The Phonetic Basis of Phonological Foot: Evidence from Japanese

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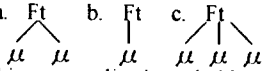
ABSTRACT

It is widely recognized that bimoraic foot represents the most canonical foot form in the phonological theory of stress and rhythm. This paper explores the phonetic basis of bimoraic units in phonological descriptions by analyzing some phonetic, phonological and lexical phenomena in Japanese from various viewpoints including historical phonology, comparative phonology and language acquisition.

INTRODUCTION

It is generally agreed that bimoraic foot represents the most unmarked foot structure. In the metrical typology of linguistic rhythm [1], for example, quantity-sensitive languages can take one of the two metrical principles, iambic or trochaic, for both of which bimoraic feet (1a) represents a better configuration than monomoraic (1b) or trimoraic feet (1c).

(1) a. Ft b. Ft c. Ft



This generalization holds true of Japanese, where the notion 'bimoraic foot' allows us to generalize a wide range of phenomena from morphological to pitch-related processes [2]. Although there is some evidence for monomoraic feet in (1b) in this quantity-sensitive system [3], bimoraic feet are no doubt much more unmarked than monomoraic feet.

While the notion 'foot' is known to be indispensable for morphological and phonological descriptions in general, it is by no means clear why such a phonological unit exists, specifically why 'bimoraicity' rather than monomoraicity or trimoraicity represents the most canonical foot form in language in general. Since the average duration of the Japanese mora is about 150 msec in normal speech [4], the average duration of bimoraic feet is about 300 msec. The question we should ask, then, is whether bimoraic foot phenomena in Japanese and other languages have to do with this phonetic duration. In this paper I will explore this possibility through analysis of the phonetic structure of bimoraic foot phenomena in Japanese from a historical, psycholinguistic and cross-linguistic viewpoints.

The key to the question of bimoraicity lies in the fact that many, if not all, of the bimoraic foot phenomena in Japanese serve to create heavy (i.e. bimoraic) syllables as opposed to light (monomoraic) and superheavy (trimoraic) syllables. Since the notions 'bimoraic foot' and 'heavy syllable' both involve integrating two moras into one phonological unit, the question of phonological bimoraicity may be linked to the question of why bimoraic syllables are preferred to monomoraic and trimoraic syllables.

DURATION OF RHYTHMIC FEET

The first fact to note regarding the phonetic duration of phonological foot is that stress feet in English and other languages take a similar phonetic duration as the bimoraic feet in Japanese. According to the experimental work by Dauer [5], inter-stress intervals in so-called stress-timed and syllable-timed languages alike fall within the range of 300-600 msec. This tendency may be interpreted as an effect of the 'neural clock' [6], a clock that strikes about two times per second in human mind. If this interpretation is correct, it follows that the Japanese mora is too short to form a rhythmic unit by itself which, in turn, suggests that Japanese has chosen to combine two moras into one unit in order to create a eurhythmic prosodic structure out of the otherwise monotonous sequences of moras. One question that remains is why Japanese does not choose to form trimoraic feet, or a prosodic unit of about 450 msec in phonetic terms: this would be closer to the average duration of the rhythmic feet in other languages and, hence, to the duration dictated by the 'neural clock'. We return to this question at the end of the paper.

CHILD PHONOLOGY

A second piece of evidence for the phonetic interpretation of phonological foot comes from a phonological analysis of children's speech in Japanese. Children's language as well as the language used by adults when addressing to young children in Japanese is crucially different from adults' language per se in containing an extremely high proportion of heavy syllables. This tendency shows up in three independent ways. First, children's vocabulary typically contains words rich in heavy syllables. According to my previous analysis [7], heavy syllables account for fifty percent (or more) of all the syllables occurring in the words spoken by two- to three-year-old children. In fact, words used at this early stage of phonological development typically take one of the two syllable structures in (2): /.I denotes a syllable boundary.

(2) a. Reduplication of a heavy syllable
hai.hai "crawling" pon.pon "belly"
tin.tin "penis"
b. A heavy syllable + a light syllable
man.ma "food" kuk.ku "shoes"
an.yo "foot, leg, walking"

This fact contrasts sharply with the fact about adult speech, where bimoraic syllables account for less than ten percent of all the syllables occurring in natural speech (the rest being light, i.e. monomoraic, syllables).

Secondly, young children show a strong tendency to choose words containing heavy syllables rather than light syllables. According to my own observation, children prefer the words in (3a) to their synonymous counterparts in (3b):

(3) a. is.sai "one year old"
ni.sai "two years old"
san.sai "three years old"
b. hi.to.tu "one year old"
hu.ta.tu "two years old"
mit.tu "three years old"

The preference of bimoraic syllables in (2) and (3) suggests that bimoraic syllables are somehow easier for children to pronounce. This might be taken as implying that it is the phonological structure of heavy syllables and not their phonetic duration that is relevant. However, this interpretation can be refuted by the fact in (4), where it is shown that one- to two-year-old children often lengthen light syllables, showing a free variation between short and long vowels. This suggests that young children at this stage of phonological development adjust the phonetic size of syllables in an attempt to attain the bimoraic duration at the phonetic level.

(4) /ni.sai/ "two years old"
→ [nisai] ~ [ni:sai]
/o.too.san/ "father"
→ [oto:san] ~ [o:to:san]

Interestingly, the tendency toward heavy syllables in (2)-(4) is not a language-specific phenomenon. Allen & Hawkins [8] note a similar tendency with respect to English-speaking children: "children's earliest phonologically patterned untteracnes typically have only heavy syllables.... The development of light syllables therefore represents...an important step in the child's development toward adult phonological rhythm" (p.274).

ADULT PHONOLOGY

It is important to emphasize here that the tendency toward establishing syllables of a bimoraic size is observed in adult language too. In fact, many of the phenomena cited for the phonological notion of bimoraic foot in the literature involve a phonetic lengthening by which bimoraicity is achieved at the phonetic level. For example, many monomoraic content words are lengthened into heavy syllables in their citation form, as illustrated in (5) ([9]). These lengthening processes seem to be phonetic rather than phonological in nature since speakers are generally unaware of the vowel lengthening involved and do not reflect it in writing (note that (5c) occurs only in some dialects of Japanese [4]). Here, again, 'bimoraic foot' phenomena attempt to attain bimoraicity at the phonetic level.

(5) a. days of the week
/ka moku do/ → [ka: moku do:]
"Tuesday, Thursday and Saturday"
b. numbers
/ni go roku/ "256" → [ni: go: roku]
c. nouns
/me/ "eye" → [me:]
/te/ "hand" → [te:]

HISTORICAL EVIDENCE

In addition to the synchronic evidence from modern Japanese, some historical evidence reinforces the idea that phonological units of a bimoraic size are motivated by the temporal structure of speech. Although it is difficult to trace the history of bimoraic feet in Japanese, it is nevertheless possible to trace the history of bimoraic syllables in the

language.

The tendency to create bimoraic syllables is not recent in the history of Japanese. Although Japanese in Nara Period (eighth century) supposedly had only one syllable structure, i.e. CV, and no contrastive vowel or consonant length, it subsequently established heavy syllables (CVC and CVV) as a legitimate syllable structure. Apart from the influence of Sino-Japanese vocabulary which was rich in this second type of syllable structure, the most noticeable internal change which contributed to the development of bimoraic syllables in Japanese is a series of sound change known as *onbin*, which started in early Heian Period (ninth century). This sound change had the effect of converting a sequence of light syllables into a heavy syllable by way of deletion of a consonant or a vowel:

(6) a. tu.ki.ta.ti → tui.ta.ti
"the first day of the month"
b. yo.mi.te → yon.de "to read"

Given this syllable-based account of *onbin*, one may naturally ask why heavy syllables became a legitimate syllable structure suddenly at this stage of the history of Japanese or, stated conversely, why only CV syllables were tolerated in the pre-*onbin* period. The key to this question lies in the distinction between phonological quantity and phonetic duration of the syllable.

The CV syllable in Old Japanese is supposed to have been phonetically much longer than the CV syllable in modern Japanese for several independent reasons. First of all, Old Japanese was closer to a tone language like modern Chinese than a pitch accent language like modern Japanese in terms of the number of distinctive pitch contrasts [10]. Since syllables tend to be longer in duration in a tonal system than in a pitch-accent system — e.g. the average duration of syllables in modern Chinese is reported to be about 450 msec [11], which is three times as long as the average CV syllable in modern Japanese — it can be assumed that the CV syllable in Old Japanese was much longer than the CV syllable in modern Japanese. Secondly, there is historical and synchronic evidence that monosyllabic content words were much longer in Old Japanese than they are in modern Japanese. This is evidenced by historic documents in which monosyllables are transcribed as possessing a bimoraic duration and also by the synchronic fact that monosyllables in the more classical and conservative dialect of Kyoto and Osaka are nearly twice as long as their counterparts in Tokyo Japanese [4].

This leads us to assume that CV syllables in Old Japanese were phonetically more equivalent to heavy syllables (CVV and CVC) than to light syllables (CV) in modern Japanese and, hence, that they were phonetically as well-formed as heavy syllables in quantity-sensitive languages. Seen in this light, *onbin* and other phonological processes responsible for the creation of bimoraic units (heavy syllables and bimoraic feet) can be analyzed as being triggered by the shortening of phonetically long CV syllables. In terms of rhythmic regulation of speech, this means that both the tendency to create heavy syllables and to group two moras into one rhythmic foot, whether at the phonetic or phonological level, can be attributed to a force that imposes bimoraicity on phonological material at the phonetic level of speech.

LOANWORD PHONOLOGY

Before concluding this paper, let us consider the question of why bimoraic feet are generally more favored than trimoraic feet. This question is difficult to answer, but it may be tackled from the viewpoint of the canonical quantity of the syllable. In addition to the phonetic processes described in (4)-(5) above, Japanese exhibits many phonological processes by which bimoraic syllables are established. In loanword phonology, for example, obstruents following a short stressed vowel in the source language are generally geminated in Japanese and, together with vowel epenthesis, produce a sequence of a heavy syllable followed by a light syllable:

(7) Consonant gemination
cup → /kap.pu/
back → /bak.ku/
push → /pus.sju/

However, this phonological adjustment is blocked if the preceding vowel is a long vowel or diphthong, i.e. if consonant gemination would produce a trimoraic syllable rather than a bimoraic syllable.

(8) Antigemination
carp → /kaa.pu/, */kaap.pu/
baiku → /bai.ku/, */baik.ku/

The stressed syllables in (7) result in a heavy syllable by undergoing gemination while those in (8) attain the same syllable quantity by NOT undergoing it. Thus the two phenomena in (7) and (8) have the same target, i.e. phonological creation of heavy syllables.

'Pre-nasal shortening' [12] produces the same effect by shortening long vowels and diphthongs followed by a nasal /n/ in the process of borrowing. This shortening too has the effect of yielding bimoraic syllables in contexts where trimoraic syllables would otherwise be created.

(9) ground → /gu.ran.do/, */gu.raun.do/
angel → /en.zje.ru/, */ein.zje.ru/

The processes in (8) and (9) are particularly interesting in suggesting that trimoraic syllables are as well as monomoraic syllables are marked in Japanese. Again, this is not a language-specific phenomenon but is observed in a variety of languages: see, e.g. [13]. This hints that three moras cannot be easily accommodated into one unit, which may be linked to the fact that trimoraic feet in (1c) are disfavored in the organization of phonological rhythm.

CONCLUDING REMARKS

In this paper I discussed the phonetic nature of phonological foot by presenting, among others, the following two lines of evidence. First, analysis of young children's speech shows two marked tendencies: (i) dominance of phonologially heavy syllables (CVV and CVC) over light syllables (CV), and (ii) lengthening of monomoraic syllables, consequently making syllables of this type equivalent to heavy syllables at the phonetic output of speech. Second, cross-linguistic and historical considerations reveal that CV syllables in Old Japanese were phonetically much longer than light syllables in modern Japanese, and that heavy syllables were established in the language immediately after CV syllables were phonetically shortened due probably to some independent prosodic factors. All these observations can be generalized if it is hypothesized that 'bimoraicity' can be achieved by phonetic means (phonetic lengthening of light syllables) as well as by phonological means (preference of heavy syllables), which, in turn, seems to suggest that 'bimoraicity' embodies a phonetic requirement on the duration of the syllable rather than any formal phonological requirement on the size of the syllable.

The notion 'bimoraic foot' naturally follows from this interpretation in such a way that establishing the bimoraic foot as a phonological unit is another way of establishing a domain where bimoraic duration (about 300 msec) is achieved at the phonetic level of speech. This phonetic notion of bimoraicity can be linked in a natural manner to the phonetic 'stress foot' in English and other languages, which is known to take a similar duration of time.

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REFERENCES

[1] Hayes, B. (1995) *Metrical Stress Theory: Principles and Case Studies*. Chicago: The University Chicago Press.
[2] Poser, W. (1990) "Evidence for foot structure in Japanese", *Language* 66: 78-105.
[3] Kubozono, H. (1995) "Degenerate feet in Japanese", ms. UC Santa Cruz.
[4] Sugito, M. (1989) "Onsetsu ka haku ka (syllable or mora)", in M. Sugito (ed.) *Nihongo no Onsei Onin*. Tokyo: Meiji-shoin.
[5] Dauer, R.M. (1983) "Stress-timing and syllable-timing reanalyzed", *Journal of Phonetics* 11: 51-62.
[6] Allen, G.D. (1973) "Speech rhythm: Its relation to performance universals and articulatory timing", *Journal of Phonetics* 3: 78-86.
[7] Kubozono, H. (1993), The syllable in Japanese, m.s. Osaka University of Foreign Studies.
[8] Allen, G.D. and S. Hawkins (1978) "The development of phonological rhythm", in A. Bell & J.B. Hooper (eds.) *Syllables and Segments*. Amsterdam: North-Holland, 173-185.
[9] Itô, J. (1990) "Prosodic minimality in Japanese", *CLS 26-II: Papers from the Parasession on the Syllable in Phonetics and Phonology*, 213-239.
[10] Komatsu, H. (1981) *Nihongo no Onin (Japanese Phonology)*. Tokyo: Chuo-koronsha.
[11] Mochizuki, Y. (1983) *Chugokugo to Nihongo (Chinese and Japanese)*. Koseikan.
[12] Lovins, J.B. (1975) *Loanwords and the Phonological Structure of Japanese*. Indiana University Linguistics Club.
[13] Myers, S. (1987) "Vowel shortening in English", *NLLT* 5: 485-518.