

Vowel Shortening and Surface Ternary Feet

—Ternary Rhythm Through Strictly Binary Footing—

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Abstract

The focus of this paper is on two types of shortening observed in recent Japanese loanwords and on the trochaic shortening in Fijian. I will argue that the Japanese shortenings take place when a metrically unstable binary foot (extrametrical foot) becomes a stray mora so as to be accommodated into one of the two proposed surface ternary foot structures whereas Fijian Trochaic Shortening occurs when a metrically unstable mora (extrametrical mora) is obligatorily accommodated into the other proposed surface ternary foot structure. I will conclude that the distinct shortening phenomena observed in the two languages can be accounted for simply on the ground of parametrical differences.

1 Introduction

Vowel shortening occurs generally in moraic trochee languages. In Fijian, for instance, there is a phonological rule called Trochaic Shortening that shortens long vowels in penultimate syllables when the final vowel is short. Representative examples are given in (1).

(1) Trochaic Shortening in Fijian (Schütz 1985)

a. <i>bú:</i> + <i>qu</i>	→	<i>búqu</i>	'my grandmother'
b. <i>tá:</i> + <i>y-a</i>	→	<i>táya</i>	'chip-TRANS.-3SG.OBJ.'
c. <i>re:</i> + <i>ta</i>	→	<i>réta</i>	'pull-TRANS'

In Japanese, there is a phonological tendency for word-final long vowels to undergo shortening after a heavy syllable. (Sukegawa et al.1990) Representative examples are shown in (2)

(2) Vowel Shortening after Heavy Syllables

a. <i>gakkoo</i>	→	<i>gakko</i>	'school'
b. <i>kekko</i>	→	<i>kekko</i>	'relatively enough'
c. <i>sensee</i>	→	<i>sense</i>	'teacher'
d. <i>kookoo</i>	→	<i>kooko</i>	'high school'
e. <i>haNkoo</i>	→	<i>haNko</i>	'seal'

In recent Japanese loanwords, word-final long vowels are also apt to shorten after a heavy syllable. Some examples are in (3). The last high-pitched mora (Accented Mora) is specified by an acute accent mark '´'.

(3) Vowel Shortening after Heavy Syllables in Recent Loanwords

a. <i>koNpyúútaa</i>	→	<i>koNpyúuta</i>	'computer'
b. <i>paraméetaa</i>	→	<i>paraméeta</i>	'parameter'
c. <i>kompóozaa</i>	→	<i>kompóoza</i>	'composer'
d. <i>purobáidaa</i>	→	<i>purobáida</i>	'provider'
e. <i>doráibaa</i>	→	<i>doráiba</i>	'driver'
f. <i>rasutaráizaa</i>	→	<i>rasutáraiza</i>	'rastaraizer'
g. <i>buráúzaa</i>	→	<i>buráúza</i>	'browser'

h. *sáabaa* → *sáaba* 'server'

Furthermore, word-final long vowels even after a light syllable tend to become short in the following recent Japanese loanwords. Consider the following recent loanwords.

(4) Vowel Shortening after Light Syllables in Recent Loanwords

a. *fórudaa* → *fóruda* 'folder'
 b. *mémorii* → *mémori* 'memory'
 c. *mónitaa* → *mónita* 'monitor'
 d. *purópatii* → *purópati* 'property'

The vowel shortening in (3) is different from (4) in that while the word-final long vowel after a heavy syllable shortens in (3), the word-final long vowel after a light syllable becomes short in (4). But for both cases, the word-final long vowel in an unaccented syllable tends to become short. On the other hand, Trochaic Shortening in Fijian is very different from the shortenings in Japanese since the long vowel in a stressed syllable shortens in Fijian.

In this paper, I will focus on the shortenings observed in recent loanwords in Japanese, as in (3) and (4) and on the trochaic shortening in Fijian. First, I will analyze accent patterns of Japanese loanwords in (3) and (4) under Metrical Phonology and show that the right peripheral bimoraic foot is extrametrical. While the analysis predicts the correct accent position, the strictly binary foot parsing creates a stray mora between two bimoraic feet. In order to confirm how stray moras are organized to achieve surface exhaustivity, I have conducted a phonetic experiment. Based on the result of the experiment, I will propose two parametrically distinct cognitive surface ternary foot structures for the two languages and argue that Fijian and Japanese shortenings are triggered by two distinctive types of extrametricality — mora and foot extrametricality respectively.

2 Accent Patterns of Japanese Loanwords

I will analyze accent patterns of Japanese loanwords in (3) and (4) and show that under a metrical approach, accent patterns will be accounted for in a principled way. I will begin with Halle and Vergnaud's (1987) exhaustivity condition. Halle and Vergnaud (1987) state that rules constructing constituents apply exhaustively over the entire string (Exhaustivity Condition). Exhaustivity may be satisfied by different types of operation. Kager (1993) argues that initial parsing feet and surface feet must be discussed at different levels. In other words, exhaustivity may be satisfied by parsing units into surface units and may be relaxed at the initial parsing level. When the strictly binary moraic feet are constructed at the initial parsing level, stray moras may occur. Therefore, I assume that while stray moras are allowed in Initial Foot Parsing (IFP), stray moras are adjoined in some way to achieve surface exhaustivity in Surface Foot Parsing (SFP). But one important question remains as to how exhaustivity should be achieved in SFP when there are stray moras. I will come back to this question later.

First, I will discuss Initial Foot Parsing (IFP), Strictly Binary Foot Parsing. Assuming that moras are organized into the strictly bimoraic trochee at the initial level, I will propose the following rules and constraints, as in (5).

(5) Rules and Constraints for Initial Foot Parsing (IFP)

- a. Moraic values are given to vowels, the first part of geminates, and the placeless nasal.
- b. Build bimoraic feet on heavy syllables.
- c. Build peak-first bimoraic trochaic feet from right to left.
- d. High vowels between voiceless consonants are not allowed to be the head of a foot. (To avoid this constraint, the head of a foot shifts to the left mora.)
- e. Degenerate feet are not allowed.

- f. A default rule assigns a ‘-’ to stray moras.
- g. The right peripheral binary foot is extrametrical.
- h. Apply End Rule Right, Word.

The rules and constraints produce the following rhythmic patterns in its leftward mode for the representative loanwords in (3) and (4).

(6) Representative Derivations

a. *koNpyúutaa* ‘computer’

By (5a): k [o] [N] py [u] [u] t [a] [a]
(+ -) (+ -) (+ -)

By (5b): k [o] [N] py [u] [u] t [a] [a]
(+ -) (+ -) <(+ -)>

By (5g): k [o] [N] py [u] [u] t [a] [a]

b. *rasutaráizaa* ‘rastaraizer’

By (5a) r [a] s [u] t [a] r [a] [i] z [a] [a]
(+ -) (+ -)

By (5b) r [a] s [u] t [a] r [a] [i] z [a] [a]
←(+ -) (+ -) (+ -)

By (5c) r [a] s [u] t [a] r [a] [i] z [a] [a]
(+ -) (+ -) (+ -)

By (5d) r [a] s [u] t [a] r [a] [i] z [a] [a]
(+ -) - (+ -) (+ -)

By (5f) r [a] s [u] t [a] r [a] [i] z [a] [a]
(+ -) - (+ -) <(+ -)>

By (5g) r [a] s [u] t [a] r [a] [i] z [a] [a]

c. *fórudaa* ‘folder’

By (5a) f [o] r [u] d [a] [a]
(+ -)

By (5b) f [o] r [u] d [a] [a]
(+ -) (+ -)

By (5c) f [o] r [u] d [a] [a]
(+ -) <(+ -)>

By (5g) f [o] r [u] d [a] [a]

d. *purópatii* ‘property’

By (5a) p [u] r [o] p [a] t [i] [i]
(+ -)

By (5b) p [u] r [o] p [a] t [i] [i]
(+ -) (+ -)

By (5c) p [u] r [o] p [a] t [i] [i]
- (+ -) (+ -)

By (5f) p [u] r [o] p [a] t [i] [i]
- (+ -) <(+ -)>

By (5g) p [u] r [o] p [a] t [i] [i]

The representations derived by Initial Foot Parsing (IFP) remain to undergo End Rule Right, Word, which correctly predicts the main accent (accented mora) of the loanwords. On the other hand, if there are stray moras, as in (6b) and (6d), they should be adjoined in some way to achieve surface exhaustivity in Surface Foot Parsing (SFP). Let us consider how stray moras are organized to

achieve surface exhaustivity in Japanese. A number of Japanese loanwords show that stray moras appear word-initially, word-medially, and word-finally, as in (7).

(7) Stray Moras in Japanese

a. Word-initial:	b. Word-medial:	c. Word-final:
<i>kuriNtoN</i> 'Clinton'	<i>táNbariN</i> 'tambourine'	<i>báto</i> 'bat'
- (+ -) (+ -)	(+ -) - (+ -)	(+ -) -
k [u] r [i] [N] t [o] [N]	t [a] [N] b [a] r [i] [N]	b [a] [t] t [o]

At the surface level, the word-initial stray mora in (7a) may attach to the following foot in order to achieve the exhaustivity condition, and the final stray mora in (7c) to the preceding foot. However, the word-medial stray mora in (7b) possibly attaches either to the preceding foot or the following foot. In order to determine how surface exhaustivity is achieved in the language, I have conducted a phonetic experiment.

3 Phonetic Experiment

The nonsense words in (8) are used for this experiment. I designed these words for the following reasons. First, fricative consonants have a relatively long acoustic realization compared to short onset consonants, such as stops. Acoustically long onset segments such as fricatives cause large deviations from isochrony. Thus, I avoided using fricative consonants. Second, all the stray strings consist of a stop and a low vowel [a] (a stray mora, which is bold-faced). [a] is inherently longest among the vowels in Japanese (Han 1962). A relatively long stray mora may show more salient durational compensation for isochrony (if there is a tendency for isochrony) than a short stray mora, such as the high vowels [i] and [u]. The durations of two underlined strings (F1 & F2) in (8i) will be compared with their counterparts (F3 & F4) in (8ii) in the same position.

(8) Words for Experiment

F1 F2	F3 F4
a. (i) <u>kata</u> ki <u>taki</u>	(ii) <u>kata</u> ki <u>kata</u> ki
b. (i) <u>kat</u> api <u>ta</u> pika	(ii) <u>kat</u> api <u>kat</u> api
c. (i) <u>kat</u> ati <u>ta</u> tika	(ii) <u>kat</u> ati <u>kat</u> ati
d. (i) <u>taka</u> N <u>ka</u> Nta	(ii) <u>taka</u> N <u>ka</u> Nta
e. (i) <u>kapa</u> N <u>pa</u> Nka	(ii) <u>kapa</u> N <u>ka</u> Nka
f. (i) <u>pata</u> N <u>ta</u> Npa	(ii) <u>pata</u> N <u>ka</u> Npa

The stray string in each word consists of a stop to avoid a possibly large deviation from isochrony, and the longest low vowel [a] to have a more salient compensation result. Furthermore, the words are designed to consist of the same CV in each foot. In addition, the high vowel [i], which is underlined as in (9), in each pair is in a devoicing environment. I assume that high vowels are prosodically very weak so that they are not allowed to be the head of a foot (Constraint). Here is derivation for the foot structure of the words in (8a) by applying the rules and constraints.

(9) Derivation for the Foot Structure of 'katakikakika' and 'katakikatakika'

a.	by (5a) & (5c)		
	(+ -)	(+ -)	(+ -)
(i)	k [a] t [a] k [i]	t [a] k [i] k [a]	
	←(+ -)	(+ -)	(+ -)
(ii)	k [a] t [a] k [i] k [a] t [a] k [i] k [a]		
b.	by (5d)		
	(+ -)	(+ -)	(+ -)
(i)	k [a] t [a] k [i]	t [a] k [i] k [a]	

- (+ -) (+ -) (+ -)
- (ii) k [a] t [a] k [i] k [a] t [a] k [i] k [a]
- c. by (5e) & (5f)
- (+ -)F1 (+ -)F2 -
- (i) k [a] t [a] k [i] t [a] k [i] k [a]
- (+ -)F3 - (+ -)F4 -
- (ii) k [a] t [a] k [i] k [a] t [a] k [i] k [a]

There are three stray moras indicated in the representation of (9c-ii). The focus of this phonetic experiment is on the middle stray mora, which may possibly attach either to the preceding foot (F3), or the following foot (F4). My basic assumption is that the stray mora shortens whichever foot it attaches to. If F3 is shorter than F4 in duration, this would suggest that the stray mora attaches to F3. If F4 is shorter than F3 in duration, this would suggest that the stray mora attaches to F4. More specifically, if the ratio of F3 to F1 is smaller than that of F4 to F2, then this would suggest that the stray element 'ka' is attached to the string F3 rather than the string F4 for the compensation for foot isochrony.

Six native speakers (A-F) of standard Tokyo Japanese were asked to utter 6 test pairs in (8) inserted in the phrase frame 'kono kanada to ____ kara yonde kudasai' (Please read from this 'Canada' and '____') at a natural tempo without unnatural pauses between words. Then, durational measurements of the recorded utterances were done by a signal analysis program. The following percentages in the Table below were acquired by dividing (F3/F1) by (F4/F2), and multiplying the quotient by 100.

Table Ratios of (F3/F1) to (F4/F2)

	A	B	C	D	E	F
1.	98.1%	96.5%	90.4%	92.8%	93.3%	90.9%
2.	97.0%	97.0%	91.5%	89.7%	94.5%	92.8%
3.	87.8%	80.5%	92.1%	96.9%	92.8%	96.0%
4.	93.7%	96.3%	97.7%	90.6%	90.9%	96.9%
5.	86.3%	88.2%	92.8%	85.8%	95.2%	87.8%
6.	86.7%	93.4%	88.8%	85.9%	91.9%	97.7%
\bar{X}	91.6%	92.0%	92.2%	90.3%	93.1%	93.7%

It is very consistent that the first string F3 becomes shorter than the second string F4 in each pair. Based on the above result of the phonetic experiment, I conclude that in Japanese stray moras are incorporated under the preceding bimoraic foot at the surface level. Interestingly, in Fijian Schütz (1985) shows that stray moras are incorporated under the following bimoraic foot at the surface level. In 1985 Schütz uses neither the term stray mora nor the distinction between the initial foot and surface foot, but I interpret his representations as follows. A stray mora is incorporated under a following bimoraic foot at the surface foot level, as in (10-ii). The output forms of initial parsing are represented in (10-i).

(10) a. *kònitara'aki* 'contract'

- (+ -) - (+ -)
- (i) k [o] n [i] t [a] r [a] k [i]
- (+ -) (- + -)
- (ii) k [o] n [i] t [a] r [a] k [i]

b. *kòniferédi* 'conference'

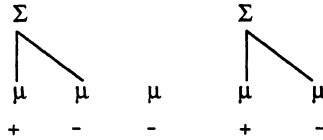
- (+ -) - (+ -)
- k [o] n [i] f [e] r [e] d [i]
- (+ -) (- + -)
- k [o] n [i] f [e] r [e] d [i]

The Japanese leftward surface-adjunction based on the phonetic experiment is quite different from the type claimed for Fijian by Schütz (1985). This point is illustrated in (11).

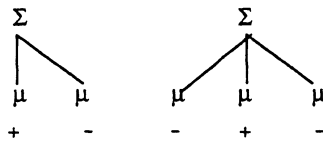
(11) Initial and surface feet in Japanese and Fijian

i. Fijian

a. Initial feet:

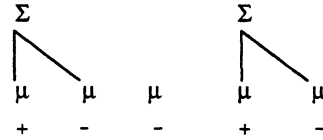


b. Surface feet:

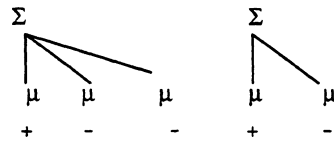


ii. Japanese

a. Initial feet:



b. Surface feet:

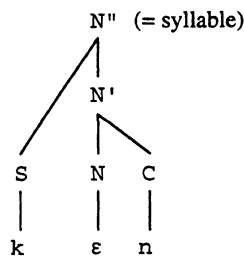


In the representations in (11), it is very clear that the surface foot structures are either binary or ternary. However, the relationship among moras is not yet clear in the flat representations in (11). The head element, marked by '+', must be closer to one of the non-head elements, marked by '-', than the other. Interestingly, they are very similar to syllable structures represented based on the x-bar theory (Inaba 1999), expanding the syllable internal structure proposed by Levin (1985). In Inaba's (1999) approach, the Japanese syllable is viewed as the maximal projection (N'') of the nucleus (N), and thus it becomes very clear that nucleus and coda as the complement are tied up together in a single unit (N') in English, and onset and nucleus as the complement in Japanese. The syllable internal structures are as follows:

(12) Syllable Internal Structures

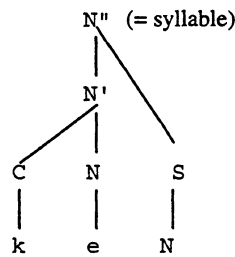
a. English

'Ken'



b. Japanese

'keN' 'prefecture'

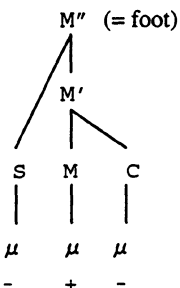


N: Nucleus
C: Complement
S: Specifier

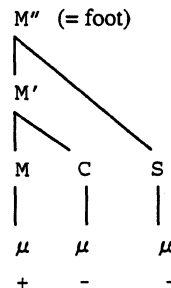
Following the discussion for the syllable internal structures above, the foot can be seen as the maximal projection of the head mora marked by '+'. We then arrive at the following surface foot structures for Japanese and Fijian.

(13) Cognitive Surface Ternary Foot Structures

a. Fijian



b. Japanese



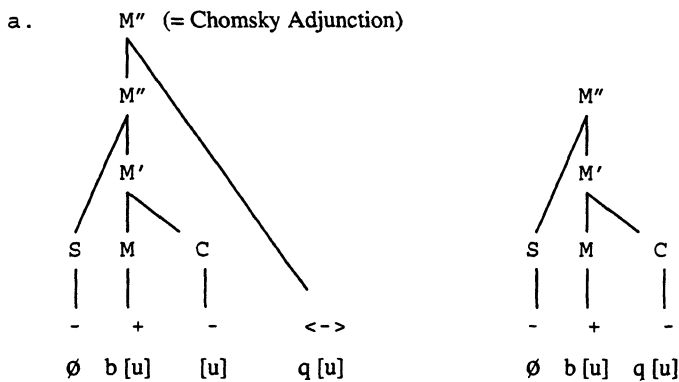
M: Moraic Nucleus
C: Complement
S: Specifier

However, one question remains unanswered, that is to say, how word-initial stray moras achieve the surface exhaustivity. Halle (1982) treats unaccented word-initial stray moras as extrametrical, extending Archangeli's (1981) treatment of them in Japanese. Following Halle's (1982) extension of Archangeli (1981) with regard to a word-initial extrametricality, I propose that an extrametrical element marked by '-' is adjoined to an expanded M'' (Chomsky Adjunction).

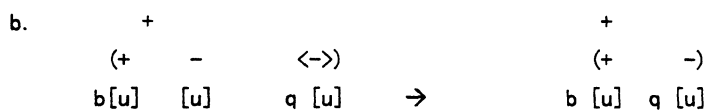
4 Fijian Trochaic Shortening

Fijian Trochaic Shortening must occur when a metrically unstable mora (extrametrical mora) is obligatorily accommodated into the proposed canonical surface ternary foot structures in (13a). This point is illustrated as in (14). The extrametrical element is adjoined to an expanded M''.

(14) Fijian Trochaic Shortening



The hierarchical representations above can be simplified as follows.

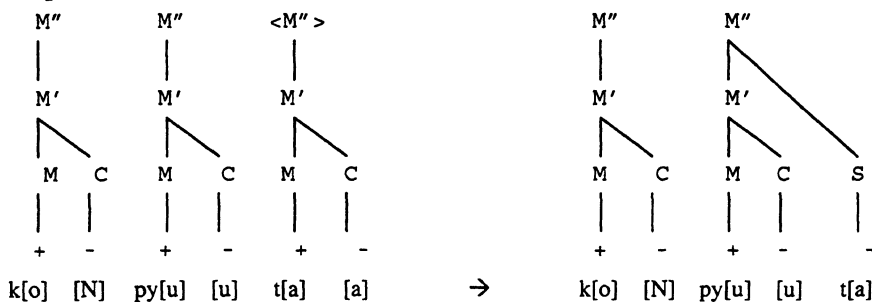


Note that the specifier precedes the nucleus is left empty in (14a). It can be said that the shortening is a process that permits a more complete parse into the canonical surface ternary foot template in (13a).

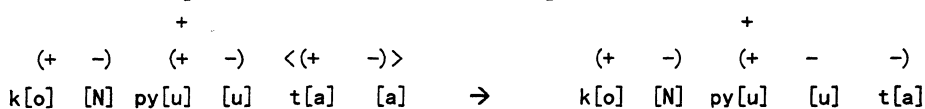
5 Japanese Shortening

On the other hand, Japanese shortening tends to take place when a metrically unstable binary foot (extrametrical foot) becomes a stray mora so as to be accommodated into the other proposed foot structure in (13b). This point is illustrated in (15).

(15) Japanese Shortening



The hierarchical representations above can be simplified as follows.



Accordingly, a representative shortening in (4) can be illustrated as follows:

$$\begin{array}{ccc}
 + & & + \\
 (+ \quad -) < (+ \quad -) > & & (+ \quad - \quad -) \\
 f[o] \quad r[u] \quad d[a] \quad [a] & \rightarrow & f[o] \quad r[u] \quad d[a]
 \end{array}$$

Note that in comparison with the surface ternary template in Fijian (13a), the specifier follows the complement in (13b); thus a stray mora in (15) can be accommodated under the specifier within the ternary foot structure. The shortening is a process that permits a more complete parse into the canonical surface ternary foot template.

6 Conclusion

I have analyzed accent patterns of recent Japanese loanwords with the strictly binary foot parsing and the foot extrametricality. While the analysis predicts the correct accent position, the strictly binary foot parsing creates a stray mora between two bimoraic feet. I have conducted a phonetic experiment as to how stray moras are organized to achieve surface exhaustivity in Japanese. Based on the result of the phonetic experiment, I have concluded that in Japanese stray moras are incorporated under the preceding bimoraic feet at the surface level. On the other hand, in Fijian Schütz (1985) shows that stray moras are incorporated under the following bimoraic feet at the surface level.

The Japanese leftward surface-adjunction is quite different from the type claimed for Fijian by Schütz. Following the discussion for the syllable internal structures, the foot can be seen as the maximal projection of the head mora marked by '+' and then, I have proposed two cognitive surface ternary foot structures for and Fijian and Japanese. Based on the proposed cognitive surface ternary foot structures in (13), I have argued that Fijian Trochaic Shortening and Japanese shortenings are triggered by two distinctive types of extrametricality — mora and foot extrametricality respectively. The distinct shortening phenomena observed in Fijian and Japanese can be accounted for simply on the ground of parametrical differences.

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