

Tonal change	Allotone pairing
45 [Hr, lh] → 44 [Hr, l]/ T __ 55 [Hr, h] → 53 [Hr, hl]/ __] 13 [Lr, lh] → 11 [Lr, l]/ T __	45 [Hr, lh] ~ **44** [Hr, l] 55 [Hr, h] ~ **53** [Hr, hl] 13 [Lr, lh] ~ **11** [Lr, l]

Certain properties can be observed from (42). First, in all of the allotone pairings, allotones always share the same register; in addition, the left tone segment in the input is always faithfully preserved in the output. This suggests that IDENT-IO-REG (43) and IDENT-IO-L-t (44) must be dominant in the language.

(43) IDENT-IO-REG: The register of an input tone must be preserved in the output.

(44) IDENT-IO-L-t: The left tone segments of an input must be preserved in the output.

Second, the changes of 45 to **44** and 13 to **11** in the non-initial position involve an unmarked process of rising tone leveling and can already be accounted for by *RISE proposed above in (33). Since the changes do not occur when 45 and 13 are at the initial/left edge, *RISE must be dominated by some positional faithfulness constraint that targets the left edge. A constraint like IDENT-IO-T-L that forbids any change of tone at the left edge would be too powerful since 55 can change to **53** at the left edge when it occurs in isolation. A careful examination of the tonal alternations shows that at the left edge, while the unattested change of 45 → **44** and 13 → **11** would result in tone segment deletion, the change of 55 → **53** does not. This suggests that MAX-IO-t-L (45), which prohibits a tone standing at the left edge from deleting its tone segment, must be playing an important role. As illustrated next, the domination of MAX-IO-t-L over *RISE can correctly predict the 45~**44** and 13~**11** alternations (see (46) & (47)) and does not rule out the change of 55 to **53** in isolation (see (48)). Nonetheless, though MAX-IO-t-L does not rule out the 55→ **53** alternation in isolation, it cannot rule out the faithful output 55 as well (see (48)); therefore, the change of 55 to **53** requires further explanation as it not only involves change but also changes from a level tone to a more marked falling tone.

(45) MAX-IO-t-L: At the left edge, deletion of tone segments is prohibited.

(46) ||MAX-IO-t-L >> *RISE|| predicts rising tone occurs in isolation

/45/	MAX-IO-t-L	*RISE
a. **44**	*!	
☞ b. 45		*

(47) ||Max-IO-t-L >> *Rise|| predicts rising tone occurs in non-initial position

/45.45/	Max-IO-t-L	*Rise
a. **44**.45	*!	*
b. **44**.**44**	*!	
c. 45.45		**!
☞ d. 45.**44**		*

(48) Max-IO-t-L does not rule out the 55→ **53** alternation nor the faithful output 55 in isolation

/55/	Max-IO-t-L
a. 55	
b. **53**	

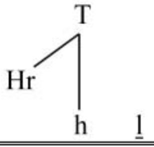
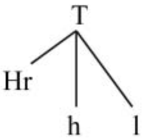
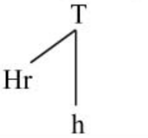
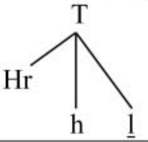
To explain the 55~**53** alternation in which **53** occurs in the utterance's final position while 55 occurs elsewhere, the present paper follows Chen's (2000:204) analysis of the northern Wu dialect of New Chongming, which exhibits similar tonal alternation. In New Chongming, a high level tone H surfaces as a high falling tone HM in the final position (e.g. /H.H/ → [H.**HM**] 'water melon'). Chen (2000:204) explains the alternation by arguing that there is a boundary low tone at final position and considers the word's final high falling tone as the result of a high level tone incorporating the boundary low tone at the phrase's final position. The Boundary Low constraint is proposed in Chen to guarantee the parsing of the boundary low tones at the surface.

(49) Boundary Low: Parse boundary L̲. (Chen 2000:204)

The present paper also attributes the occurrence of **53** in the phrase's final position to the presence of a final boundary low tone, as illustrated in (50). The assumption of the boundary low tone, together with the Boundary Low constraint, predict a high falling **53** tonal output for an input high level tone 55 at phrase final position.[10] To emphasize the realization of **53** for 55 as the result of boundary low tone association rather than tone segment insertion, Dep-IO-t is assumed to play a dominant role in the language, as shown in (50). (The boundary low tone is represented as 1̲ in the tableaux.)

[10] Notice that incorporation of the boundary low tone results in 53 rather than 51, suggesting that tautosyllabic tone segments must not disagree in register in Chengdu (see Chen 2000).

(50) Dep-IO-t and Boundary Low predict [**53**] for an input /55/ at phrase final position

/55/ [Hr, h], $\underline{l}$ 	Dep-IO-t	BoundaryL
a. **53** [Hr, hl] 	*!	*
b. 55 [Hr, h] 		*!
☞ c. **53** [Hr, h$\underline{l}$] 		

While Boundary Low plays the key role in predicting the 55~**53** alternation, it is worth investigating what role it plays in the alternation/non-alternation of the rest of the tones in Chengdu. For 31 (Lr, hl), as it always ends with a low tone segment at the phrase's final position, it also satisfies the constraint vacuously. On the other hand, 45 and 13 do not always surface with a low tone segment at the phrase's final position. When preceded by another tone, 45 and 13 end with a low tone segment (i.e. 44[Hr, l], 11[Lr, l]) in the phrase's final position. Nonetheless, when in isolation, they surface as 45[Hr, lh] and 13[Lr, lh], violating Boundary Low.

When 45 and 13 are in isolation, the association between them and the boundary low tone could result in complex contour tones, i.e. 454[Hr, lh$\underline{l}$] and 131[Lr, lh$\underline{l}$], if input tone segments are fully preserved, or result in level tones, i.e. 44[Hr, l$\underline{l}$] and 11[Lr, l$\underline{l}$], if the right input tone segment is deleted. The former situation violates the markedness constraint, *ComCon, which prohibits complex contours, while the latter violates Max-IO-t, which prohibits deletion of tone segments. Therefore, the domination of *ComCon and Max-IO-t over Boundary Low helps to ensure the realization of 45 and 13 when they are pronounced in isolation.

(51) *ComCon: No complex contour tones.

(52) Max-IO-t: deletion of tone segments is prohibited.

(53) ||*ComCon, Max-IO-t >> BoundaryL|| predicts 45 and 13 in isolation

/45/ [Hr, lh], l	*ComCon	Max-IO-t	BoundaryL
a. **454** [Hr, lhl]	*!		
b. **44** [Hr, 1]		*!	
☞ c. 45 [Hr, lh]			*

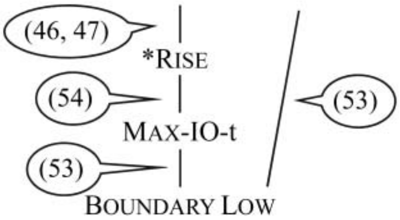
To predict the change of 45 and 13 to **44** and **11** in the post-tonal/non-initial position, *Rise, which triggers the alternation, must rank above Max-IO-t, which forbids the change.

(54) ||*Rise >> Max-IO-t|| predicts 45 → **44** and 13→ **11** in the post-tonal/non-initial position

/31.45/	*Rise	Max-IO-t
a. 31.45	*!	
☞ b. 31.**44**		*

The final constraint ranking for general tone sandhi is given in (55).

(55) Dep-IO-t, Max-IO-t-L,*ComCon, Ident-IO-L-t, Ident-IO-Reg



Now we should see how these constraints account for general tone sandhi in AAB, ABB, and AABB. In $A_1\underline{A}_2B$ reduplication, A_1 never changes, while B undergoes general tone sandhi. In $AB_1\underline{B}_2$ reduplication, A never changes, while B_1 undergoes general tone sandhi. Tableaux (56) and (57) illustrate that the lack of tone sandhi at the left edge (A_1 and A) is predicted by the top-ranked faithfulness constraints, in particular Dep-IO-t and Max-IO-t-L (see (56a/b) and (57a/b)), while tone sandhi in B and B_1 is predicted by *Rise (when B and B_1 correspond to /45/ and /13/ in the input; see (57c/d)) or by Boundary Low (when B corresponds to /55/ in the input; see (56c/d)).[11] (Irrelevant tones are substituted by X in the tableaux that follow.)

[11] Notice that B_1 in AB_1B_2 reduplication that corresponds to underlying /55/ does not undergo tone sandhi since 55 only undergoes tone sandhi in the phrase's final position.

(56) A-A-B

/13+RED+55/	Max-IO-t-L	Dep-IO-t	*Rise	BoundaryL
a. **11**-X-**53**	*!			
b. **131**-X-**53**		*!		
c. 13-X-55			*	*!
☞ d. 13-X-53			*	

(57) AB-B

/31.45+RED/	Max-IO-t-L	Dep-IO-t	*Rise	BoundaryL
a. **11.53**-X	*!			
b. **313.53**-X		*!		
c. 31.45-X			*!	
☞ d. 31.**44**-X				

For $A_1A_2B_1B_2$ reduplication, A_1 never changes, while B_1 and B_2 follow general tone sandhi. The lack of tone sandhi in A_1 is also predicted by the top-ranked faithfulness constraints. For B_1 and B_2, they are in BR correspondence and are governed by Ident-BR. Nonetheless, they are not always identical. BR identity is not achieved when B_2 corresponds to an input /55/ tone; in that case, B_1 is faithful to the input tone while B_2 will undergo tone sandhi due to Boundary Low (e.g. *tsʰaŋ*31.*tsʰaŋ***55**. *tu*55.*tu***53**<55 腸腸肚肚 'internal organs'). The realization of 55 in B_1 needs to resort to Ident-IR since B_1 is a reduplicant. As illustrated in (58), Ident-BR needs to be dominated by Ident-IR and Boundary Low to predict the realization of 55 in B_1 and **53** in B_2.

(58) In AAB_1B_2, ||Ident-IR, BoundaryL >> Ident-BR|| predicts 55 in B_1 and **53** in B_2
A-AB-B

/X.55#RED/	Ident-IR	BoundaryL	Ident-BR
a. X-X.**53**-**53**	*!		
b. X-X.55-55		*!	
☞ c. X-X.55-**53**			*

Ident-IR, on the other hand, needs to be outranked by *Rise since B_1 does not surface as rising contours when B_2 corresponds to /45/ and /13/ in the input, as illustrated in (59).

(59) ||*Rise >> Ident-IR|| predicts B_1 is not rising when B_2 corresponds to /45/ and /13/
*Rise >> Ident-IR
/X.13#RED/
X-X.**11**-**11** > X-X.13-**11**

In addition, IDENT-IR needs to be outranked by *FLOAT and MAXFLOAT proposed for special tone sandhi to ensure realization of the floating tone even if it will result in the non-identity between the input and reduplicant, as illustrated in (60).

(60) ||*FLOAT, MAXFLOAT>> IDENT-IR|| predicts ⑮ is realized at the cost of IR non-identity
AB-B

/13.31 + RED, ⑮/	*FLOAT, MAXFLOAT	IDENT-IR
a. 13.31-31	*!	
☞ b. 13.31-**55**		*

In addition to dominating IDENT-IR, *FLOAT and MAXFLOAT need to outrank BOUNDARY LOW. This is to predict realization of the floating tone in the reduplicant in ABB reduplication, which appears in the phrase's final position, as illustrated in (61).

(61) ||*FLOAT, MAXFLOAT >> BOUNDARYL|| predicts that ⑮ is realized at the cost of not ending with a boundary L
AB-B

/31.31 + RED, ⑮/	*FLOAT, MAXFLOAT	BOUNDARYL
a. 31-31.-**31**	*!	
☞ b. 31-31-**55**		*

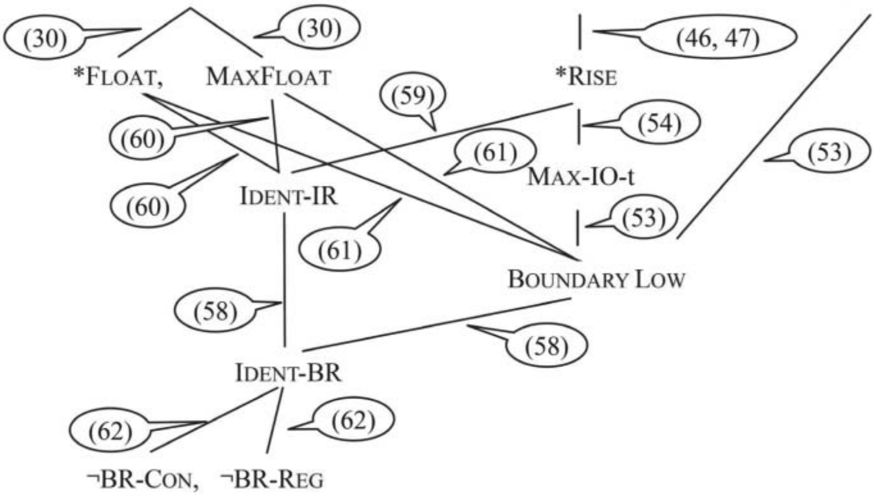
Finally, IDENT-BR must dominate ¬BR-REG and ¬BR-CON proposed for special tone sandhi to guarantee the correct correspondence in B_1 and B_2 since B_1 and B_2 always agree in register and almost always agree in contour, as illustrated in (62).

(62) ||IDENT-BR >> ¬BR-REG, ¬BR-CON|| predicts the correspondence of B_1 and B_2 in AAB$_1$B$_2$ A-AB-B

/X.13 #RED, ⑮/	IDENT-BR	¬BR-CON	¬BR-REG
a. X-**X.53.-11**	*!		
b. X-**X.31.-11**	*!		*
☞ c. X-**X.11.-11**		*	*

The final constraint rankings for the four reduplication patterns are summarized below:

(63) Max-A, Max-T,*55+[55], Align-TR-L   Dep-IO-t, Max-IO-t-L, Ident-IO-L-t, *ComCon, Ident-IO-Reg



4. Conclusion

This paper examines reduplication in Chengdu and proposes an OT analysis to account for the reduplicant size, the reduplicant placement, and tone sandhi in Chengdu reduplication. For the reduplicant size, the paper assumes that while the reduplicant in AA, AAB, and ABB is monosyllabic, that in AABB is disyllabic. The differences in the reduplicant size are accounted for by assuming the reduplicant of AA, AAB, and ABB to be stem-internal and that in AABB to be stem-external, which are governed by different alignment constraints that contribute to the different reduplicant sizes. For reduplicant placements, reduplicants in the patterns of AA, AAB, and ABB reduplication are clearly suffixal. As for AABB reduplication, although the reduplicant appears to be an infix, it is considered as a suffix whose movement into the base is considered as being triggered by a linearity constraint that requires the input segmental sequence to be preserved in the output. Finally, for tone sandhi, the tonal alternations in reduplication are different from general tone sandhi and this difference is shown to be the effect of general tone sandhi plus a floating high tone. General tone sandhi is shown to be mainly triggered by *Rise and Boundary Low, while the floating high tone, which is usually realized on the left edge of the reduplicant, is mainly captured by the interaction between MaxFloat, *Float, and Align-TR-L.

Appendix: The minor patterns of reduplication in Chengdu

In addition to the four common patterns of reduplication, Chengdu has three other patterns that are less productive. They are ABAB reduplication, ABAC reduplication, and ABCB reduplication, as illustrated in (1).

(1) a. ABAB reduplication

i.	45.**11**$^{<13}$.45.**11**$^{<13}$	*p^{h}in ts^{h}eu p^{h}in ts^{h}eu* 拼湊拼湊 'to assemble a bit'
ii.	55.**11**$^{<13}$.55.**11**$^{<13}$	*suei nən suei nən* 水嫩水嫩 'to be somewhat soft'
iii.	55.55.55.**53**$^{<55}$	*tsɨ tiɛn tsɨ tiɛn* 指點指點 'to give some directions'

b. ABAC reduplication

i.	55.**11**$^{<13}$.55.31	*ta tɕin ta ts^{h}u* 打進打出 'to keep going in and out'
ii.	13.**11**$^{<13}$.13.**11**$^{<13}$	*t^{h}iau saŋ t^{h}iau ɕia* 跳上跳下 'to keep jumping up and down'
iii.	55.31.55.**53**$^{<55}$	*tɕi mi tɕi iɛn* 擠眉擠眼 'to keep winking'

c. ABCB reduplication

i.	13.**11**$^{<13}$.13.**11**$^{<13}$	*saŋ k^{h}an ɕia k^{h}an* 上看下看 'to keep looking up and down'
ii.	55.55.13.**53**$^{<55}$	*tso ɕyan iəu ɕyan* 左選右選 'to keep shopping around'
iii.	31.**11**$^{<13}$.55.**11**$^{<13}$	*xəu t^{h}iau u t^{h}iau* 猴跳武跳 'to keep jumping about'

One thing of interest is that in the reduplication patterns of ABAC and ABCB, it is often the main verb that is doubled, as pointed out by one of the reviewers.

In terms of tone sandhi, unlike in the four common patterns of reduplication, tonal alternations observed in these reduplication patterns are no different from non-reduplicative tone sandhi. In all three of the patterns, which are all quadrisyllabic, though the third tone never undergoes change, the two-tone pair on the left and that on the right are targeted for general tone sandhi. This suggests that the first two and the last two tones must have formed separate tone sandhi groups. Consider *p^{h}in ts^{h}eu p^{h}in ts^{h}eu* 拼湊拼湊 'to assemble a bit' /45.13.45.13/. The resulting tonal output, 45.**11**.45.**11**, is derived by operating general tone sandhi in the domain (σσ)‖(σσ).

(2) *p^{h}in ts^{h}eu p^{h}in ts^{h}eu* 拼湊拼湊 'to assemble a bit'

p^{h}in ts^{h}eu p^{h}in ts^{h}eu

(σ σ) ‖ (σ σ)

<u>45. 13</u>. <u>45. 13</u>	Input
| |	General TS rule (2c)
45. **11**.45. **11**	Output

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成都話的重疊詞變調：優選理論的分析

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本文以優選理論 (Optimality Theory) 探討成都話中涉及特殊變調的四種重疊型式（包含 AA 型式、AAB 型式、ABB 型式、以及 AABB 型式），並針對其重疊部分 (reduplicant) 之大小、位置、以及重疊型式之連讀變調現象提出分析。本文指出，重疊部分的大小差異主要是受到不同對整 (alignment constraint) 制約的影響；而重疊部分的位置基本上出現在詞基之後，AABB 型式的例外情形乃是受到要求維持輸入音段先後次序的線性制約 (linearity constraint) 所影響。最後，在特殊變調方面，本文指出，這四類重疊型式之變調現象看似不同，卻都內含一個浮游聲調 (floating tone)，且該聲調均出現在重疊部分之左側，造成特殊的變調現象。

關鍵詞：成都話，重疊詞，特殊變調，浮游聲調，優選理論