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On the Rhythmic Vowel Deletion in Maga Rukai*

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Kager (1997, 1999) successfully interprets vowel deletion as fewer violations of Parse-Syllable and thus removes the metrical opacity in Optimality Theory. But the configurational Markedness constraints on phonotactics and Ft-Form in Kager's analyses fail to predict which vowel should be the target of deletion in Maga. This paper thus, following Itô and Mester (1999), proposes alignment constraints of vowels and consonants at the two edges of a foot, concluding that the ranking of Markedness constraints (mostly *Super-Complex or consonant clusters are limited to two) >> Parse-Syllable >> Alignment constraints (mostly Align-Vowel-Right-Ft) >> Faithfulness constraints can explicitly capture the three properties of vowel deletion in Maga, namely (1) vowel deletion is rhythmic, (2) odd-numbered-syllabled vowels rather than even-numbered-syllabled vowels counted from the word-initial position get deleted, and (3) non-phonemic final vowel lengthening is exclusive for disyllabic words.

Key words: alignment constraint, vowel deletion, Maga Rukai, Optimality Theory

1. Introduction

As Kager (1997, 1999) points out, rhythmic vowel deletion is a phenomenon that targets vowels of weak positions in iterative feet. By further classification, Kager argues that there are two types of rhythmic vowel deletion. One type is gradient, and the other categorical. While the former refers to deletion whose phonological context is recoverable from the output by either phonetic cues or secondary stresses, as in Macushi Carib, the latter refers to deletion whose syllabicity of the deleted vowel is completely destroyed and whose secondary stresses that coincide with the rhythmic vowel deletion patterns are not available, as in Southeastern Tepehuan. Since the specific metrical context of the latter case is only momentarily available during intermediate levels and is destroyed after vowel deletion and resyllabification on the surface, this opacity poses a challenge to the output-oriented Optimality Theory (henceforth OT). Instead of accounting for rhythmic vowel deletion with metrical conditions, Kager, however, explains such a phenomenon by minimal violations of Parse-Syllable and thus successfully removes the opacity problem by making the analysis fully surface-based.

Despite the fact that Parse-Syllable dispels the (potential) metrical opacity in OT, it is, however, doubtful if Parse-Syllable alone can completely settle all the problems related to metrical feet. In Kager's analyses, it is due to the conspiracy of Ft-Form,

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Parse-Syllable and other markedness constraints on phonotactics that the deletion patterns in Southeastern Tepehuan are properly explained. However, as will be argued in this paper, in a language where there are fewer restrictions on both Ft-Form and on phonotactics, such as Maga, the interaction of those Markedness constraints and Parse-Syllable is insufficient in deciding the correct winning candidate. Instead, Alignment constraints, mostly Align-Vowel-Right-Foot, are the crucial constraints that constrain the rhythmic vowel deletion patterns. Conceptually, Parse-Syllable explains vowel deletion and Markedness constraints on phonotactics govern the rhythmicity of deletion, while Alignment constraints on vowels target the positions of deletion. The interaction of these three constraint sets, namely Markedness constraints, Parse-Syllable and Alignment constraints on vowels, then can explicitly capture the essence of rhythmic vowel deletion cross-linguistically.

Empirical evidence is thus necessary to support such a claim. Since vowel deletion patterns in Maga have never been well presented in the literature, in addition to arguing for the necessity of building up a new constraint model in OT, a thorough study of the data prior to the theoretical argumentations is indispensable. This paper is thus organized as follows. §2 offers background information on Maga and §3 presents a more detailed discussion on the data, followed by an OT analysis in §4. §5 discusses some “exceptional” cases, followed by the comparison of alternatives and some theoretical discussion in §6. In the last section, we conclude that the ranking of Markedness constraints >> Parse-Syllable >> Alignment constraints >> Faithfulness constraints can explicitly capture the following three properties of vowel deletion in Maga, namely (1) vowel deletion is rhythmic, (2) odd-numbered-syllabled vowels rather than even-numbered-syllabled vowels counted from the word-initial position get deleted, and (3) non-phonemic final vowel lengthening is exclusive for disyllabic words.

2. Background on Maga

Maga is one of the six dialects of Rukai (The other five are Tanan, Budai, Tona, Labuan and Mantauran) (Li 1977a). The village name Maga was used before and during the Japanese occupation of Taiwan. It is now called Maolin. To follow the convention and to avoid confusion, however, in this paper the term Maga Rukai, (or simply Maga) will be used to refer to the dialect and Maolin will be used to refer to the village.

There are seven vowels in Maga Rukai, namely /i, e, u, o, ɨ, ə, a/. Despite the fact that there are long vowels on the surface, as in *cme:*[1] ‘bear’ (cf. *comay* ‘bear’ in Proto

[1] The original descriptions in both Li (1977a) and Hsin (2000) for long vowels are in fact VV, rather

Rukai), it will be argued that the word-final-only long vowels are in fact due to the Alignment constraint of vowels on prosodic units and are thus not phonemic. Regarding consonants, there are at least sixteen consonants[2], namely /p/, /t/, /k/, /b/, /d/, /ɖ/ (retroflex stop), /g/, /m/, /n/, /ŋ/, /c/, /v/, /θ/, /s/, /l/ and /r/ (cf. Li 1977a, Li and Saillard 1997, and Hsin 2000). Last but not least, different from the glide-loss report by Li (1977a) and Li and Saillard (1997), in this paper we agree with Hsin (2000) that there are semivowels /y/ and /w/ in Maga on the surface, as in *olyá:* 'sinicized tribes' (cf. *oliá* by Li 1977a), despite the fact that it is unknown whether there are underlying semivowels.[3]

Stress is not phonemic in Maga; it predictably falls on the penultimate syllable[4] and there is no secondary stress, as in *krára* 'anteater' and *tbalŋáni* 'arm'.

Syllable structure of Maga is phonologically significant. CV is the typical syllable structure in Rukai, except for Maga; Maga is the only language that allows consonant clusters among modern Rukai dialects (Li 1977a). Empirically, the distribution of word-internal consonant clusters and that of word-initial consonant clusters are not symmetric such that some clusters only appear word-internally but never word-initially. According to the Maximal Onset Principle (Clements 1990), we thus agree with Hsin (2000) that the maximal syllable structure in Maga is CCVC.

A more intriguing issue is why and how Maga uniquely has consonant clusters and

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than V:. But to be clearer in the presentation of long vowels, we consistently change all their descriptions to V: in our paper.

2 The reason for "at least sixteen" is the undecided statuses of /ð/, /z/ and /ʔ/. Compatible with previous studies (Li 1977a, Li and Saillard 1997 and Hsin 2000), we find that /ð/ and /z/ occur very rarely, mostly in loan words, as in *kvaðnɨ* 'a type of bamboo', *vnəəðə* 'plum', *kzuku* 'thousand' and *mkatnozono* 'a kind of mushroom' (cf. *makatonozono* 'a kind of mushroom' by Li 1977a)). Besides, according to Tsuchida (1970), glottal stop occurs in one word (and its derivation): *ʔiu* 'goat' and *saŋiʔiu* 'smell of goat'. Li (1977a) and Hsin (2000) however doubt Tsuchida's report, in view of the very single occurrence of the glottal stop in *ʔiu* 'goat'. In addition, this particular form has no cognates in other dialects, and Li (1977a) and Hsin (2000) have indicated that in their own collections of data, no glottal stop was observed. The dilemma is that these three consonants are empirically available, but their distribution is very limited and restricted. We therefore hesitate in indicating the exact number of Maga consonants. Notice that, however, these three consonants will not make any difference in our analysis; none of them will occur in our data.

3 We believe that the underlying form of *olya:* 'sinicized tribes' is *olia:* The high vowel in vowel sequences undergoes devocalization; there are therefore semivowels on the surface in Maga. For details on devocalization, see (20) in §4.2.

4 Stress might in fact be more complicated than this short statement would indicate. Li (1975b) briefly mentions that in some rare cases, stress might fall on the antepenult, as in *krulúəŋɨ* 'sparrow', *lóəŋɨ* 'horn' and *cíua* 'bamboo shoot' (cf. *cíwa* by the author). In the author's own collection, there are some additional examples that display irregular stress assignment, as in *uθíəbɨ* 'hew' and búəte 'flesh' (cf. *uθiə́bɨ* 'hew' and *buə́te* 'flesh' in Maga and *uθiabə* and *boate* in Proto Rukai, Li 1977a.). This rare irregularity seems to happen only when the vowel on the penult is a schwa, but it is not true that this irregularity applies to all data with a schwa on the penult, as in *u-sə́pi* 'sweet'. The issue why a schwa on the penult cannot be a stress bearer in some cases might be worth further investigation, but this is not relevant to the topic in this paper and thus should be ignored. Unless specified, stress of all the data in this paper still consistently falls on the penultimate syllable.

consequently a much bigger syllable (compared with other Rukai dialects). By historical reconstruction through dialectal comparisons, it is evident that this innovation in Maga results from the loss of vowels, as in *krara* 'anteater', (cf. *k**a**rara* in Tona and in Proto Rukai), and *blɨblɨ* 'banana', (cf. *b**ə**ləb**ə**lə* in Tona and in Proto Rukai) (Li 1977a).

Previous studies explain this vowel deletion phenomenon by stress, as in Li (1977b) or by metrical theory, as in Hsin (2000, 2003). While Hsin (2000) points out that Li's analysis results in contradiction in stress assignment, this paper will argue that Hsin's analysis involves redundancy and misses the generalization. Before we further discuss the theoretical advantages in our analysis, a thorough look at the data and detailed presentation of previous analyses are necessary.

3. Rhythmic vowel deletion

3.1 Literature review

The study of Rukai can be traced back to Ogawa and Asai (1935), whose major contribution is to document long texts of Rukai cross-dialectally. Additional cross-dialectal studies include Li (1977a) (Mantauran, Tona, Maga, Budai, Tanan, with the sixth dialect, Labuan, in the postscript) and Zeitoun (1995) (Mantauran, Tona, Maga, Budai and Labuan), while dialect specific studies include Li (1973, 1975a) (Tanan), Shelley (1979) and Zeitoun (2000a) (Budai), Zeitoun (1997a, 1997b, 1997c, 2000b) (Mantauran), Li (1997a) (Tona), Li (1975b), Saillard (1995), Li and Saillard (1997) and Hsin (2000, 2003) (Maga), among others.

Among the large number of studies, Li (1975b) and Li (1977a) should be considered salient to Maga phonology, the reason being that Li (1975b) initiates the phonological study of Maga, and Li (1977b), by historical reconstruction through dialectal comparisons, presents the internal relationship of Rukai dialects and singles out the phonological significance of Maga such that Maga is the only dialect with complex consonant clusters. Saillard (1995) focuses on syntax whereas the phonological part in Li and Saillard (1997) is a more general study. Hsin (2000) offers a wide-ranging investigation into Maga phonology, from the basic phonological inventory to complicated morphophonemic alternations, followed by Hsin (2003) with a further discussion of the mid vowel issue.

Despite all those prominent contributions, in the literature, however, there has never been any empirical report specifically on vowel deletion in Maga, which is in fact a widely exercised strategy among Maga speakers. Li (1975b) briefly mentions the empirical data of deletion, followed by a rule-based analysis in Li (1977b). Hsin

(2000) deals with more vowel deletion, but Hsin (2000) fails to cover the various patterns of vowel deletion in Maga. Likewise, Li (1977a) offers rich data that reveal the productivity of vowel deletion in Maga; those data are nevertheless arranged in alphabetical order, not according to patterns of vowel deletion. In view of this, we thus reorganize the data in the literature (with the author's own field notes) and classify them according to their patterns of vowel deletion. Reorganizing the Maga data, offering a complete picture of the rhythmic vowel deletion phenomenon, and generalizing the pattern should then be considered significant. Therefore, a thorough look at the reorganized data prior to the detailed presentation of previous analyses is required.

3.2 Collection of language data

By mainly consulting the word lists by Li (1975b), Li (1977a), Li (1997b), and Hsin (2000), we collected all the Maga data and Tona data in this paper during our own field trip in Maolin in the year 2005. Every difference between literature reports and the author's own records will be specified.

There are two informants. One is Mu, Chun-Mei, female, born in 1943, who moved from Tona to Maga at the age of 17 after marriage. Her major contribution is cross-dialectal contrast between Maga and Tona. The other is Wei Ding-Shang, male, born in 1940, who, except for several years for education, seldom leaves Maolin. Unless specified, Wei contributes the major crucial data of Maga in this paper.

3.3 The data

There will be two types of data. One is data on vowel deletion and the other is data on devocalization. Regarding the data of vowel deletion, it will be further classified into two types: one that undergoes rhythmic vowel deletion and the other remains immune from vowel deletion. Although devocalization does not seem to be related to the issue of rhythmic vowel deletion prima facie, it will be argued that the phenomenon of devocalization is in fact a relevant issue such that it can be properly explained by the same constraint set for rhythmic vowel deletion.

To make the pattern clear, our presentation of data will be classified by syllable numbers. Notice that differences in syllable numbers do not play a role in our analysis. Also notice that counting of syllable numbers is based on Proto Rukai (or simply PR henceforth), instead of on Maga Rukai. Besides, focus of this paper is to investigate which vowel is deleted, rather than to investigate what phonological changes happened historically. Differences in phonetic correspondences between either Maga and Proto Rukai, as in *tbɨθɨ* ‘belt’ (Maga) and *təbəθə* ‘belt’ (Proto Rukai[5]), or between Maga and Tona, as in *ɨsɨbɨ* ‘juice’ (Maga) and *ʔəsəbə* ‘juice’ (Tona), thus should be ignored.

Furthermore, as Kager (1997) mentions, rhythmic vowel deletion may actually produce vowel-zero alternations in stems, due to prefixation, which affects the odd-even count. That is, when the stem is affixed, the phonological environment changes; the vowels on odd-numbered syllables of the stem are now on even-numbered syllables and vowels on even-numbered syllables now on odd-numbered syllables; those deleted vowels thus reappear, as in the negation form of (1a). By adding the ghost vowels induced by morphology back to the stem, the “full form” of the stem is reconstructed. (And by the same method, we get the input form for our OT analysis). The reconstructed CV syllable structure in Maga is identical to the correspondent form in Proto Rukai and Tona.[6] Notice that, however, although we provide data of Maga negation forms to exemplify the fact that targets of the deleted vowels do vary by their prosodic position and ghost vowels do reappear when their phonological environments change, in order to reduce the (potential) intervening factors from morphology, we do not intend to include polymorphemic words in this paper. Hsin (2000) mentions that the final vowel of the stem is uniformly lengthened in negation. Since the lengthening is uniform, it should be considered morphologically driven rather than phonologically conditioned. The problem is that Maga morphology (or Maga morphophonemic alternations) is so far not fully understood; a clear example of the interaction between morphology and phonology, like the observation in Hsin (2000), is not always available. We are therefore not always sure why and how some specific morphological affix gets itself involved in vowel deletion (or not), and whether a certain situation is morphologically driven or phonologically conditioned. Since vowel deletion, if entangled with morphological processes, could be a different story from that of monomorphemic words, in order to reduce the risk of being misled by morphology and in order not to complicate the issue, polymorphemic data were excluded from this paper. Likewise, although we provide data with both diachronic contrast (Maga and PR) and synchronic contrast (bare stems and negation forms), we do not intend to discuss the diachronic changes. All the discussions in this paper focus on synchronic patterns. Now consider the following data in (1) to (3).

5 All the PR data in this paper are directly adopted from Li (1977a).

6 Ignore the phonological differences in segments between Maga, Tona and Proto Rukai.

(1) Data on rhythmic vowel deletion

	Maga	Negation	Full-form	Tona	Proto Rukai	gloss
a.	vlo:	i-k-valo:[7]	v**a**lo	valo	valo	'bee/honey'
b.	mca:	i-k-maca:	m**a**ca	maca	maca	'eye'
c.	u-kla:[8]	i-k-kəla:	k**ə**la	wa-kəla	kəla	'arrive'
d.	kpiŋi	i-kipŋi:	k**i**piŋi	kopiŋi	kipiŋi	'clothing'
e.	tbɨθɨ	i-k-tibθɨ:	t**i**biθi	təbəθə	təbəθə	'belt'
f.	vŋatɨ	i-k-vaŋtɨ:	v**a**ŋatɨ	vaŋatə	baŋatə	'nine'
g.	blɨblɨ	i-k-bɨlbɨlɨ:	b**ɨ**lɨb**ɨ**lɨ	bələbələ	bələbələ	'banana'
h.	trupŋu	i-k-tarpuŋu:	t**a**rup**u**ŋu	taopoŋo	taɭopoŋo	'hat'
i.	lpɨlpɨ	i-k-lɨplɨpɨ:	l**ɨ**pɨl**ɨ**pɨ	ləpələpə	ləpələpə	'beans'
j.	kladɽiŋɨ	i-kaldɽɨrŋɨ:	k**a**ladɽ**i**rɨŋɨ	kaladɽəəŋə	kaladɽərəŋə	'plant name'
k.	tbalŋanɨ[9]	i-k-tablaŋnɨ:	t**a**bal**a**ŋanɨ	tabalaŋaʔanə	tabalaŋaʔanə	'arm'
l.	ma-srɨgsɨgɨ	i-k- sargɨsgɨ:	s**a**rɨg**ɨ**sɨgɨ	ma-saəgəsəgə	-sarəgəsəgə	'numb'
m.	s-tuŋtuŋcu	i-k-sa-tŋutŋucu:	s**a**-tuŋ**u**tuŋ**u**cu	sa-toŋotoŋoo	sa-toŋotoŋoc/ɭo	'beak'[10]

The generalization of the distribution of the deleted vowels is that except for the word-final syllable, every vowel on odd-numbered syllables counted from the word-initial position will be deleted.

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7 cf. *i-k-valu:* by Hsin (2003).

8 Some forms, such as '*malməkə* 'rotten' (cf. *malaməkə* in PR and Tona), and *makɖuru* 'dirty' (cf. *makoɖoɭo* in PR and *makaɖoo* in Tona) seem to be peculiar in the sense that the first syllable is privileged from vowel deletion; this is nevertheless very misleading. If we assume that the *ma-* is in fact a morphological prefix, as is evidenced by their negation forms, namely, *i-k-lamkə:* 'not rotten', and i-*k-kuɖru:* 'not dirty' respectively, vowel deletion on these stems then patterns together with other monomorphemic data. Likewise, the *u-* in (1c) is in fact a verbal-prefix and should be separated from the stem. To reduce the interference from morphology, however, as mentioned, those polymorphemic data, thought presented, are seldom adopted as crucial data.

9 Notice that the proto form of *tbalŋanə* 'arm' is *t**a**bal**a**ŋ**aʔ**anə* (Li 1977a). But according to Li (1977a), /ʔ/ is fundamentally lost in the Maga inventory; /ʔ/ is therefore not included in the input form. The two neighboring vowels happen to be identical, (both are /a/). Since word internal vowel geminates are rare (Hsin 2000), we assume that the Maga input form is *t**a**bal**a**ŋanə*, a five-syllabled word.

10 Words longer than four syllables are barely available. The purpose of (1l) and (1m) is simply to illustrate the vowel deletion pattern in five-syllabled stems. Ignore why the *sa-* prefix in (1m) gets itself involved in vowel deletion while the *ma-*prefix in (1l) does not; as mentioned, morpheme specific issues should be excluded from this paper.

(2) Data of null application of vowel deletion rule

	Maga	Negation	Full-Form	Tona	PR	gloss
a.	θuθu	i-k-θuθu:	θuθu	θoθo	θoθo	‘breast’
b.	pago	i-k-pago:	pago	pago	pago	‘gall’
c.	aramə	i-k-armə:	aramə	aamə	aðamə	‘bird’
d.	obisi	i-k-obsi:	obisi	obisi	ubisi	‘hair, pubic’
e.	giŋigiŋi	i-k-giŋigiŋɨ:	giŋigiŋi	giŋigiŋ	giŋigiŋ	‘longan’
f.	s-pakɨpakɨ	i-k-sa-pakɨpakɨ:	s-pakɨpakɨ	pakəpakə	pakəpakə	‘wing’

Different from the data in (1), the data in (2) remain immune from vowel deletion. These data, including variants of disyllabic words, variants of pseudo reduplicated forms and blocking of vowel deletion on trisyllabic words without an onset word-initially (or simply a VCVCV word) have been poorly observed in the literature. They seem to be exceptional to the widely exercised vowel deletion strategy. We will have a more detailed discussion on these data in §5. An aggressive assumption regarding these “exceptions” or “irregularities” is that vowel deletion is the general tendency; those “irregular” words are “idiosyncratically starting to be affected by the constraints in the grammar” (Hui-chuan Jennifer Huang, p.c.).

(3) Data on devocalization

	Maga	surface form	gloss	Negation
a.	bia	[byá:]	‘plant name’	i-k-bya:
b.	iəla	[yə́la]	‘snow’	i-k-yəla:
c.	mumuələ	[mumwə́lə]	‘snail’	i-k-mumwələ:

Devocalization in Maga is first observed by Hsin (2000). After reconfirming Hsin’s report on devocalization, we agree with Hsin that there are glides on the surface in Maga (cf. Li 1977a and Li and Saillard 1997). The data of devocalization seem to be irrelevant to the topic of rhythmic vowel deletion. It will be argued in §4.2 that devocalization should not be treated as a separate issue from vowel deletion. Rather, devocalization serves as an example of consequences of Parse-Syllable and Max-IO, which are already included in the constraint set for the vowel deletion phenomenon.

3.4. Rule-based analysis and metrical account

Since data like (2) have been poorly noticed and data such as (3) are not considered relevant to rhythmic vowel deletion in the literature, we will first focus our discussion on data (1), where there is regular vowel deletion. In the following section, we will discuss previous analyses specifically on the vowel deletion phenomenon.

Li (1977b) argues that every non-final, even-numbered-syllabled vowel counted from the stressed syllable is deleted, as in *rɨ$_2$gɨ́$_1$rɨ$_2$gɨ$_3$* → *rgɨ́rgɨ* ‘mountain’ and *ta$_4$ba$_3$la$_2$ŋa$_1$nɨ$_2$* → tbalŋánɨ ‘arm’ (A detailed paraphrase of Li’s analysis is given in (4) and (5) respectively.)

(4) *rɨgɨrɨgɨ* (UR) --> *rɨgɨ́rɨgɨ* (stress assignment) --> *rɨ$_2$gɨ́$_1$rɨ$_2$gɨ$_3$* (counting distance) --> *rgɨ́rgɨ* (deletion) --> *rgɨ́rgɨ* (surface) ‘mountain’

(5) *tabalaŋanɨ* (UR) --> *ta$_4$ba$_3$la$_2$ŋa$_1$nɨ$_2$* (counting distance) --> *tbalŋanɨ* (deletion)--> *tbalŋánɨ* (stress assignment) --> *tbalŋánɨ* (surface) ‘arm’

As Hsin (2000) points out, however, there is a conflict between stress assignment and vowel deletion in Li's analysis. In (4) *rgɨ́rgɨ* ‘mountain’, stress in fact falls on the antepenult underlyingly and stress assignment is applied prior to vowel deletion, while in (5) *tbalŋánɨ* ‘arm’, stress falls on the penult underlyingly, followed by vowel deletion. The assumption that stress in Maga is lexically specified, i.e. stress might fall either on the penult or on the antepenult syllable, can solve the problem in Li’s analysis, but that will bring up new problems such that if stress is underlyingly unpredictable in Maga, Maga will turn out to be too different from other Rukai dialects, whose stress consistently and predictably falls on the penult, and that if Maga stress is unpredictable underlyingly, the fact that stress always falls on the penult on the surface in Maga will become an unexplainable coincidence.

Hsin thus explains the rhythmic deletion by metrical theory. The deletion process of Maga involves building iambic feet from left to right first, followed by deleting the left vowel of each foot, and then stress assignment to the right most trochaic foot.

This metrical account may reduce the conflicts in Li’s analysis. Kager (1997, 1999), however, explicitly points out that one of the disadvantages of the derivational analysis of metrical theory is abstract steps. The abstract step in Hsin’s analysis is the left to right iambic foot parsing, which is never available on the surface, as the only self-evident foot structure in Maga is trochaic word-finally.

Another disadvantage of Hsin’s analysis is redundancy. In Hsin’s analysis, all the data are first classified into disyllabic words and words longer than disyllabic; words longer than disyllabic are further classified into odd-numbered-syllabled words and even-numbered-syllabled words. That is, both syllable length and syllable number types play a role. Regarding vowel length, the lengthening rule is exclusively necessary for disyllabic words after syncope, as in (6a). Regarding syllable number types, the vowel in a degenerate foot, i.e. the final syllable of an odd-numbered-syllabled word, is deleted, but will be added back later by the "echo vowel insertion rule" after syncope, as in (6b), while in contrast, even-numbered-syllabled words do not need such an additional "echo vowel insertion rule", as in (6c). Distinctions between syllable length and syllable number types are considered redundant in this paper and will be presented in §4.1.

(6) Metrical account by Hsin (2000)

UR	a. *maca* 'eye'	b. *tabalaŋanɨ* 'arm'	c. r*ɨgɨrɨgɨ* 'mountain'
syncope	*mca*	*tbalŋan*	*rgɨrgɨ*
lengthening rule	*mca:*	--	--
echo vowel insertion	--	*tbalŋanɨ*	--
stress	*mcá*:	*tbalŋánɨ*	*rgɨ́rgɨ*

Finally, Hsin (2000) fails to correlate devocalization with the vowel deletion phenomenon. According to Hsin (2000), the preceding vowel in vowel sequences of rising sonority will undergo devocalization, as in (3). Devocalization is to devocalize the vowels into semivowels. In this sense, devocalization is to reduce vowel numbers and thus to better satisfy Parse-Syllable. In addition, words undergoing devocalization should also be targets of the deletion rule. Based on these two reasons, to include devocalization into our discussion is thus legitimate.

4. An Optimality Theory analysis

After the discussion of the problems of the rule-based analysis by Li (1977b) and the metrical account by Hsin (2000), we try to solve the problem within the framework of Optimality Theory. Prior to the tableaux come the definitions of constraints.

4.1 Constraints and OT analyses

(7) **GrWd=PrWd**

A grammatical word must be a prosodic word.

(8) **All-Ft-Right**
Every foot stands at the right edge of the PrWd.

(9) **Foot Form** (cover term)
a. **Ft-Bin**
Feet are binary under moraic analysis.
b. **RhType=T**
Feet are left headed.

(10) ***Super-Complex** or simply ***Comp**
Consonant clusters are limited to two.

(11) **Parse-Syllable** or simply **Parse-Syl**
Syllables are parsed by feet.

(12) **Faithfulness constraints** (on vowels)
a. **Max-IO (vowels)** or simply **Max-IO**
No deletion of vowels.
b. **Dep-IO (vowels)** or simply **Dep-IO**
No insertion of vowels

(13) **Alignment constraints**
a. **Align-V-R-Ft**
Align parsed vowels with the right edge of a foot.
b. **Align-C-L-Ft**
Align parsed consonants with the left edge of a foot.

Constraint (7) to constraint (10), widely used in OT, are unranked in Maga, as there is no crucial evidence in deciding their ranking. These constraints in Maga are obviously undominated; any candidate that violates any of the constraints will be ruled out. Thus, since violations of any of these constraints always result in obvious disfavor, sometimes some of the constraints are ignored in the discussion in some tableaux.

The alignment constraints in (13), first proposed by the author, might seem ad hoc; they are, however, crucial in our analysis for two reasons. First, these alignment constraints help in deciding/predicting which particular vowel rather than the other should get deleted. And second, these alignment constraints, (right alignment on vowels in particular) fundamentally explain the non-phonemic word-final lengthening exclusive to disyllabic words in Maga.

Before we further argue that the interaction of Markedness constraints on phonotactics and Parse-Syllable by Kager (1997, 1999) is not sufficient and thus Alignment constraints are necessary in solving the issue of rhythmic vowel deletion in Maga, let us have a look at Kager's analysis on Southeastern Tepehuan first. (Notice that the data and the analysis are highly simplified from the original work.)

(14) Kager's work on Southeastern Tepehuan

/tɨroviɲ/	*Complex	FT-FORM	Parse-Syl	MAX-IO V
a.✓(tɨr).viɲ			*	*
b. (tɨ.ro.viɲ)		*!		
c.(tro.viɲ)	*!			*
d. (tɨ.ro)viɲ		*!		

In Southeastern Tepehuan, other things being equal, deleting the odd-numbered vowels is less optimal than deleting the even-numbered vowels counted word-initially, because that will lead to violations of *Complex (No consonant clusters), as in (14c). In addition, there are restrictions on Ft-Form such that feet are binary and only (H) and (LH) are grammatical while (LL) is not. Candidate (14a) is thus the winning candidate.

Cases in Maga are, however, very different. First, Maga phonotactics allows consonant clusters of two. Therefore, unlike Southeastern Tepehuan, deleting either the first vowel or the second vowel counted word-initially will not lead to any violations of *Super-Complex, as in (15h) and (15i). (To facilitate reading, we use numbers, instead of traditional asterisks, for numbers of violations.) In addition, deletion of either the first or the second vowel does not make any difference in Ft-Form; no violations of Ft-Form will be incurred. Candidate (15h) and candidate (15i) tie with each other in every aspect regarding all the configurational constraints we have discussed so far. In other words, there are languages whose rhythmic vowel deletion patterns cannot be explained by merely the interaction of constraints on phonotactics and Parse-Syllable. Additional constraints are necessary and we propose that this necessary constraint is Alignment constraints on vowels. Conceptually, Parse-Syllable is to explain the metrical opacity of vowel deletion, while other Markedness constraints, such as *Complex, No-Coda or Ft-Form, decide the target of the deleted vowel in Southeastern Tepehuan. But for a language that has fewer restrictions on phonotactics, which means that there are consequently more possible candidates that cannot be effectively evaluated by Markedness constraints, Alignment constraints on vowels become crucial in deciding the target of the deletion rule. To put it in another way, Alignment constraints on vowels are essentially necessary cross-linguistically. In a language where there are more restrictions on phonotactics, all possible candidates but the winning candidate can be successfully ruled out by Markedness constraints and Parse-Syllable; the effect of the lower-ranked Alignment constraints on vowels is thus invisible. Nevertheless, in a language where Markedness constraints and Parse-Syllable are not sufficient in ruling out less optimal candidates, such as Maga, the effect of Alignment constraints on vowels becomes visibly influential and thus has to be listed on the tableaux.

(15) Tableau on configurational constraints

/tɨbɨθɨ/	GrWd=PrWd	Foot -Form	All-Ft-Right	* Comp	Parse-Syl	No-Coda	Max-IO
a.tɨ(bɨθɨ)					1!		
b.(tɨbɨθɨ)		1!					
c.tbθ	1!			1			3
d.(tbθɨɨ)				1!			2
e.tɨ(bθɨɨ)					1!		1
f.(tɨ.bɨθ)						1!	1
g. (tɨb.θɨ)						1!	1
->h.(tɨ.bθɨ)							1
->i.(tbɨ.θɨ)							1

In particular, Parse-Syllable and those configurational constraints, namely Syllable-Form and *Super-Complex fail to explain the non-phonemic final vowel lengthening for disyllabic words, such as *valo* 'bee/honey' --> *vlo*:, as these CVCV words are already "perfectly optimal" in configurations, in terms of CV syllable structure and bimoraic foot form. Alignment constraints, however, can better explain final vowel lengthening, as in tableau (16).

(16) Tableau of final vowel lengthening on disyllabic words

/valo/	Ft-Form	All-Ft-Right	Parse-Syl	Align-V-R-Ft	Dep-IO	Max-IO	Align-C-L-Ft
a.(valo)				2!			2
b.✓ (vlo:)					1	1	1
c. (va:l)				1!	1	1	3

Candidate (16a) is perfectly optimal in terms of CV syllable structure. And since it is bimoraic, it satisfies the requirement of Ft-Form; Parse-Syllable is also satisfied without the expected vowel deletion. However, compared with the winning candidate (16b), the vowel /a/ in candidate (16a) is two segments away from the right edge of the foot.[11] Candidate (16a) is thus less optimal. Likewise, (16c) can never be the winning candidate, which is not due to configurational constraints, such as No-Coda, but is crucially due to the right alignment constraint on vowels. Other things being equal, deleting the right vowel (or the even-numbered-syllabled vowels, to be precise) will definitely always result in more violations in Align-V-R-Ft and thus is always less optimal than deleting the left one (or the odd-numbered-syllabled vowels). And since this exclusive final vowel lengthening on disyllabic word is phonologically driven so as to better satisfy alignment constraints on vowels, the surface long vowels in Maga are not phonemic.

Recall Hsin's analysis in (6a). The metrical account is to delete the weak vowels in a left to right iambic foot structure. But the "iambic" foot structure is only momentarily true before vowel deletion; this iambic foot structure is not surface-true and this can be hardly explained by those configurational constraints. Our Alignment constraints on vowels, instead, explicitly capture the opacity in the pattern.

Cases for words longer than disyllabic are a bit complicated, in the sense that (1) unlike disyllable words to which vowel deletion seems to be redundant, for trisyllabic or longer words, vowel deletion is intuitively inevitable, which otherwise results in violations of Ft-Form or Align-V-R-Ft and Parse-Syllable, as in (17a) and (17b), and (2) vowel deletion is rhythmic, which otherwise results in consonant clusters of more than two and that violates *Super-Complex, as in (17d). Detailed illustrations of tableaux on multisyllabic words are given as follows.

[11] McCarthy (2003) proposes that alignment constraints must not be gradient. But since candidates in our analysis differ themselves to varying degrees on the distance of vowels to the right edge, we still follow the convention of alignment constraints by Prince and Smonlensky (1991, 1993) and evaluate the violations in alignment constraints gradiently.

(17) Example of trisyllabic words

/tɨbɨθɨ/	GrWd=PrWd	Ft- Form	* Comp	Parse-Syl	Align-V-R-Ft	Max-IO	Align-C-L-Ft
a.tɨ(bɨθɨ)				1!	2		2
b.(tɨbɨθɨ)		1!			2+4		2+4
c.tbθ	1!		1			3	
d.(tbθɨː)			1!			2	1+2
e.✓(tbɨθɨ)					2	1	1+3
f.(tɨbθɨ)					3!	1	2+3
g.(tɨbɨθ)					1+3!	1	2+4
h.tɨ(bθɨː)				1!		1	1
i. (tɨbθɨː)		1!			3	1	2+3

Final vowel lengthening is no longer possible, the reason being that with final vowel lengthening, either Ft-Form will be violated, as in (17i), or Parse-Syllable will, as in (17h). Consider the winning candidate (17e). Although there is one vowel that does not align with the right edge of the foot, that is a compromise to the higher-ranked constraint, *Super-Complex; candidate (17d) will otherwise be the winning candidate.

To sum up so far, the schema is that (1) due to fewer violations of Parse-Syllable, there is vowel deletion, (2) vowel deletion is rhythmic, or that will result in violations of *Super-Complex, (3) due to the right alignment constraint on vowels, odd-numbered-syllabled vowels rather than even-numbered-syllabled vowels (counted from the word-initial position) get deleted, and (4) also due to the right alignment constraint on vowels, there is non-phonemic final vowel lengthening exclusively for disyllabic words. To put it in another way, regarding the essence of rhythmic vowel deletion, Parse-Syllable explains vowel deletion, and Markedness constraints on phonotactics govern the rhythmicity of deletion, while Alignment constraints on vowels target the positions of deletion. We can get more supportive evidence from quadrisyllabic and longer words in the same way.

(18) Example of quadrisyllabic words

/bɨlɨbɨlɨ/	Ft-form	All-Ft-Right	*Comp	Parse-Syl	Align-V-R-Ft	MAX –IO	Align-C-L-Ft
a.(blɨbɨlɨ)	1!				2+4	1	1+3+5
b.(bɨlɨ)(bɨlɨ)		1!			2+2		2+2
c.(blbɨlɨ)			1!		2	2	1+2+4
d.bɨ(lbɨlɨ)				1!	2	1	1+3
e.✓ (blɨblɨ)					3	2	1+3+4
f.(bɨlblɨ)			1!		4	2	2+3+4
g.(blɨblɨ:)	1!				3	2	1+3+4
h.blɨ(blɨ:)				1!		2	1

(19) Example of five-syllabled words

/kalaɖɨriŋɨ/	Ft-form	All-Ft-Right	* Comp	Parse-Syl	Align-V-R-Ft	Max-IO	Align-C-L-Ft
a✓.kla(ɖrɨŋɨ)				1	2	2	1+3
b.ka(lɖɨrŋɨ)				1	3!	2	1+3+4
c.klaɖrɨ(ŋɨ:)				2!		2	
d.kla(ɖɨriŋɨ)	1!			1	2+4	1	2+4
e.(klaɖɨ)(riŋɨ)		1!			2+2	1	1+3+2
f.ka(lɖriŋɨ)			1!	1	2	2	1+2+4
g.klaɖɨ(rŋɨ:)				2!		2	1
h.kla(ɖɨrŋɨ)				1	3!	2	2+3

Notice that we do not have any derivational or abstract steps in our analysis. Besides, with the same set of constraints, our analysis explains all the data well, from disyllabic words to five-syllabled words. The distinctions between syllable length (disyllabic words versus longer ones) and syllable number types (odd-numbered-syllabled words versus even-numbered-syllabled words) in Hsin (2000) thus become redundant. Our one-step OT analysis therefore should be considered more economical than the metrical account in Hsin (2000). In addition, these constraints explain more than just vowel deletion; they can further explain devocalization, a separated issue in Hsin's analysis.

4.2 Devocalization and vowel deletion

We have presented the data of devocalization in (3), now repeated here as (20).

(20) Data on devocalization

Maga	surface form	gloss	Negation
a. bia	[byáː]	‘plant name’	i-k-byaː
b. iəla	[yə́ːla]	‘snow’	i-k-yəlaː
c. mumuələ	[mu.mwə́ːlə]	‘snail’	i-k-mumwələː

The generalization is that in vowel sequences, the former vowel (the high vowel) undergoes devocalization while the latter vowel remains intact. Intuitively, devocalization is the best way to satisfy both Parse-Syllable and Max-IO; protection of the latter vowel from deletion is due to another constraint: Max-IO[V.

(21) **Max-IO[V**

No deletion of every vowel standing at the left edge of a syllable.

Although we define Max-IO[V as “no deletion of every vowel standing at the left edge of a syllable,” it is more a segmental faithfulness constraint than a positional faithfulness constraint, as it protects every onsetless vowel, not just word-initial onsetless vowels, but also all onsetless vowels of all positions, from being deleted.[12] In addition, Max-IO[V should be considered phonologically and morphologically significant. In normal cases, when vowel deletion happens to the CV syllable structure, there is in fact one consonant left, serving as some kind of trace of the “fragmental syllable”. For onsetless vowels, should vowel deletion really happen, nothing will be left to serve as any kind of trace of this particular ghost syllable and this particular syllable will turn out to be unidentifiable. Max-IO[V is thus well-motivated.

Another constraint we need is *Geminate[13], which is due to Maga phonotactics.

(22) ***Geminate**

No geminates.

[12] We are aware of the cost and the complexity of specifying syllable information in the input. But since it is impossible (or at least impossible at the current phase of the development in OT) to express the concept ‘protection of an onsetless vowel from deletion’ without referring to “syllables” or “syllable information” in the input, we tentatively adopt this “naive” constraint.

[13] We will have more detailed discussions on gemination in §5.3.

(23) Tableau on devocalization and final vowel lengthening[14]

/bia/	Max-IO [V	Ft-Form	Parse-Syl	Align-V-R-Ft	Dep-IO	Max-IO	Align-C-L-Ft
a.(bia)				1!			
b.✓ (bya:)					1		1
c.(bi:._)	1!					1	
d.(b_a:)					1	1!	
e. (bya)		1!					1

Since vowel deletion is rhythmic, in vowel sequences, one of the two vowels, if not both, should be the potential target of vowel deletion. Deleting the latter, however, violates Max-IO [V, as in (23c), while deleting the former always results in one more violation in Max-IO, as in (23d), compared with the winning candidate (23b). And again, as mentioned, due to the right alignment constraint on vowels, candidates without vowel deletion and final vowel lengthening, as in (23a), are less optimal than the winning candidate.

Hsin (2000) fails to correlate devocalization with vowel deletion and considers them two separate issues. In particular, although Hsin (2000) empirically describes that there is vowel lengthening when devocalization takes place, Hsin (2000) still fails to correlate final vowel lengthening for CVCV words that undergo vowel deletion without devocalization, as in (1a) to (1c), with CVV words that undergo devocalization, as in (20a). In contrast, we not only correlate these two seemingly irrelevant issues but also explain them with the same set of OT constraints[15]. Under our OT analysis, non-phonemic final vowel lengthening, regardless of whether there is devocalization or not, exclusively happens to disyllabic words, due to the right alignment constraint on vowels.

Likewise, words longer than two syllables with devocalization are parallel to those without devocalization in the sense that final vowel lengthening is no longer possible. Also parallel to those multisyllabic words with a CV structure, null application of vowel deletion in vowel sequences violates Parse-Syllable, as in (24a) and (25a). And again, to delete the latter vowel in vowel sequences violates Max-IO[V, as in (24d) and (25c), while deleting the former leads to one more violation of Max-IO (Vowel), as in (24e) and (25d).

A brief summary of the constraints regarding devocalization is that to better

[14] To save space, some non-crucial constraints might be excluded from the following tableaux.

[15] Technically, (21) and (22) seem to be additional constraints for devocalization. (21) and (22) are actually general constraints for all Maga data, the only problem being that they are not relevant to data of deletion in (1) and are thus ignored in tableaux (16) to (19). To include these two constraints in tableaux (16) to (19) will not lead to different results. The constraint set for data without devocalization is thus still the same as that for data with devocalization.

satisfy both Parse-Syllable and Max-IO, there is devocalization. And the fact that it is the first vowel rather than the second vowel that undergoes devocalization is well explained by Max-IO[V. With the interaction of Ft-Form and Alignment constraints, data of devocalization also undergo vowel deletion. And this phenomenon is well captured in our analysis.

See tableaux (24) and (25) for detailed illustrations of how these constraints work respectively when vowel sequences appear in word-initial position and word-medial position.[16]

(24) Tableau on devocalization without final vowel lengthening

/iəla/	Max-IO [V	Ft-form	All-Ft-Right	Parse-Syl	Align-V-R-Ft	Dep-IO	Max-IO
a. i(əla)				1!	2		
✓b. (yəla)					2		
c. (_._.la:)	2!					1	2
d.(i._.la)	1!				2		1
e. (_.əla)	1!				2		1

(25) Tableau on devocalization for quadrisyllabic words

/mumuələ/	Max-IO[V	Ft-form	All-Ft-Right	*Geminates	Parse-Syl	Align-V-R-Ft	Max-IO
a. mumu(ələ)					2!	2	
✓b. mu(mwələ)					1	2	
c. mu(mu._.lə)	1!				1	2	1
d. (mum_._.lə)	1!					3	2
e.(mmwələ)				1!		2	1

To sum up, the motivation of devocalization is to better satisfy Parse-Syllable and Max-IO, which are already included in the constraint set for vowel deletion; the schema for vowel deletion with devocalization and vowel deletion without devocalization is thus the same, but Hsin (2000) fails to correlate these two phonological phenomena. Thus, more than just eliminating abstract steps and the distinctions between syllable length and syllable number types, our analysis explains more data than the analysis in Hsin (2000) and therefore is more economical; our analysis thus should be considered preferred.

[16] Notice that when vowel sequences of rising sonority appear word-finally, there will be some final vowel lengthening, as in *tmuθua* 'mouse' --> [tmuθwáa] and *surua* 'soup'--> surwáa.) (Hsin 2000:45). This should be considered positionally conditioned, as it only happens when the vowel sequence occurs word-finally.

5. When vowel deletion does not happen

In previous sections, we have explicated how and why vowel deletion happens. The linguistic fact is, however, more complicated than we just mentioned. In fact, there are quite a few "exceptional" cases. Regarding disyllabic words, some words just remain immune from vowel deletion. Vowels occurring between identical consonants and pseudo reduplicated forms are also intricate such that the expected vowel deletion fails to happen to some cases. In the following sections, we will classify the data in terms of syllable types. Those "exceptional" cases remain unexplainable by every theory so far. The details of each pattern are as follows.

5.1 Disyllabic words

We have had a quick look at data that remain immune from vowel deletion in (2). Here we will have a more detailed look at each pattern of the data from (26) to (28) and (32).

(26) Variants on disyllabic words

	Maga	Negation	Full-Form	Tona	PR	gloss
a.	u-kla:	i-kəla:	u-kəla	wa- kəla	kəla	'arrive'
b.	u-pna:	i-k-pana:	u-pana	pana	pana	'shoot with arrows'
c.	vlo:	i-k-valo:	valo	valo	valo	'bee/honey'
d.	cke:	i-k-cake[17]:	cake	caki	caki	'excrement'
e.	mca:	i-k-maca:	maca	maca	maca	'eye'
f.	rva:	i-k-rava:	rava	avaʔa	ɭava	'flying squirrel'
g.	θuθu	i-k-θuθu:	θuθu	θoθo	θoθo	'breast'
h.	pago	i-k-pago:	pago	pago	pago	'gall'
i.	lɨkɨ	i-k-lɨkɨ:	lɨkɨ	lə-ləkə	ləkə	'ear discharge'
j.	pitu	i-k-pitu:	pitu	pito	pito	'seven'
k.	rima	i-k-rima:	rima	ima	ɭima	'five'
l.	u-sipi	i-k- sipi:	u-sipi	sipi	sipi	'dream'
m.	u-kanɨ	i-k-kanɨ:	u-kanɨ	kanə	kanə	'eat'
n.	nna:, nana[18]	i-ka-nna:, i-k nana:	nana	nana	nana	'pus'

[17] cf. *i-cakii* by Hsin (2003).

[18] *nna:* and *nana* 'pus' are first reported by Li (1977a). Notice that *nna:* is the only data where word-initial geminates are plausible. *nna:* 'pus' and its negation form *i-ka-nna:* 'not pus' are however only reconfirmed by Mu; for Wei, *nna:* and *i-ka-nna:* are not acceptable.

As (26) shows, there are two types of disyllabic words; one type undergoes vowel deletion with final vowel lengthening, as in (26a)-(26f), and the other remains intact from vowel deletion, as in (26g)-(26n). (Notice that for (26g)-(26n), even morphology, namely negation here, cannot trigger deletion). In terms of quantity, CV: outnumbers CVCV. (CVCV and CV: are 18 versus 30, among all the 489 items by Li (1977a).)[19]

What is unexplainable about the two patterns in (26) is that each pattern does not form a natural class of any kind, neither phonologically nor morphologically. Morphologically, parts of speech do not play a role, as both types include verbs and nouns. Segmental phonology could not explain the data either, because there are no specific segmental phonological environments that trigger or block deletion. We do not have minimal pairs, but we have near minimal pairs that illustrate that segmental phonology plays no role. Consider (26c) and (26h). Their vowel sequences (underlyingly) are identically /a/ + /o/, but they undergo different patterns. Likewise, in (26b) and (26m), the consonant sequences are both a voiceless stop + coronal nasal and they also undergo different patterns. Since neither phonology nor morphology can explain the variants, we can only say that these data have their idiosyncratic behaviors.

5.2 Pseudo reduplicated forms

Parallel to disyllabic words, there are also two patterns among pseudo reduplicated forms, as in (27).

[19] PR data with word-final diphthongs like *kalaw* 'type of fish' and *comay* 'bear' (cf. *klo:* 'type of fish' and *cme:* 'bear' in Maga) do not count as either type. Li (1977a) assumes that the loss of word-final semivowels is compensated by vowel lengthening, while Hsin (2000) explains word-final long vowels by (1) vowel coalescence of the original diphthongs and (2) word-final lengthening after vowel deletion (comay -> come -> cme -> cme:). If Hsin is correct, then the CV: type should be greater in number.

(27) Data on pseudo reduplicated forms

	Maga	Negation	Tona	Proto Rukai	gloss
a.	giŋigiŋi	i-k-giŋigiŋɨ:	giŋigiŋ	giŋigiŋ	'longan'
b.	s-pakɨpakɨ	i-k-sa-pakɨpakɨ:	pakəpakə	pakəpakə	'wing'
c.	ma-kəθəkəθə	i-k-kəθəkəθə:	ma-kəθəkəθə[20]	kəθəkəθə	'tight'
d	a-ŋiriŋiri	i-k-ŋiriŋiri:	aŋii	----	'laugh'
e.	rgɨrgɨ	i-k-rɨgrɨgɨ:	əgəəgə	ɭəgəɭəgə	'mountain
f.	tkatka	i-k-taktaka:	takaa[21]	takataka	'elder sibling'
g.	lpɨlpɨ	i-k-lɨplɨpɨ:	ləpələpə	ləpələpə	'beans'
h.	bləblə	i-k-balbalə:	baləbalə	baləbalə	'bamboo'
i.	blɨblɨ	i-k-bɨlbɨlɨ:	bələbələ	bələbələ	'banana'
j.	kcəkcə	i-k-kackacə:	kacəkacə	kacəkacə	'bark of tree'

According to Zuraw (2002), there exists a "coupling" effect among pseudo reduplicated forms such that pseudo reduplicated forms prefer enhancement or preservation of word-internal self-similarity; pseudo reduplicated data thus might behave differently from other examples. (27a)-(27d) seem to bear this coupling effect in the sense that they remain intact from vowel deletion. (Notice that in (27a)-(27d), negation does not trigger vowel deletion either). In contrast, data in (27e)-(27j) seem to lack such a coupling effect, because they undergo vowel deletion. Besides, those output forms of pseudo-reduplicated words after vowel deletion in fact can remain pseudo-reduplicated, so do their negation forms.[22] Therefore, it is imprudent to explain the data in Maga (merely) by the coupling effect. Furthermore, although all the pseudo reduplicated forms that undergo vowel deletion are nouns, to classify these two patterns of data in terms of parts of speech is inappropriate, as there are both verbs and nouns in (27a)-(27d). And by further comparing (27b) with (27f), it is evident that segmental phonology does not play a role either; the consonant sequences are both a voiceless stop + /k/. So, we have no proper explanation for this idiosyncratic behavior of (27).

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[20] cf. *mwa-kəθəkəθə* 'tight' by Li (1977a).
[21] cf. *kakaa* or *takataka* 'elder sibling' by Li (1977a).
[22] Ignore the uniform final vowel lengthening in negation, which should be morphological driven. The more accurate transcription for words like *i-k-bɨlbɨlɨ*: 'not bamboo' should be *i-k-bɨlbɨlɨ-ɨ*; the stem is thus still pseudo reduplicated.

5.3 Geminates

Like disyllabic words and pseudo reduplicated forms, there are two patterns among geminates, but the case for geminates is a bit more complicated. Li (1977b) notes that generally there is no deletion of a vowel if it occurs between identical consonants. A more accurate description, according to Hsin (2000), however, is that in non-derived words and in initial positions, deletion between identical consonants is not allowed. It seems to be the case, as in (28).

(28) Null application of vowel deletion by word-initial geminates

Maga	Negation	Full-form	wrong prediction	gloss
a. cacŋalɨ	i-k-cacaŋlɨ:	cacaŋalɨ	* ccaŋlɨ	‘star’
b. dadranɨ	i-k-dadarnɨ:	dadaranɨ	* ddVrnɨ	‘road’
c. mumwələ[23]	i-k-mumwələ:	mumwələ	*mmwələ	‘snail’
d. me-ddali	i-k-dadali:	me-dadali	*me-dadli	‘near’
e. ma-kkule	i-kɨ-kakule:	ma-kakule	* ma-kakle	‘narrow’

Recall our constraints in §4.2. By the same set of constraints, we can make the correct prediction, as in (30). But since the more accurate description regarding the distribution is that word-initial geminates are not possible, we then slightly modify our *Geminates constraint in (22) into a more restricted one, ***[PrWd Geminate**.[24]

(29) ***[PrWd Geminate** (or simply ***[Geminates**)

No prosodic words start with geminates.

(30) Tableau on null application of vowel deletion by * [PrWd Geminates

/cacaŋalɨ/	Ft-form	All-Ft-Right	*Comp	*[Geminates	Parse-Syl	Align-V-R	Max-IO
a. (ccaŋlɨ)				1!		3	2
b. caca(ŋalɨ)					2!	2	
c. ca(caŋlɨ)					1	3!	1
d ✓ ca(cŋalɨ)					1	2	1
e. (cacŋlɨ)			1!			4	2

[23] Its input form is /mumuələ/ ‘snail’. See (20) for details.

[24] This slight modification makes no difference in the previous analysis in §4.2. Readers might go back to tableau (25) to double-check.

Due to the *[Geminates constraint, deleting the first vowel is not possible, as in (30a). But due to Parse-Syllable, deletion is inevitable; (30b) will otherwise be the winning candidate; preserving the word-initial vowel and deleting the others is what *[Geminates and Parse-Syllable conspire. And again, due to Align-V-R-Ft, (30c) can never win out (30d).

The linguistic fact is yet more complicated than what Li (1977b) and Hsin (2000) report. Compare (31a) with (31b).

(31) Data of intricate germination

Maga	Negation	Full-form	wrong prediction	gloss
a. bruc.cu[25]	i-k-barcucu:	barucucu	* brucucu	'egg'
b. θlevava	i-k-θalvava:	θalevava	* θlevva	'rainbow'

(31a) and (31b) are near minimal pairs in the sense that the last two consonants in each case form a natural class with the same distribution (both /c/ in (31a) and /v/ in (31b) are fricatives and they both occupy the onset positions of the final syllable and the penult syllable in their full form respectively). What is unexplainable is that they present different patterns; vowel deletion happens in (31a) but vowel deletion fails to happen in (31b).

No matter how we modify our constraints on geminates, we could not explain all the data well. The more restricted positional markedness constraint, *[Geminate, seems to work well for all data, except for (31b) such that it underpredicts the blocking on word-internal geminates, while the more general markedness constraint, *Geminate, fails to explain the plausibility of word-internal geminates, as in (31a). Conjunction of these two constraints on geminates results in overprediction such that there will be no geminates in Maga at all, while to discard both constraints fails to capture the linguistic fact that geminates do prevent potential vowel deletion in some cases.

The best way to explain such an intricacy is then to further subcategorize the data by the distribution of (potential) geminates, namely (1) data with potential word-initial geminates and vowel deletion is eventually blocked, as in (28a)-(28c), (2) data with potential word-internal geminates and vowel deletion is eventually blocked, such as (31b), and (3) data with potential word-internal geminates and vowel deletion eventually happens, as in (31a). There is no exception in group (1) so far, but there is also no generalization rule so far as to what word under what condition should be

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[25] Phonetically, the word for 'egg' is *bruc.* (pause). *cu.* To pronounce it as *brucu* or *brucəcu* is considered unacceptable by my informants. And since /cc/ is not a plausible word initial consonant cluster (Hsin 2000), the syllabification for *bruccu* 'egg' is *bruc.cu.*

classified into group (2) or into group (3). The classification of group (2) and group (3) seems to rely on idiosyncrasy.

5.4 VCVCV words

Different from the variations between disyllabic words, pseudo reduplicated forms and geminates, in this section, we will show that the expected vowel deletion fails to happen to any VCVCV word. Consider the following data in (32).

(32) Data on trisyllabic words

	Maga	Negation	Full-form	Tona	Proto Rukai	gloss
a.	θbuŋu	i-k-θubŋu:	θ**u**buŋu	θoboŋo	θoboŋo	'bag'
b.	vlese	i-k-valsi[26]:	v**a**lese	valisi	valisi	'tooth'
c.	lbete	i-k-labti:	l**a**bete	labiti	labiti	'skirt (man's)'
d.	tbɨθɨ	i-k-tibθɨ:	t**ɨ**bɨθɨ	təbəθə	təbəθə	'belt'
e.	tburu	i-k-tubru:	t**u**buru	toboro	toboro	'bamboo'
f.	aḍisi	i-k-aḍsi:	aḍisi	ʔaḍisi	ʔaḍisi	'eagle'
g.	ɨsɨbɨ	i-k-ɨsbɨ:	ɨsɨbɨ	ʔəsəbə	ʔəsəbə	'juice'
h	obisi	i-k-obsi:	obisi	obisi	ubisi	'hair, pubic'
i.	abarə[27]	i-k-abrə:	abarə	ʔabaə	ʔabarə	'coconut'
j.	uŋulu	i-k-uŋlu:	uŋulu	wa- ʔoŋolo	ʔoŋolo	'drink'

What is unexplainable about those VCVCV words is that, if there is no word-initial consonant, vowel deletion never happens to any vowel of any syllable.[28] Preservation of word-initial vowels can be explained by Max-IO[V; preservation of word-final vowels can be explained by the right alignment constraint on vowels; preservation of the vowels on the second syllable is as yet totally unexplainable. In other words, it is outside our prediction that the correct output form for words like *abarə* 'coconut' is *abarə*, rather than **abrə*; all VCVCV words are exceptional to the widely-exercised Parse-Syllable and the Alignment constraint on vowels. Vowel

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[26] Ignore the morphophonemic alternation between *i~e* of bare stems and negation forms in (32b) and (32c).

[27] Maga data on 'coconut' was marked as unavailable by Li (1977a)

[28] The only ambiguous item that might be exceptional to this observation so far is *oru* 'head'(Li 1977a) (cf. *aoḷo* 'head' in PR by Li (1977a)). But the word for 'head' turns out to be *aoru*, negation form *i-k-aoru* in both Mu's and Wei's speech. *oru* is considered acceptable but less preferred, according to my two informants. (Also cf. *aoru* by Hsin (2000:46)). Since there is discrepancy in transcriptions and the number is just one, we ignore this single item.

deletion is simply blocked, not by segmental phonology, or any morphological factors, but seemingly just by the syllable structure. Morphology cannot explain the data, as all the data in (32) are nouns. And the consonant sequences in (32e) and (32i) are identically /b/ + /r/; segmental phonology thus does not play a role either. Notice that syllable numbers cannot be a factor, as CVCVCV words are also trisyllabic but vowel deletion happens. In addition, it is not accurate to claim that onsetless vowel syllables will necessarily block vowel deletion. Consider the data of vowel sequences in (20). Neither of the vowels in vowel sequences in (20) gets deleted, but vowel deletion happens to other syllables. In addition, as the negation data presented in (32f)-(32j) show, when the VCVCV words are prefixed, vowel deletion happens to the stems. Therefore, a more accurate statement about the special pattern of VCVCV words should be that when being non-derived and onsetless word-initially, their special syllable structure will completely nullify vowel deletion.

We try to attain some more non-derived, word-initial onsetless data to support (or argue against) our "structural preservation" assumption. That is, if other non-trisyllabic stems without word-initial onsets also remain intact from vowel deletion, then our hypothesis that the structure of being onsetless word-initially guarantees the blocking of vowel deletion gets confirmed. Onsetless non-trisyllabic words are, however, barely available. Among all the 489 items in Li (1977a), we can find only 3 examples[29]. And these three words all behave aberrantly. Consider the following data in (33).

(33) Data without word-initial consonants

	Maga	Negation	Full-Form	Tona	Proto Rukai	gloss
a.	atabŋə[30]	i-k-atabŋə:	atabaŋə[31]	atabaŋə	atabaŋə	'cockroach'
b.	arɨglɨ	i-k-arɨglɨ:	arɨgɨlɨ	aəgələ	ɭa-ɭəgələ	'fly, small'
c.	rsɨrsɨ	i-k-arsɨrsɨ:	arɨsɨrɨsɨ	aəsəəsə[32]	aɭisəəsə	'nit'

[29] There are some more data, such as *u- gmɨgmə* 'hold in hand', (cf. *ao-gəməgəmɨ* in PR), *o-rcɨŋɨ* 'hot' (cf. *ao-ɭacəŋe* in PR) and *u-lupu* 'hunt' (cf. *oalopo* in PR). Those data are however not valid evidence in the sense that **ao* in PR is in fact a verbal-prefix and **ao* are coalesced into /o/ in modern Maga. As mentioned, we should separate morpheme prefixes from the stem. These stems are thus not vowel-initial and are not valid evidence. Words with a trisyllabic PR sources are also excluded from discussion. For example, although *aŋaroo* 'fly, big' seems to be quadrisyllabic, the final two vowels in fact result from the diphthong *aɭaŋaw* in PR (Li 1977a); their being intact from vowel deletion and their patterning together with other VCVCV words is thus not surprising.

[30] cf. *tabŋə* 'cockroach' by Li (1977a).

[31] The full form of (33a) and (33b) are in fact unknown, as negation does not induce the reappearance of the ghost vowels. We assume the full forms of (33a) and (33b) by the data of Tona and PR.

[32] cf. *aəsəsəəsə* 'nit' by Li (1977a.)

(33a) and (33b) are underlying quadrisyllabic. Their initial vowels are well-protected from vowel deletion, strengthening our Max-IO[V constraint. Vowel deletion on the penult rather than on the antepenult, however, presents the aberrancy of the data from other quadrisyllabic words, as in (1g)-(1i). (33c) serves as a counter example of (33a) and (33b). The initial vowel in (33c) is deleted. (Evidence of a deleted onsetless vowel word-initially in (33c) is its negation form. The correspondent data in Tona and in PR also suggest the plausibility of an underlying onsetless vowel). (33c) thus poses a challenge to our Max-IO[V and strongly argues against our structure preservation assumption about the null application of vowel deletion to VCVCV words. Notice that, however, (33c) is the only example among the more than 400 items by Li (1977a). Besides, (33a) and (33b), in contrast, serve as supporting evidence for our constraint and our assumption. Most important of all, either (33a) and (33b) or (33c) is extremely rare. They are so rare that they can be even ignored or be explained lexically; to ignore them or to explain them lexically helps us move to the conclusion that the syllable number of three is the only possible syllable structure for a vowel-initial word. In addition, since all three examples in (33) behave in a unique way, (vowel deletion in (33a) and (33b) happens to the unexpected position and (33c) is the only example that violates Max-IO[V,) it is not unreasonable to conclude that all data without a word-initial consonant bear the properties of being aberrant to some extent. In other words, although the data in (33) do not directly support our word-initial-onsetless-structural-preservation assumption, due to their aberrancy and exiguousness, it is at least not unreasonable to assume that the special behavior of vowel blocking on VCVCV words is due to their special syllable structure.

5.5 Behind idiosyncrasy

In §5.1 to § 5.3, we explain the two patterns in disyllabic words, pseudo reduplicated forms and the variants among gemination by idiosyncrasy. Idiosyncrasy certainly can be one of the explanations. But we would like to offer a one-step further explanation on “idiosyncrasy”. Recall in §2 that CV is the prototype of all Rukai dialects and vowel deletion is an innovative phenomenon in Maga (Li 1977a). We therefore assume that in the old grammar of Maga, the Faithfulness constraint, namely Max-IO, is undominated. The constraint ranking in the old grammar is thus Max-IO >> Parse-Syllable >> Align-V-R-Ft, as in (34).

(34) Tableau on two- syllable words intact from vowel deletion

/pago/	Max-IO	Ft-Form	All-Ft-Right	*Comp	Parse-Syl	Align-V-R-Ft	Dep-IO
a. (pgo:)	1!						1
b.✓ (pago)						2	

The constraint ranking Parse-Syllable >> Align-V-R-Ft >> Max-IO we talked about in §4 is innovative. This new grammar was supposed to be applied to other data, but not to disyllabic words, pseudo reduplicated forms, word with potential geminates and VCVCV, for the reasons that disyllabic words are too short to be deleted, that there is a coupling effect among pseudo reduplicated forms, that geminates are not preferred in Maga, and that VCVCV is special in structure. But this innovative grammar is so influential and is starting to affect disyllabic words, pseudo reduplicated words and words with potential geminates. Regarding disyllabic words, new grammar is greatly and idiosyncratically being applied, and the old grammar, Max-IO >> Parse-Syllable >> Align-V-R-Ft is fading away, so CV: is outnumbering CVCV. The dual form in (26n), namely *nna*: and *nana* 'pus' (cf. *nana* 'pus' in PR), serves as evidence of the transitional phase.

For pseudo reduplicated forms, by the empirical data we have so far, nouns are being more affected by the new grammar than verbs, so more nouns undergo vowel deletion than verbs. Likewise, words that might lead to internal geminates are idiosyncratically starting to be affected by the new grammar as well; we therefore could not find any generalization as to whether vowel deletion should be blocked by internal geminates or not.

Thus, although "idiosyncrasy" explains all the variants, the more accurate expression is that those data are idiosyncratically being affected by the innovative grammar. Overall, disyllabic words are being affected by the new grammar most, so most disyllabic words undergo vowel deletion, followed by pseudo reduplicated forms. Geminates are less affected by the new grammar; deletion that might lead to word-internal geminates is thus available but rare. Deletion that might lead to word-initial geminates is never possible at the current phase. VCVCV is the only type that has never been affected by the new grammar at all so far. To illustrate the influence of the new grammar, empirically according to the quantity (by percentage) of the affected data in each pattern, the continuum of the general tendency of vowel deletion is disyllabic words >> pseudo-reduplicated forms >> word-internal geminates >> word-initial geminates and VCVC words.

More empirical evidence that presents the influence of this innovative grammar is the difference of field records in the past years, as in *makatonozono* 'a kind of mushroom' (Li 1977a) and ***mk**atonozono* (Li, 1997b) but ***mk**a**tn**ozono* (2005, the author), *t**a**kat**a**ka* 'elder sibling' (Li 1977a) but *tkatka* (2005, the author), *u-s**i**nis**i**no*: 'wash clothes' (Li 1997b:543) but *u-snisnoo* (2005, the author), *u-t**u**bii* 'cry', (Li 1997b: 543) but *u-tbii* (2005, the author), and *ma-b**u**suku* 'drunken' (Li 1997b:545) but *ma-bsuku* 'drunken' (2005, the author). Among them, the diachronic change of the pseudo reduplicated form, *tkatka* (2005, the author) from *t**a**kat**a**ka* 'elder sibling' (Li 1977a) serves as the canonical supporting evidence for our assumption that new grammar is winning out over the old grammar and vowel deletion is the general tendency. Other than this "witnessed" diachronic change in vowel deletion within the past thirty years, variants in Mu's speech include *o-s**u**rudu~o-srudu* 'suck', and *l**a**báci~lbáci* 'earrings', *ma-b**u**tuku~ma-btuk*u 'wide', just to name a few, suggesting that vowel deletion is a widely-exercised strategy even among the same data of the same individual.

5.6 Sporadic irregular forms

The last group includes words that are totally exceptional to the vowel deletion rule, such as (1) *tralupu* 'owl', (negation form, *i-k-tarlupu*, cf. *kokoŋo* in Tona, data in PR unavailable), *malimɨmɨ* 'sweet' (cf. *malimәmә* in PR and *malәmәmә* in Tona), and *marimuru* 'forgetful' (cf. *marimoro* in PR and *maimoo* in Tona), and (2) *dmele* 'hemp' (cf. *damili* in PR and Tona), *ma-paŋrɨ* (**ma-pŋɨrɨ*) 'spoiled cooked food' (cf. *mapaŋәḷә* in PR, *mapaaŋә* in Tona[33]) and *tom.ma* 'dried field' (**tmoma*) (cf. *tomoma* 'dried field' (Maga) (Li 1997b:533)). While group (1) merely undergoes partial vowel deletion or no vowel deletion at all, vowel deletion happens to the unexplainable position in group (2). Although we can explain words that are completely intact from vowel deletion in group (1) by their idiosyncratic resistance to the new grammar, words with partial vowel deletion in group (1) and words in group (2) remain a puzzle. Idiosyncrasy is the best explanation (if not the only explanation) so far.

6. Alternatives and theoretical discussion

In §4.1 and tableau (15), we have presented that without alignment constrains on vowels, configurational constraints and Parse-Syllable alone cannot explain the vowel deletion phenomenon in Maga. In this section, we will discuss another alternative. To fairly compare these two analyses, we refine the constraint set so the alternative technically works.[34] But it will be argued that our alignment constraints still win out

[33] Data for 'spoiled cooked food' was marked as unavailable in Tona by Li (1977a).
[34] We are grateful to Prof. Hui-chuan Jennifer Huang (personal communication) for this alternative.

over the alternative due to economy and burden of explanation. Before the proposed alternative comes the definition of each constraint.[35]

(35) ***[CV**

Avoid simple consonant word-initially.

(36) ***CC#**

Avoid word-final syllables with complex onsets.

(37) Tableaux on configurational constraints[36]

i. /valo/	Max-IO [V	Ft-form	All-Ft-Right	*Comp	Parse-Syl	*[CV	*CC#	Max-IO
a.(valo)						1!		
b.✓ (vlo:)							1	1
c. (va:l)						1!		1
ii. /bia/								
a.(bia)						1!		
b.✓ (bya:)							1	
c.(bi:)	1!					1		1
d.(ba:)						1!		1
iii. /tɨbɨθɨ/								
a.(tbθɨ:)				1!			1	2
b.✓(tbɨθɨ)								1
c.(tɨbθɨ)						1!	1	1
iv. /bɨlɨbɨlɨ/								
a.bɨ(lbɨlɨ)					1!	1		1
b.✓ (blɨblɨ)							1	2
c.(bɨlblɨ)				1!		1	1	2
v. /kalaɖɨrɨŋɨ/								
a✓.kla(ɖrɨŋɨ)					1			2
b.ka(lɖɨrŋɨ)					1	1!	1	2
c. kla(ɖɨrŋɨ)					1		1!	2
d. (klɖɨrŋɨ)				1!			1	3

[35] We are aware of the problem that constraints (35) and (36) may look specific. But the purpose of these constraints is to exemplify that configurational constraints technically work. Therefore ignore the issue regarding whether these constraints are well motivated.

[36] To save space, some constraints are not included and only crucial candidates are discussed.

The essence of the operational schema with these two configurational constraints is as follows. Due to *CC#, deletion of the vowel on the penult is less preferred, unless null application of vowel deletion on the penult will result in violations of other high-ranked constraints, such as *[CV, Parse-Syllable or *Super-Complex, as in candidate (37iv.a) to candidate (37iv.c). The conspiracy of *[CV and *CC accounts for final vowel lengthening in disyllabic words, regardless of whether there is devocalization or not, as in (37i) and (37ii) respectively, while the rhythmic pattern is due to the combined effect of *[CV, Parse-Syllable and *Super-Complex, as in candidate (37v.a) to candidate (37v.d).

Technically, both analyses work. This alternative offers another viewpoint of looking at the data and explains as many examples as our analysis. The crucial distinction between these two analyses is that the function (or effect) of our right alignment constraint on vowels is split into two configurational constraints and that makes the two analyses essentially and fundamentally different.

In configurational analysis, both *[CV and *CC# are negative, sequential and positional constraints; they both ban some kind of sequence at some marginal position. Our alignment analysis is greatly inspired by Itô and Mester (1999) and thus should be considered an extension of their work. Ever since the proposed Generalized Alignment Theory (McCarthy and Prince 1994), Alignment has been developed into a large family of constraints requiring correspondences at the two edges of prosodic categories of all kinds. As Itô and Mester (1999) point out, in alignment constraints, the first argument is quantified universally while the second existentially. Take the Onset constraint and the No-Coda constraint as examples. It can be formulated as every left edge of the syllable ends with a consonant and every right edge of the syllable ends with a vowel, or simply Align-Left (σ, C) and Align-Right (σ, V) respectively (McCarthy & Prince 1993). Due to internal richness, Itô and Mester (1999) nevertheless argue for the plausibility of exchanging the logical force of the two arguments, namely every consonant aligns with the left edge of the syllable and every vowel aligns with the right edge of the syllable, or Align-C and Align-V respectively. The significance of Align-C or Align-V is more than just a restatement of familiar conditions. They significantly reduce the need for configurational constraints, such as No-Coda and Onset (Itô and Mester 1999). In addition, they serve as a more economical schema in analyses. For example, Align-C alone bears the combined effect of Onset and *Complex, as consonants are required to align with the left edge of the syllable (Onset) and the second consonant in CC does not align with the left edge of the syllable (*Complex) respectively (Itô and Mester 1999). In a language where onsets are highly preferred but complex onsets are not allowed, as in Hebrew (Bat-El 2004), the constraint ranking will either be Faith-IO (consonant) >> Onset, *Complex or simply Faith-IO (consonant) >> Align-C, where the combined effect of Onset and *Complex can be replaced in an economical way.

Exactly parallel to Align-C and Align-V by Itô and Mester (1999), the argument that bears universal quantificational force in our Align-V-R-Ft are segments such that every vowel stands at the right edge of a foot. This constraint is empirically supported by the non-phonemic final vowel lengthening of disyllabic words in Maga. In terms of economy, exactly like Align-C alone bearing the combined effect of Onset and *Complex in Itô and Mester (1999), Align-V-R-Ft in our analysis alone bears the combined effect of the two configurational constraints in the alternative and should be considered preferred in terms of economy such that fewer constraints are needed.

Other than the reason of economy, the problem of the "configurational" definition in *CC# is the crucial reason that leads to the disadvantage of the configurational analysis. Consider the following tableau first.

(38) Tableau on problematic *CC#

/tabalaŋanɨ/	Max-IO [V	Ft-form	All-Ft-Right	*Comp	Parse-Syl	*[CV	*CC#	Max-IO
a. ✓ tba(lŋanɨ)								2
b. tba(laŋnɨ)							1	2

*CC# is the crucial constraint that rules out candidate (38b). But recall the background information in §2. Following Hsin (2000), we believe that some clusters appear only word-internally and the maximal syllable structure in Maga is CCVC. /ŋn/ happens to be one of the clusters that appear only word-internally; following Hsin (2000), the syllabification of **tba(laŋnɨ)* is thus **tba(laŋ.nɨ)*. Technically, **tba(laŋ.nɨ)* does not violate any *CC#, as the definition of *CC is "avoid word-final syllables with complex onsets". To make the constraint work, the definition has to be modified into a less restricted one: avoid consonant clusters in the internal position of the foot. But that is obviously against the general assumption that constraints target the edges or margins of certain prosodic categories (such as the right or left edge of a foot/syllable), rather than the internal position of some prosodic categories (such as the internal sequences that span two syllables within a foot) (Broselow 2003). /ŋn/ in **tba(laŋnɨ)* is not the only problematic case. Other examples include *tloɖo* 'bridge' (full form *taloɖo*), and *bθeŋe* 'jaw' (full form *baθeŋe*), but *t*alɖo* 'bridge'*, and* **baθŋe* 'jaw', just to name a few[37]. (*lɖ* and *θŋ* appear only word-internally but never word-initially, Hsin 2000:28). Although *CC is not the crucial constraint that rules out

[37] There are more than 50 combinations of consonant clusters that appear only word-internally (Hsin 2000:28).

*t*a*lɖo* and **baθŋe*, with the definitional problem, counting the violations of the internal consonant sequences in the last foot remains a fundamental issue.

Although due to some edge effect, what holds true on the marginal positions might not necessarily hold true on word-internal positions (Broselow 2003), and the ban of *ŋn* onset clusters word-initially therefore does not necessarily imply the ban of such a sequence as onset clusters word-internally. It becomes arguable if such a "not necessarily true implication" does exist in Maga or not, since there is no further evidence regarding this issue so far. If such an edge effect does not hold true in Maga, the configurational analysis certainly fails. To argue for the existence of such an edge effect, more evidence and/or further assumption is necessary. This is, however, not necessary in our alignment analysis. And we leave the burden of explanation (or burden of further evidence/assumption) to the proponents of the configurational analyses.

To sum up, Align-V-R-Ft in our analysis is well-motivated in the literature and fully supported by the empirical data. Due to economy principle of fewer constraints and burden of explanation (or burden of one more assumption), our alignment constraint analysis thus should be considered preferred to the alternative with configurational constraints.

7. Conclusion

Vowel deletion in Maga is a complicated issue; to explain such an issue with one single statement, as in Li (1977b) or Hsin (2000), oversimplifies the issue. And since there has never been any thorough presentation specifically on the patterns of vowel deletion in Maga, reorganization of the data in the literature and offering a complete picture of the patterns thus should be considered significant. We therefore first empirically classify the data into polymorphemic words and monomorphemic words. To reduce the interference of morphology, we also separate bound morphemes from stems, concentrating our analysis on bare stems and non-derived words. And then we extract irregular forms from regular ones. Among the regular forms, we generalize the patterns, and consider vowel deletion and relevant devocalization issues. Among irregular forms, we first further subcategorize the data into disyllabic words, geminates, pseudo reduplicated forms and VCVCV words, and then conclude that the intricacy in these irregular forms is better explained by the fact that these data are idiosyncratically being affected by the innovative grammar in Maga. Empirically based on the quantity (by percentage) of the affected words in each pattern, the influence of the new grammar can be expressed on a continuum, namely disyllabic words >> pseudo reduplicated forms >> word-internal geminates >> word-initial geminates and VCVCV words.

Theoretically, we first argue that the interaction of Markedness constraints on phonotactics and Parse-Syllable is not sufficient in explaining rhythmic vowel deletion in Maga. Instead, alignment constraints on vowels are necessary. While Parse-Syllable explains the metrical opacity of deletion, Alignment constraints on vowels capture the opaque structure of weak vowels in metrical feet, which is only momentarily available in the intermediate levels. We therefore conclude that the constraint ranking Markedness Constraints >> Parse-Syllable >> Align-V-R-Ft >> Faithfulness Constraints can explain both vowel deletion and devocalization in Maga. While Align-V-R-Ft explains that (other things being equal) odd-numbered-syllabled vowels rather than even-numbered-syllabled vowels counted word-initially should be the targets of the deletion rule and that non-phonemic final vowel lengthening is exclusive for disyllabic words (regardless of whether there is devocalization or not), the conspiracy of Parse-Syllable and the Markedness constraint, namely *Super-Complex, accounts for the rhythmic pattern of vowel deletion in Maga.

There are at least four contributions in our analysis. First, we eliminate the abstract steps and the distinctions between syllable length and syllable number types in Hsin (2000). And second, with the same set of constraints, we explain not only vowel deletion but also devocalization, which are treated as separate issues in Hsin (2000). Due to the economy principle, our OT analysis thus should be considered preferred to the metrical account of Hsin (2000). Third, by pointing out the fact that the interaction of Markedness constraints and Parse-Syllable is not sufficient in solving the deletion patterns in a language that has few restrictions on phonotactics, it is evident that Alignment constrains on vowels should be inevitable in terms of rhythmic vowel deletion. And finally, our Align-V-R-Ft supports the assumption by Itô and Mester (1999) that arguments which bear universal quantificational force in the Alignment family can be segments. Due to economy and burden of explanation, this alignment constraint analysis is considered advantageous to the alternative with configurational constraints.

A small amount of data that present real irregularity in the sense that there is either partial vowel deletion or that deletion happens in the unpredicted position, remain puzzling in all theories. Word-usage frequency, historical factors and/or morphology might all play a role. We therefore look forward to future research on these issues. Specific studies on polymorphemic words, regarding how and why specific morphological affixes get involved in vowel deletion are also important issues, the significance of which is to complete the whole picture of vowel deletion in Maga.

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馬加方言中的母音刪除

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Kager (1997, 1999)認爲：母音之所以被刪除，主是爲了減少未被整合至韻步的音節數；Kager 因此順利解決母音刪除的環境，就優選理論而言，不能直視其真的困窘。不過本篇文章會明白指出，Kager 分析中的有標制約(markedness constraints)及韻步形貌制約(Ft-Form)，並不足以預測在馬加方言中，究竟是奇數音節的母音或是偶數音節的母音應該要被刪除。有鑑於此，以 Itô and Mester (1999)的研究爲基礎, 本文提出每一個母音都需與韻步的右緣對齊的新制約，並且認爲：有標制約(主要的制約是：子音群不可以超過兩個) >> 音節整合制約(Parse-Syllable) >> 對齊制約(Alignment constraints) (主要的制約是：每一個母音都要與韻步的右緣對齊) >> 信實制約(Faithfulness constraints) 可以明白地闡述馬加方言中的三個特質，亦即(1)母音刪除具有節律間歇性，(2)從字首算起，奇數音節的母音會被刪除，以及(3)只有雙音節字才會發生不具辨義性質的字尾母音延長。

關鍵詞：對齊制約、母音刪除、馬加方言、魯凱語、優選理論