

Moras, Syllables, and Feet in Japanese

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Han (1994) argues that moras are isochronous units, but no inference is drawn for isochrony regarding the length of the syllable in Japanese. As the tempo of speech increases, however, the phonetic reality of moras seems to become less obvious (Beckman 1982 and Larish 1989). This paper provides a new insight on the apparent gap between phonology and phonetics, which comes from the distinction between Initial Foot Parsing (IFP) and Surface Foot Parsing (SFP). Moreover, it emphasizes an important consideration of timing units larger than moras.

1. INTRODUCTION

1.1. MORAS IN JAPANESE

Moras are traditionally considered to be abstract units, but ones that play a crucial role in Japanese phonology (Bloch 1950, Hockett 1955, and Ladefoged 1982). Japanese poetry is often cited as proof that the mora is a psychological unit. Haiku, consisting of three lines of five, seven, and five *onsetsu*, is one form of Japanese poetry. *Onsetsu* is often translated as 'syllables' in some of the Japanese literature, but this is a mistranslation. If the syllables are all light, as in (1a), the syllable count and the mora count agree as to the *onsetsu*. But in (1b), the *onsetsu* of the poetry coincides with the mora count, but not the syllable count.

(1) a. *Onsetsu* = Mora = Syllable

<i>fu ru i ke ya</i>	'an old pond'
<i>ka wa zu to bi ko mu</i>	'a frog hopped into'
<i>mi zu no o to</i>	'the sound of water'

b. *Onsetsu* = Mora ≠ Syllable

<i>ka ki ku e ba</i>	'eating persimmon'
<i>ka ne ga na ru na ru</i>	'the bell rings'
<i>hoo ryuu ji</i>	'at the Horyuji temple'

Vance (1987) argues for the indispensable psychological reality of the mora. He notes that when a glottal stop follows word endings in /Vi/, as in an accented word like /háí/ 'yes', the vowel sequence squeezes into a single mora. This point is schematized as follows.

(2) Glottal Stop Compensation

	μ	μ			μ	μ
			→			
h	a	i		h	ai	ʔ

After the two vowels are squeezed into a single mora to make a diphthong at a rapid speech style, the stranded mora is realized as a glottal stop to maintain its durational tempo.

Han's (1994) phonetic experiment shows evidence to determine the acoustic correlates of mora timing. The mora, therefore, is accepted by many Japanese scholars as psychological units in Japanese. However, it should be noted that some scholars (Beckman 1982 and Larish 1987) deny the phonetic reality of the mora in Japanese.

1.2. SYLLABLES IN JAPANESE

When western scholars first introduced the concept of the syllable, many Japanese scholars did not accept it as a phonological unit in Japanese. Currently, the vast majority of Japanese scholars accept the notion of mora as a psychological unit, but the role of syllables in Japanese is still under debate. In general, some scholars accept the syllable as a unit in standard Japanese mainly for the following reasons: if the syllable is defined as the accent-bearing unit, some cases of accent assignment for loanwords or nonsense words can be accounted for in a very general way (McCawley 1968). Generally, the accent for loanwords is assigned on the antepenultimate mora (the third mora from the end), as in (3a). For some other loanwords, the accent is assigned on the fourth mora from the end of a word, as in (3b). With the concept of the syllable, the accent-assignment rule is formulated more simply and accurately by making reference to the syllable that contains the antepenultimate mora.

(3) Accent Assignment in Japanese Loanwords

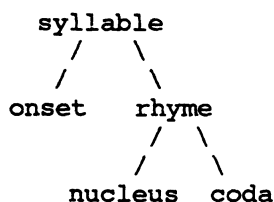
a.	<i>makudonárudo</i>	'MacDonald's'
	<i>pairótto</i>	'pilot'
	<i>sutoráiki</i>	'strike'
b.	<i>bakéesyoN</i>	'vacation'
	<i>koNpyúutaa</i>	'computer'
	<i>diméNsyoN</i>	'dimension'

McCawley's accent-assignment rule, however, fails to account for the accent position of some other loanwords. I will return to this issue in section 7.

2. THE TRADITIONAL VIEW OF SYLLABLE-INTERNAL STRUCTURE

Under the traditional view of the internal structure of the syllable, this phonological constituent is composed of an onset, a nucleus, and a coda. For Hockett (1955), a nucleus is an obligatory member of the unit. The nucleus and the coda form a unit called a rhyme, as in (4).

(4) Syllable Structure (Hockett 1955)



Fromkin and Rodman's (1983) study of speech errors shows that the onset-rhyme boundary in English is a significant switching point.

(5) Speech Errors Found in English

<u>sp</u> l+inters / bl+ <u>i</u> sters	→	<u>sp</u> l+isters
<u>sm</u> +art / cl+ <u>e</u> ver	→	<u>sm</u> +ever
<u>fr</u> +own / sc+ <u>ow</u> l	→	<u>fr</u> +owl
a <u>sw</u> +inging / h+ <u>i</u> p chick	→	a <u>sw</u> +ip chick

By showing that the onset-rhyme boundary in English is a significant switching point, these errors provide evidence of the onset, or rhyme, as a unit. At least, the onset is a single unit.

In Japanese, however, Kubozono (1989) shows that neither the onset itself, nor the rhyme, plays a significant role.

(6) Blend Words in Japanese (Kubozono 1989)

/tomare/ + /sutoppu/ 'stop' 'stop'	→	[tomappu]
/todana/ + /hoNdana/ 'cupboard' 'bookshelf'	→	[ton:dana]
/kosihikari/ + /sasanisiki/ 'rice variety' 'rice variety'	→	[košinišiki]
/teNsai/ + /siNdoō/ 'genius' 'God's child'	→	[ten:do:]
/kodomo/ + /otona/ 'child' 'adult'	→	[kodona]

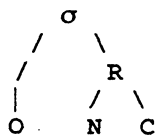
Unlike English, the words above do not have a switching point between the onset and the rhyme.

As Beckman (1982) states, one might relate the evidence as above to the ability of the speakers to recognize the writing system. Katada (1990), however, provides evidence for the switching point between the onset-nucleus and the coda, based on a language game called *siritori* 'end taking' played by two groups of literate adults and illiterate children. In this game, the current speaker is to give a noun beginning with 'the last sound' given by the previous speaker. For instance, one says [riŋgo] 'apple', which ends with [go], and the next speaker takes a turn by giving a word like [gorira] 'gorilla', which begins with [go]. The game is over when a player supplies a word, which ends with the placeless moraic nasal [N], such as [kiriN] 'giraffe' or [mikaN] 'orange', because there is no word beginning with the [N] in Japanese. Katada's paper shows that while the adults' group is orthography-oriented, the children's group is sound-oriented. However, it is very clear that the onset and the nucleus are treated as a single unit and the coda is treated as an independent unit by both groups.

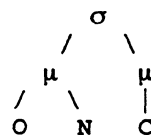
Furthermore, the breakdown into the onset-nucleus, or the coda, in Japanese is confirmed on phonetic grounds. While the lengthening of a vowel before a voiced consonant occurs in English (Chen 1970), in Japanese a preceding segment plays a crucial role for the duration of a vowel in word-medial position in Japanese (Takeda et al. 1989). This suggests that the preceding segment must be closer to the nucleus than the coda in Japanese.

Thus, past studies such as Kubozono (1989), Katada (1990), and Ito et al. (1992) treat moras as subconstituents of syllables in Japanese, as in (7b), as opposed to the representation in (7a), which is often considered as the universal syllable structure. The lower-case 'σ' is used to refer to a syllables, and the mu 'μ' to a mora.

(7) a. English Syllable Structure



b. Japanese Syllable Structure



R: Rhyme
O: Onset
N: Nucleus
C: Coda

The representation in (7b) clearly shows that the nucleus and the onset are tied up together in a single unit and the coda is independent from the rest. It seems very appropriate for Japanese syllable structure. However, it falsely

indicates that the onset and the nucleus form a mora as a single unit. Hayes (1995) states that no language assigns moraic values to onset consonants. I will return to this issue in section 6.

3. FEET IN JAPANESE

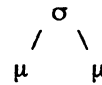
The emergence of the notion of mora under theories of metrical phonology stems from the mora concept of the Prague School that gives weight to syllables (Trubetzkoy 1969). Thus, a light syllable is defined as consisting of one mora and a heavy syllable as consisting of two moras. In other words, moras are considered to be subconstituents of syllables. Recently, in the literature dealing with the concept of prosodic hierarchy in Japanese, prosodic syllables have been discussed. While Kubozono (1989), Katada (1990), and Ito et al. (1992) provide insightful accounts for the syllable-internal structure in the language, they all maintain that moras are subconstituents of syllables, as in (8).

(8) Prosodic Syllables in Japanese

a. Light Syllable



b. Heavy Syllable



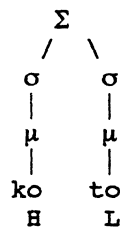
Poser (1990) claims that two moras are associated with a higher metrical unit, a foot, in Japanese. He provides eight pieces of evidence for bimoraic foot phenomena. One piece of his evidence comes from truncated words with a hypocoristic form (endearing form), *tyaN*. It is always preceded by two moras, but not always two syllables. This point is illustrated, as in (9). A '+' in the original names indicates a morpheme boundary.

(9)	original names	→	TruncatedNames	Mora-count	Syllable-count
a.	<i>ina+ba</i>	→	<i>inatyaN</i>	2	2
b.	<i>yama+kosi</i>	→	<i>yamatyaN</i>	2	2
c.	<i>ka+too</i>	→	<i>katotyaN</i>	2	2
d.	<i>koN+doo</i>	→	<i>koNtyaN</i>	2	1
e.	<i>iti+no</i>	→	<i>itityaN / ittyaN</i>	2	2 / 1

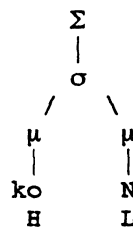
If Japanese feet are bimoraic, each foot contains the same number of moras, but not necessarily the same number of syllables. In other words, a bimoraic foot may consist of one or two syllables, regardless of accent position, as shown in (10). The upper-case sigma 'Σ' indicates an isochronous unit called a foot. A high-tone (H) or low-tone (L) is linked to a mora.

(10) Prosodic Foot in Japanese (Moraic Trochees)

a. *koto* 'Japanese harp'



b. *koN* 'navy blue'



The representations in (10) are labeled moraic trochees in the foot typology of Hayes (1995). His metrical stress theory focuses on stress languages, based on the earlier proposition (Jakobson 1931) that the stress-bearing unit is

the syllable. Thus, it claims that feet are built on syllables in all stress languages, and moras as weight units are subconstituents of syllables.

4. STATEMENT OF PROBLEMS

When we posit moraic trochees, in which moras are subconstituents of syllables, we face up to a problem. Consider the following two syllable internal structures.

(11) Two Types of Syllable Internal Structure

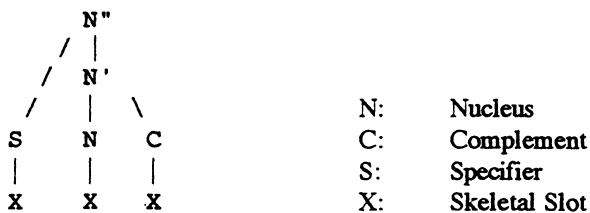


Hayes (1989) stated that since no language assigns a moraic value to an onset consonant, the onset consonant is attached to the syllable node, as in (11a). However, Hayes (1995) currently employs representation (11b), following treatments of Hyman (1985), Katada (1990), and Ito et al. (1992), in which the onset belongs to the first mora, as in (11b). The representation in (11a) seems more preferable for English because the onset is treated as an independent unit. The representation in (11b) seems appropriate for Japanese because the onset and the nucleus are treated as a single unit. However, the representation in (11a) does not comply with the theory of prosodic hierarchy (Selkirk 1980, Ito 1986, and Hayes 1990), which requires that every prosodic element must be immediately dominated by a one-step higher prosodic element. In (11b), on the other hand, the onset is considered to be part of a mora, but in no language is a mora value assigned to an onset consonant, hence the 'paradox'.

5. SYLLABLE STRUCTURE BASED ON THE X-BAR CONVENTION

Levin (1985) extends the x-bar convention to phonology. She proposes that the syllable is the maximal projection (N^{''}) of the single primitive category or nucleus (N). Based on her extended x-bar analysis, the traditional syllable structure in (7a) is represented as follows.

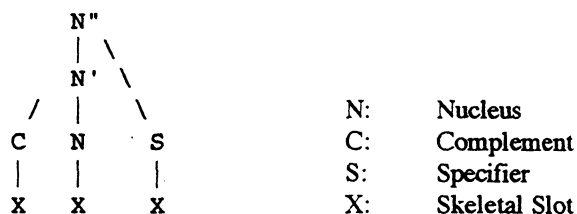
(12) English Syllable Internal Structure (Levin 1985)



The syntactic terms, complement and specifier, are used to indicate distance relationships. That is, the complement has a closer relationship to the nucleus than the specifier. The traditional term, rhyme, is viewed as N'. The representation above shows that the nucleus and the complement are tied up together in a single unit, and the specifier is an independent unit.

Following Levin (1985), I propose the following syllable internal structure for Japanese, based on the structure in (7b).

(13) Japanese Syllable Internal Structure



The representation above indicates that the complement and the nucleus are tied up together in a single unit and the specifier is an independent unit. The two representations in (12) and (13) reveal structural symmetry between related constituents.

6. A NEW VIEW OF PROSODIC HIERARCHY IN JAPANESE

6.1. THE BIMORAIC TROCHEE

Han (1994) shows that moras are psychologically isochronous units, but no inference is drawn for psychological isochrony regarding the length of the syllable in Japanese. That is to say, moras play a crucial role as timing units in Japanese, but syllables do not. She states that there are many Japanese-Americans who speak perfect Japanese without the ability to read and write the language. They must have acquired regular patterns of timing by listening to the spoken language. Han questions how those illiterate speakers of Japanese could have acquired their oral language by listening and speaking if there is no phonetic correlates to the timing unit. In other words, moras are psychologically isochronous units, which must correlate patterns of timing at the surface level one way or another.

If syllables do not correlate patterns of timing at the surface level, Hayes' (1995) moraic trochees in (10), which are originally proposed for stress languages, are misleading for Japanese. Syllables are neither the basic timing units nor parsable units, on which feet are built. Moras are the units of timing and directly related with feet. There is no reason for syllables to interpose between moras and feet. I propose the following bimoraic trochee for Japanese.

(14) Foot Structure in Japanese (Bimoraic Trochee)



Syllables are divorced from the foot and moras are direct subconstituents of the foot. Then, a question arises as: what is the role of syllables in Japanese? The answer lies in the fact that syllables are associated with the sonority scale as production units in Japanese.

The divorced syllables are freed into a separate hierarchy; yet the whole prosodic make-up of Japanese includes the syllable structure. I will illustrate the whole prosodic hierarchy of Japanese in section 8.

6.2. INITIAL FOOT PARSING AND SURFACE FOOT PARSING

When the strictly binary moraic feet are constructed, stray moras may occur. One important question is how and when exhaustivity should be achieved when there are stray moras. Halle and Vergnaud (1987) argue that the exhaustivity condition should be respected in foot parsing.

(15) Exhaustivity Condition (Halle and Vergnaud 1987)

Rules constructing constituents apply exhaustively over the entire string.

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. Instead, the strict binarity requirement must be preserved at the initial parsing level, but the initial parsing allows stray moras. Along with these arguments, the bimoraic trochee in (14) can be defined as the initial foot as contrasted with the surface foot. 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). Furthermore, I include the idea that prosodic organization into a foot structure arises in the process of ongoing speech by complying with surface exhaustivity. IFP takes place right to left in Japanese and left to right in some other languages. However, based on the idea that footing occurs in ongoing speech, SFP should always take place from the beginning to the end of its domain, achieving surface exhaustivity. Levin (1988) reports that in Cahuilla foot parsing takes place from right to left after prefixation and from left to right after suffixation. If footing occurs in ongoing speech such bidirectionality is very peculiar. The distinction between IFP and SFP provides an explicit account of the bidirectionality.

6.3. SURFACE EXHAUSTIVITY

Schütz (1985) provides foot structures for Fijian loanwords. He uses neither the term stray mora nor the distinction between the initial foot and surface foot, but I interpret his representations as follows. Bimoraic feet are built allowing stray moras at initial foot parsing. The output forms of initial parsing are represented in (16a-i) and (16b-i). The stray mora is incorporated under the following bimoraic foot at surface foot parsing. A pair of square brackets is used to indicate a mora and a pair of parentheses to indicate a foot. The '+' in a pair of parentheses is used to refer to the head element of a foot and the '-' to the non-head element. Main accent is specified by an acute accent mark ' ´ ' and secondary accent by a grave accent mark ' ` '.

(16) Initial Feet and Surface Feet in Fijian

a. *pàrakaràvu* 'paragraph'

(i) Initial feet	→	(ii) Surface feet
(+ -) - (+ -)		(+ -) (- + -)
p[a]r[a]k[a]r[a]v[u]		p[a]r[a]k[a]r[a]v[u]

b. *tàlevisóni* 'television'

(i) Initial feet	→	(ii) Surface feet
(+ -) - (+ -)		(+ -) (- + -)
t[a]l[e]v[i]s[o]n[i]		t[a]l[e]v[i]s[o]n[i]

The stray moras above are associated with the following foot in Fijian. A number of Japanese loanwords show that stray moras appear word-initially, word-medially, and word-finally.

(17) Stray Moras in Japanese

a. Word-initial: *puríNsesu* 'princess'

- (+ -) (+ -)
p[u]r[i]N[s]e[s]u

b. Word-medial: *bátoman* 'batman'

(+ -) - (+ -)
b[a][t]t[ó]m[a]N

c. Word-final: *tefebi* 'television'

(+ -) -
t[e]r[e]b[i]

The word-initial stray mora in (17a) may attach to the following foot, and the final stray mora in (17c) to the preceding foot. However, the word-medial stray mora in (17b) possibly attaches either to the preceding foot or the following foot. Inaba's (1997) phonetic experiment provides evidence for surface feet and shows that at the surface level in Japanese, the word-medial stray moras are associated with the preceding feet rather than with the following feet. Moreover, the experiment shows that the initial stray mora is extrametrical, which is indicated by '<>', as in (18b).

(18) Initial Feet and Surface Feet in Japanese

a. *báttomaN* 'batman'

b. *puríNsesu* 'princess'

(i) (+ -) - (+ -)
b[a] [t]t[o]m[a][N]

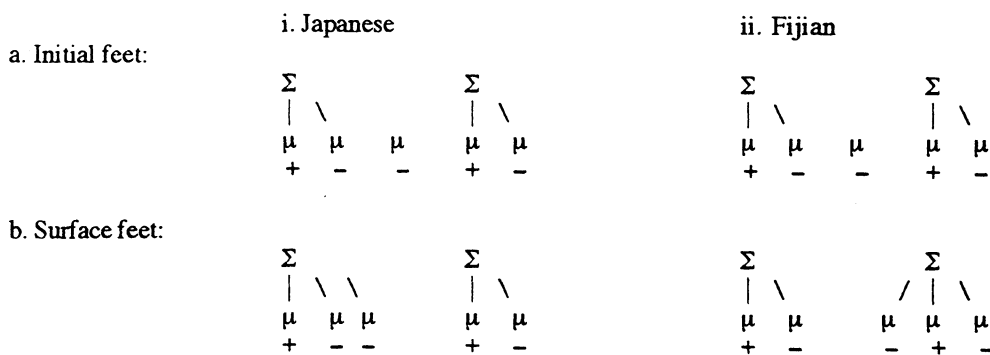
- (+ -) (+ -)
p[u]r[i][N]s[e]s[u]

(ii) (+ - -) (+ -)
b[a] [t]t[o]m[a][N]

(<-> + -) (+ -)
p[u]r[i][N]s[e]s[u]

At the surface level, the non-initial stray mora is associated to the preceding foot. This Japanese leftward surface-adjunction is quite different from the type claimed for Fijian (Schütz 1985). This point is illustrated in (19).

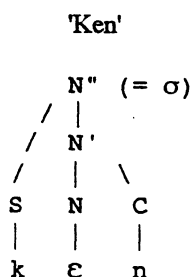
(19) Initial and surface feet in Japanese and Fijian



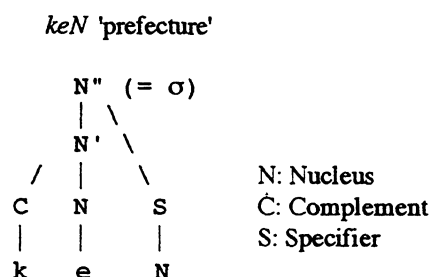
It is very clear that the surface foot structures are either binary or ternary. However, the relationship among moras is not yet clear in the flat representations in (19). The head element, marked by '+', must be closer to one of the non-head elements, marked by '-', than the other. Interestingly, they are very similar to the syllable structures represented in (12) and (13). They are repeated in (20).

(20) Syllable Internal Structures

a. English



b. Japanese

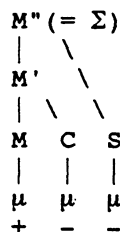


6.4 SURFACE FEET IN JAPANESE

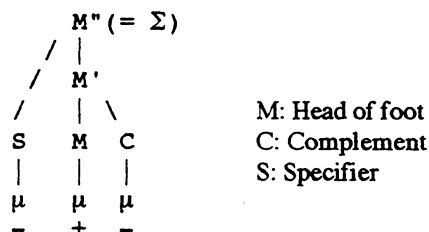
Following the discussion in section 5 for the syllable internal structures, the foot can be viewed as the maximal projection of the head mora marked by '+'. We then arrive at the following surface foot structures for Japanese and Fijian, based on the representations in (19).

(21) Prosodic Surface Feet

a. Japanese Surface Feet



b. Fijian Surface Feet



Each hierarchical foot structure above is viewed as the maximal projection of the head element marked by '+'. It clearly shows that the complement (obligatory) is closer to the head than the specifier (optional). Moreover, it is more constrained than the flat representations in (19) in the sense that only strictly binary branching is allowed at each level. This strict binarity is parallel to the labels S (strong) and W (weak), which are relationally defined in major metrical theories. Another parallelism is that in both the syllable-based and the foot-based analyses, the specifier either precedes or follows the head, depending on the language. The surface foot structures in (21) predict that non-initial stray moras are only allowed to be associated with the specifier position (a right branch) of the preceding foot in Japanese and stray moras are with the specifier position (a left branch) of the following foot in Fijian.

7. A METRICAL APPROACH TO ACCENT PATTERNS OF LOANWORDS

McCawley's accent -assignment rule fails to account for the following loanwords. The accent does not fall on the syllable containing the antepenultimate mora.

(22) Exceptions to McCawley's Accent-Assignment Rule

a.	<i>herikóputaa</i>	'helicopter'
b.	<i>arérugii</i>	'allergy'
c.	<i>orijinárítii</i>	'originality'
d.	<i>rejísutaa</i>	'register'
e.	<i>dirékutaa</i>	'director'
f.	<i>akóodioN</i>	'accordion'
g.	<i>resépusyoN</i>	'reception'

I explore the theoretical underpinning of proposed foot structures by reexamining the accent patterns of Japanese loanwords. Initial feet and surface feet of the representative examples are shown as below. Extrametricality is indicated by '<>'.
'<>':

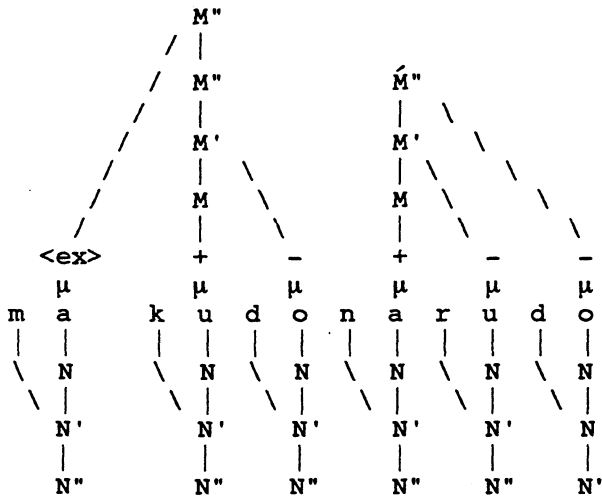
(23)	a. <i>makudonárudo</i>	b. <i>puríNsesu</i>	c. <i>herikóputaa</i>
(i) Initial Feet:	- (+ -) (+ -) - μ μ μ μ μ μ m a k u d o n a r u d o	- (+ -)<(+ -)> μ μ μ μ μ μ p u r i N s e s u	(+ -) (+ -)<(+ -)> μ μ μ μ μ μ h e r i k o p u t a a
(ii) Surface Feet:	+ (<> + -) (+ - -) μ μ μ μ μ μ m a k u d o n a r u d o	+ (<> + -) <(+ -)> μ μ μ μ μ μ p u r i N s e s u	+ (+ -) (+ -)<(+ -)> μ μ μ μ μ μ h e r i k o p u t a a

In Surface Foot Parsing (IFP), stray moras are incorporated under the surface ternary foot structure achieving surface exhaustivity. If we assume that the right-peripheral bimoraic foot is extrametrical, as in (23b-i) and (23c-i), their accent patterns are accounted in a unified manner. That is, accent is assigned to the head of the final visible foot. As in (23a-i), if a stray mora intervenes between it and the word boundary, the final foot is not peripheral, and the foot extrametricality is then blocked by the Peripherality Condition (Hayes 1995). The '+' on the right-peripheral top of the existing '+' in (23ii) indicates the accent position of the loanwords.

8. SURFACE PROSODIC MAKE-UP

The loanword *makudonarudo* 'MacDonald's', for instance, is assumed to have the following surface foot and syllable structures. Following Halle's (1982) extension of Archangeli (1981) with regard to a word-initial extrametricality, the initial stray mora marked by '·' is adjoined to an expanded Mⁿ (Chomsky Adjunction). I omit the x-tier to avoid unnecessary complication in the representations, but it should be understood that the foot and syllable structures are built on the x-slots and moraic values are associated with the x-slots as well. The whole prosodic make-up includes mora-based foot structures on one hand and syllable structures on the other.

(24) a. *makudonárudo* 'MacDonald's'



9. CONCLUDING REMARKS

Moras are generally believed to be abstract psychological units in Japanese. As the tempo of speech increases, however, the phonetic reality of moras becomes less obvious. The proposed prosodic hierarchy answer the question of why phonetic experiments have not successfully convinced us of the surface reality of moras at a relatively fast tempo, but have instead just provided a tendency toward mora isochrony at the surface level. That is to say, feet are bimoraic or trimoraic and thus moras themselves are no longer direct timing units at the surface level. This paper emphasizes an important consideration of the timing units larger than moras.

Vance (1987) suggests that researchers must distinguish elaborate from careful pronunciations. Native speakers' intuitions apply to careful pronunciations. Elaborate pronunciations refer to overly precise pronunciations. Han had her subjects use careful pronunciations. Beckman conducted her experiment at 'a comfortable speaking rate'. It is assumed that Beckman's data were obtained at a faster tempo than Han's. Han's study is more likely to reveal native speakers' intuitions, but as the tempo of speech increases, the phonetic reality of moras becomes less obvious. The surface prosodic make-up in (24) reveals this fact. A new insight on the apparent gap between phonology and phonetics comes from the distinction between Initial Foot Parsing (IFP) and Surface Foot Parsing (SFP).

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