



PERCEPTION OF MORA IN THE THREE DIALECTS OF JAPANESE

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ABSTRACT

One naturally spoken token of the words *beru* and *beeru* was edited by LPC synthesis to produce stimuli varying in the timing of F0 fall. These stimuli were presented in two durational contexts to listeners representing the three varieties of Japanese who were asked to judge which of the words the stimuli sounded like. The results showed that there was a significant effect of F0 pattern on the judgement made by the Standard and Osaka group whereas no such effect was observed for the accentless group. The durational context played no role for the former group but increased accuracy in judgement for the latter group. The finding that F0 pattern influenced the perception of vowel mora in the Standard/Osaka group gives support to the traditional description that it is the mora, not the syllable, that is the unit of tone assignment in these varieties of Japanese. However, it does not support the definition of the Japanese mora as fundamentally a durational phenomena and nothing else.

I. INTRODUCTION

There has been growing interest in the usefulness of the concept of "mora" in current phonological theory [1][2][3]. However, a precise phonetic nature of mora has yet to be provided. Auer contents that it is difficult or even impossible to give a phonetic definition for mora because of the great variety found in the superficial processes of different languages [4]. On the other hand, a working phonemic definition as a minimal prosodic unit is possible.

In phonetic literature, studies of mora have been focused almost exclusively on Japanese, a well established mora language. In part this is because of the moraic character of the Japanese writing system. The central phonetic issue discussed in relation to mora in Japanese has been its role as a more or less constant unit of timing. It has been claimed that each mora, regardless of its moraic structure, represents an approximately equal length of time [5][6][7]. Experimental evidence has been reported both in support of and against such a claim as well as more radical interpretation of mora-timing [8][9][10][11]. These works, however, lack in some important respects. First, data on vowel and nasal mora are limited in comparison to those on obstruent mora. Second, the factor of pitch accent is not taken into consideration for the vowel mora. For example, all the word pairs for single/geminate vowels used in Han are not strictly minimal pairs since they are accompanied by different tonal patterns [8]. I assume that this is not due to the carelessness of the researcher but due to the fact that it is difficult to find suitable minimal pairs that contrast only in vowel duration in Japanese [12]. Finally, studies on the perception of mora are rare [13].

In most varieties of Japanese, a mora, rather than a syllable, is recognized as the unit of tone assignment. Interestingly, this seems to apply not only for the sonorant mora but for the voiceless obstruent mora as well [14]. Previously, we have provided evidence that change in the fundamental frequency (F0) pattern alone can alter the perception of the vowel mora [15]. Since the relative phonological weight carried by pitch accent differs dialectally, it is reasonable to assume that listeners of varying dialects differ in perceptual sensitivity to F0 patterns. In our pilot study, it was shown that the effect of F0 on the perception of mora was likely to be language (dialect) specific [16]. However, the difference between Standard and Osaka Japanese was not obvious partly due to the small sample size. In the present study we continue to investigate the relative importance of F0 pattern as a perceptual cue for the vowel mora in two durational contexts for the three varieties of Japanese. For our purposes, we have used a classification of Japanese based solely on pitch accent patterns (e.g. Hirayama [17]). Although Hirayama's classification allows for somewhat finer variations, we simplified it into three groups (Osaka, Standard, and accentless) according to the relative importance played by pitch phonology. The relative importance of pitch phonology decreases in that order. That is to say, greater importance of pitch phonology is attributed to Osaka Japanese than to Standard Japanese. The basic experimental design was the same as that used in the previous study [16].

II. METHOD

2.1 Stimuli

A pair of English loan words *beru* 'bell' (2 mora word) and *beeru* 'veil' (3 mora word) were used. These words have pitch accent patterns as [béru] and [béeru] respectively in Standard and Osaka Japanese. In accentless areas, they are spoken with a more or less flat pitch pattern throughout. One naturally spoken token of each of the words by a speaker of Osaka Japanese was computer edited to produce stimuli varying in F0 patterns. The timing of the F0 fall of these words was shifted systematically by LPC synthesis at every 5 frames (32 ms) from the original point. Thus F0 fall was gradually shifted into the vowel [e] for *beru* while F0 fall was gradually moved away from [ee] for *beeru*. Four stimuli were derived from *beru* and five from *beeru* (Fig. 1). The stimuli were randomized in the two durational conditions. First within the same word group, e.g. either *beru* or *beeru* (A), and then across the two words (B). Each stimulus occurred six times in A and five times in B.

2.2 Subjects

21 native speakers of Japanese were selected as listeners in this study. There were seven subjects for each of the three dialects of Japanese. Most of them were guest researchers and their families at Lund University. Care was taken so as not to include a subject who had a complicated accent background, e.g. one who had grown up in Tokyo but whose parents were from Osaka, etc. was not included. None of the subjects had a history of hearing loss or difficulty. The subjects were not informed about the purpose of experiment.

2.3 Procedure

Three experimental test sessions were conducted with groups comprised of 5-8 subjects. They listened to good quality cassette recordings in a small quiet room. After being instructed in the task and given several trials, they were asked to write down either beru or beeru in Japanese Kana as they listened to each stimulus once. There were 99 stimuli randomly organized with 4 second intervals between them.

III. RESULTS

Results are presented in Fig.2. On the horizontal axis, the number of each stimulus is plotted. The vertical axis shows the listeners' responses to be heard as the other word. Difference in response in regard to the durational context, i.e. whether the stimulus was presented within the same word group or whether it appeared across two word groups, is indicated as A and B respectively.

The results show very clearly that the Standard and Osaka group differ from accentless group in their sensitivity to F0 pattern. As the original F0 fall is shifted further and further, listener responses in the former group increased systematically, i.e. they heard it more and more as the other word. Beru 4 stimuli, for which the entire F0 fall was shifted into [e], was heard as beeru by 100% (A) and 79% (B) of the Osaka group and by 81% (A) and 71% (B) of the Tokyo group. Beeru 5 stimuli for which the F0 fall was removed totally from [ee] was heard as beru by 89% (A) and 86% (B) of the Osaka group and by 70% and 86% (B) of the Standard group. An unpaired t-test for these stimuli showed that the difference in response between the Osaka/Standard and non-accent group was significant ($p < 0.005$). The difference between the Osaka and Standard groups were found to be insignificant except for beru stimuli 4 ($p < 0.05$). The accentless group showed no systematic response to the change in F0 pattern.

The durational context played no significant role for the Osaka/Standard group but it increased accuracy in judgement in the accentless group. A paired t-test for each stimuli showed that the difference caused by durational context is significant in the accentless group for the beru stimuli ($p < 0.005$). About 40% of the original beru stimuli was constantly heard as beeru in condition A. In condition B, it was decreased to almost zero. Beeru stimuli, on the other hand, were consistently heard as beru regardless of the condition by this group.

It should be noted that the perceptual capacity was found to be considerably idiosyncratic and within a single speaker the responses were found to be reliable. For example, speaker X judged beru in stimulus 2, 3, and 4 consistently as beeru, while speaker Y regularly judged only stimulus 4 as beeru. As for the effect of F0, there was tendency that when two stimuli of extreme value were adjacently placed, the second one was heard as the other counterpart. In the accentless group, two of the listeners consistently judged all the beru stimulus as beeru in condition A. It was not until they were presented in condition B, that they were differentiated.

IV. DISCUSSION

The results of the present experiment confirmed our previous experiments that F0 pattern has a critical influence on the perception of vowel mora for Standard and Osaka Japanese, at least in the type of material used in this study [15][16]. The important perceptual event appeared to be whether there was a fall in pitch during the vowel [e] or not. If there was, it tended to be heard as beeru and if not, as beru. The duration of [e] in the token beeru was as long as 300 ms yet 71-89% of the stimuli were heard as beru when F0 fall was removed from [e]. For this group, listener judgement in two durational contexts was not significantly different.

The differentiation of beru and beeru, on the other hand, was not at all affected by F0 pattern for the accentless group. About 40% of the beru stimuli in A was judged as beeru. This may be due to the relatively long duration of [e] in the original token. This ambiguity decreased drastically when beru stimuli was mixed with beeru stimuli in condition B. Beeru stimuli was judged as beru both in A and B.

One strong implication here is that the influence of F0 on the perception of vowel mora appears to be heavily dependent on the structure of pitch phonology to which the speaker is familiar with, and that it is not universal. The fact that there was no big difference between the Osaka and Standard groups may

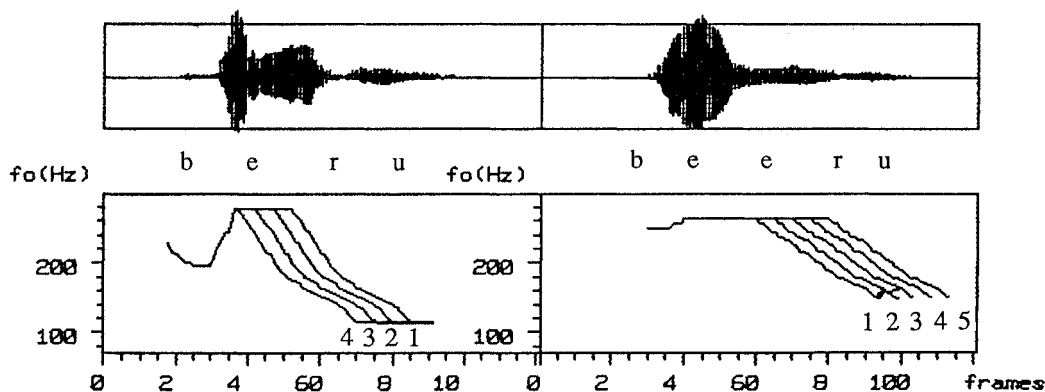


Fig.1 - Waveform and synthesized F0 contour of beru and beeru.

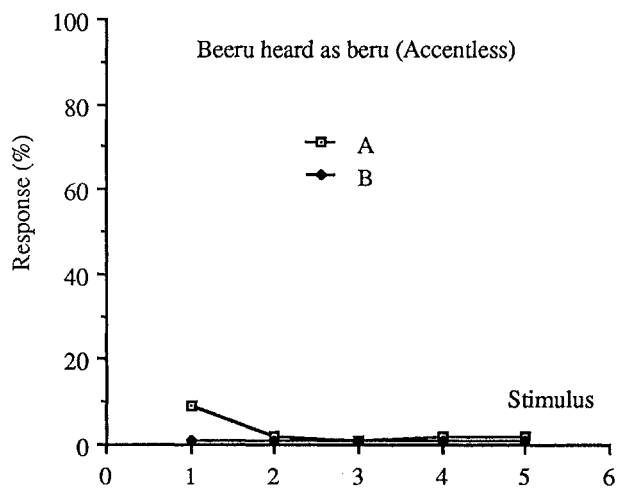
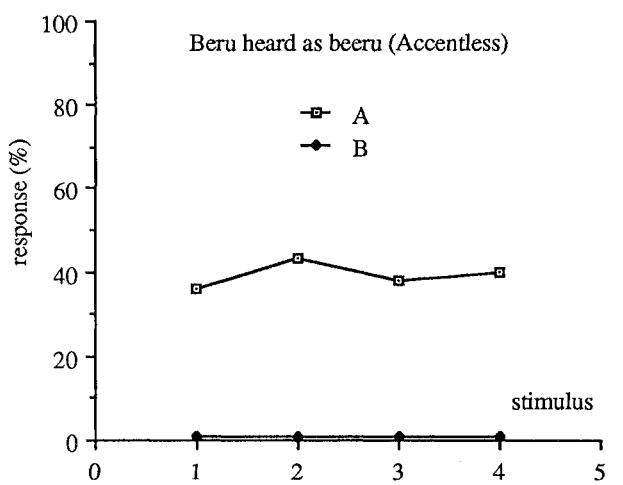
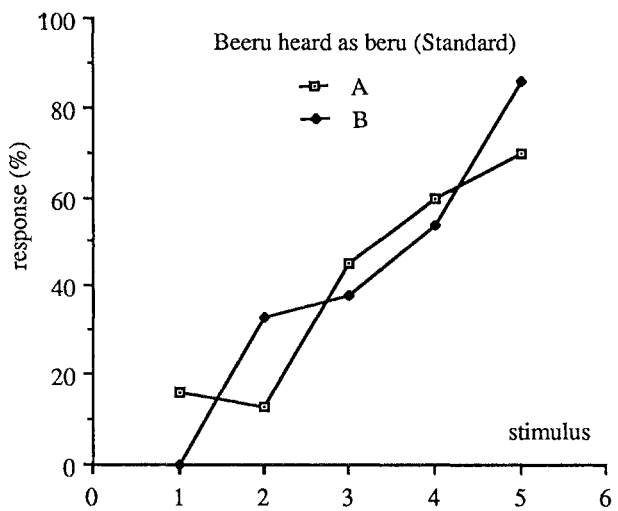
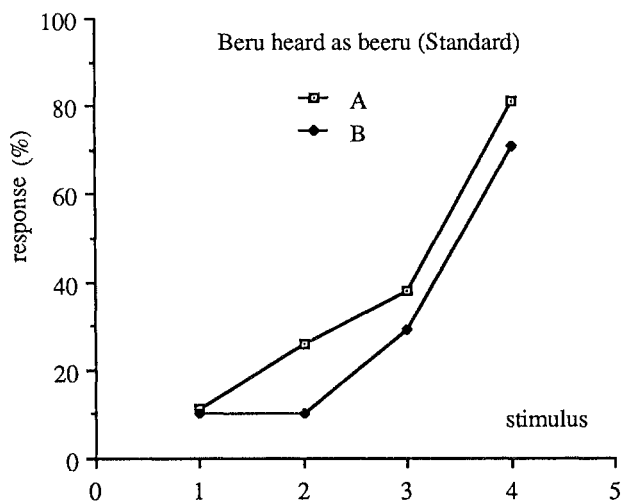
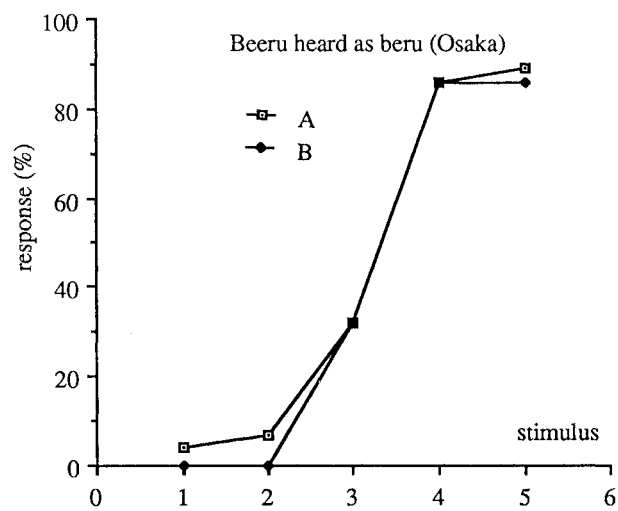
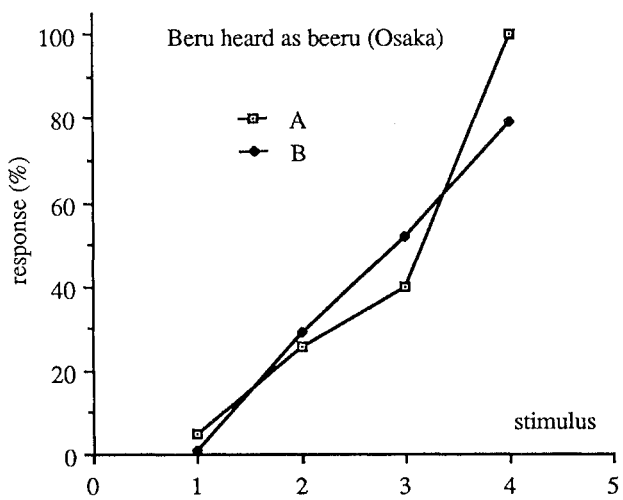


Fig.2 - Effect of F0 and durational context on the perception of *beru* and *beeru*.

imply that listeners are only sensitive to the F0 event which is of phonological importance and not to the F0 in general. Since the pitch accent patterns for the two words used in the experiment were the same for both dialects, the responses were basically the same.

These findings support the traditional description that it is a mora rather than a syllable that is the unit of tone assignment in Standard and Osaka Japanese. On the other hand, the description of the mora solely in terms of duration appears to be inadequate since the timing of F0 alone can change the identification judgement of *beru* and *beeru*. One of the popular methods in which Japanese is classified into different dialects, is by pitch accent pattern [17]. Less common classification systems are based on the basic rhythm unit of the language such as the mora and syllable [18]. It is interesting to note that there is a good match between those regional areas without pitch accent and areas where basic unit of rhythm is a syllable and not a mora. Such observations together with the results of perceptual studies point to the importance of pitch in relation to the issues of mora. To define the Japanese mora "fundamentally in terms of duration and nothing else" should be questioned [6].

The results of our research on mora in Japanese may be of general interest in relation to issues in the perception of speech rhythm and timing. A number of studies have been devoted to the effect of F0 pattern on perceived vowel duration. Both Lehiste and Pisoni found that stimuli with a changing F0 were perceived longer than stimuli with a level F0, while Rosen's experiments did not support such a claim [19][20][21][22]. None of these studies, however, had given very rigorous consideration to the exact role played by F0 and duration in listeners' phonology in relation to the actual material used in their experiments. Our studies on the perception of mora have led us to believe that such considerations are extremely important.

REFERENCES

- [1] A.S.Prince, "A Metrical Theory of Estonian Quantity," *Linguistic Inquiry* 11, pp.511-562, 1980.
- [2] L. Hyman, *A Theory of Phonological Weight*. Dordrecht: Foris. 1985.
- [3] B. Hayes, "Compensatory Lengthening in Moraic Phonology," *Linguistic Inquiry* 20, pp.253-306, 1989.
- [4] P. Auer, "Some Ways to Count Morae: Prokosch's Law, Streitberg's Law, Pfalz's Law, and Other Rhythmic Regularities," *Linguistics* 27, pp. 1071-1102, 1989.
- [5] B. Bloch, "Studies in Colloquial Japanese IV: Phonemics," *Language* 26, pp.86-125, 1950.
- [6] C. Hockett, *A Manual of Phonology*, Bloomington: Indiana University Publications in Anthropology and Linguistics, 1955.
- [7] P.Ladefoged, *A Course in Phonetics*, New York: Harcourt Brace Jovanovich, 1975.
- [8] M.S.Han, "The Feature of Duration in Japanese," *Onsei no Kenkyuu* 10, pp.65-80, 1962.
- [9] C. Hoerquist, "Syllable Duration in Stress-, Syllable- and Mora-Timed Languages," *Phonica* 40, pp.203-237, 1983.
- [10] M. Beckman, "Segment Duration and the "Mora" in Japanese," *Journal of Phonetics* 39, pp.113-35, 1982.
- [11] R.F.Port, J. Dalby & M. O'Neill, "Evidence for Mora Timing in Japanese," *Journal of the Acoustical Society of America* 81, pp.1574-85, 1987.
- [12] Y. Nagano-Madsen, "Mora and Temporal-Tonal Interaction in Japanese," *Working Papers* 35, Department of Linguistics, Lund university, pp.121-131, 1989.
- [13] H. Fujisaki, K. Nakamura & T. Imoto, "Auditory Perception of Duration of Speech and Non-Speech Stimuli," *Auditory Analysis and Perception of Speech*, ed. G. Fant & M.A.A.Tatham, pp197-219, Academic Press, 1975.
- [14] M. Sugito, "Soku-On oyobi Tyoo-On ni Akusento o Oku Hatsuwa no Nenreini yoru Henka to Sono Onkyooteki Tokutyoo," *Kokugogaku* 147, pp.92-106, 1986.
- [15] Y. Nagano-Madsen & L. Eriksson, "The Location of F0 Turning Point as a Cue to Mora Boundary," *Papers from the Third Swedish Phonetics Conference, Speech Transmission Laboratory - Quarterly Progress and Status Report (STR-QPSR) 1/1989*, Department of Speech Communication and Music Acoustics, Royal Institute of Technology, Stockholm, pp.41-45, 1989.
- [16] Y. Nagano-Madsen, "Influence of Fundamental Frequency Pattern on the Perception of the Vowel Mora in Japanese," *Papers from the Fourth Swedish Phonetics Conference, PHONUM*, Department of Phonetics, University of Umeå, pp.31-34, 1990.
- [17] T. Hirayama, *Kokugo no Onsei*. Iwanami Syoten, Tokyo, 1971.
- [18] Nihongo Hyakka Dai-Jiten, ed., H. Kindaiti, D. Hayasi, and T. Sibata, *Taisyuukan Syoten*, pp.952, 1988.
- [19] I. Lehiste, "Influence of Fundamental Frequency Pattern on the Perception of Duration," *Journal of Phonetics* 4, pp.113-117, 1976.
- [20] D. B. Pisoni, "Fundamental Frequency and perceived Vowel Duration," *Research on Speech Perception, Progress Report No.3*, Department of Psychology, Indiana University, pp.146-154, 1976.
- [21] S.M. Rosen, "The effect of Fundamental Frequency Patterns on Perceived Duration," *STL-QPSR 1/1977*, pp.17-30, 1977.
- [22] S.M. Rosen, "Fundamental Frequency Patterns and the Long-Short Vowel Distinction in Swedish," *STR-QPSR 1/1977*, pp.31-37, 1977.