

# Quantity Comparison of Japanese and Finnish in Various Word Structures

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## Abstract

The durational patterns of short and long vowels and consonants were investigated at the segmental and lexical level using variable syllable structures in Japanese and Finnish. The results showed that the Japanese segmental ratios between short and long in both vowels and consonants were longer than those of Finnish only when all segments were pooled. However, this was not necessarily true when observing their positions in different structures. Compared the lexical increase ratios based on the CVCV words, Japanese and Finnish showed regular patterns according to the word structures respectively. The Japanese patterns were very isochronical in any word structures, whereas the Finnish durational ratios stably decreased within the same moraic word structures with the same number of segments but different combinations of the same vowel and consonant. These results suggest that Japanese has a tendency to be more mora-counting than Finnish in temporal isochrony.

## 1. Introduction

Japanese and Finnish can be compared in terms of the durational differences of short/long vowels and short/long consonants that are linguistically distinctive. Finnish syllable structures are more complicated than Japanese. Standard Japanese is a mora-counting and pitch-accented language, while standard Finnish has a strong tendency to trochaic rhythm. Among bisyllabic words Finnish has eight different syllable structures as the combination of the short/long vowels and the short/long consonants – CVCV, CVCVV, CVVCV, CVCCV, CVVCVV, CVCCVV, CVVCCV, and CVVCCVV. On the other hand, Japanese can have seven of these, i.e. except for CVVCCVV. In this study I used bisyllabic words containing /a/ and /aa/, and /m, p, s/ and /mm, pp, ss/, in which Finnish and Japanese have a contrast between short and long segments in common. These eight kinds of structure words are counted as having two to five morae in the Japanese mora-counting concept. Neither of these two languages share meaningful words which all have these combinations with exactly the same short/long vowels and consonants. Therefore, I used nonsense words for both languages. In this study I investigated following questions.

- Are there differences in producing short and long segments between Japanese and Finnish?

- Are there differences in word duration between these two languages when syllable structure differs?
- Do word durations increase regularly according to the increasing number of morae when the number of segments increases in Japanese and Finnish?

## 2. Experimental procedure

Test words in eight syllable structures for Finnish and Japanese are listed in Table 1.

Table 1: Test words in eight syllable structures for Finnish and Japanese.

Syllable structure	Test word	Test word	Test word
CVCV	mama	papa	sasa
CVCVV	mamaa	papaa	sasaa
CVVCV	maama	paapa	saasa
CVVCVV	maamaa	paapaa	saasaa
CVCCV	mamma	pappa	sassa
CVCCVV	mammaa	pappaa	sassaa
CVVCCV	maamma	paappa	saassa
CVVCCVV	maammaa	paappaa	saassaa

These test words were imbedded in a carrier sentence for respective language.

- Finnish: *Sanokaa \_\_\_\_\_ kahdeksan kertaa.* (Please say \_\_\_\_\_ eight times.)
- Japanese: *Mooikkai \_\_\_\_\_ to itte kudasai.* (Please say \_\_\_\_\_ once more.)

Informants were Tokyo dialect speakers and southern Häme dialect speakers, who are from Helsinki and the surrounding area, respectively. Both language speakers had no or a little knowledge of the other language. The test words were read five times by the respective three informants as the words were written according to the writing system of the respective language. Japanese test words were written by only in *hiragana* so that the informants could concentrate only on their sound. The informants of both languages were given instructions to read at the natural speed of their own. The recordings were made in the recording room of the Department of Phonetics at the University of Helsinki. For

the recordings a DAT tape recorder and microphone AKG C420 were used. The microphone was securely fixed so that the distance between the mouth and the microphone remained unchanged. The speech was digitized as sound files using the speech analysis programme Praat 4.0.1. The number of word tokens was 720 and that of segmental tokens was 2,880. Spectrograms were used to measure the segmental durations. Long segments had no internal segment boundary and were measured as one segment.

### 3. Results and analysis

All the data from vowels and consonants were pooled together and calculated to acquire the overall mean values of the segments and words.

#### 3.1. Segmental durations

Table 2 shows the pooled overall mean durations of the short/long vowels and short/long consonants respectively.

Table 2: Overall mean durations of the segments in Japanese and Finnish and durational differences between the languages. a=/a/, aa=/aa/. p, m, s=/p, m, s/, mm, pp, ss= word-medial /mm, pp, ss/.

Segments	Japanese (ms)	Finnish (ms)	Difference (ms)
a	79,6	79,3	0,3
aa	199,3	180,5	18,8
m	69,2	69,1	0,2
mm	161,4	137,3	24,1
p	96,4	94,4	2,0
pp	206,4	188,3	18,1
s	88,5	82,8	5,7
ss	172,4	168,2	4,2

Japanese vowel durations in both short (79.6 ms) and long (199.3 ms) were longer than their Finnish counterparts (79.3 ms and 180.5 ms respectively). The ratios between /a/ and /aa/ were 1:2.3 for Finnish vs. 1:2.5 for Japanese. The difference of the ratios between short and long vowels was longer (20 %) in Japanese than in Finnish. The difference durational values were 0.3 ms for /a/ and 18.8 ms for /aa/ between two languages. This may indicate that the mean duration of Finnish /a/ is nearly the same as the Japanese counterpart, but that of Finnish /aa/ is shorter than that of the Japanese counterpart.

The mean durational values of all consonants /p, m, s, pp, mm, ss/ were higher in Japanese than in Finnish. The ratios between word-medial /p, m, s/ and their long counterparts /pp, mm, ss/ were as follows.

p:pp → Finnish 1:1.99 (94.4 ms:183.3 ms) < Japanese 1:2.14 (96.4 ms:206.4 ms)

m:mm → Finnish 1:1.99 (69.1 ms:137.3 ms) < Japanese 1:2.33 (69.2 ms:161.4 ms)

s:ss → Japanese 1:1.95 (88.5 ms:172.4 ms) < Finnish 1:2.03 (82.8 ms:168.2 ms),

These indicate that the Finnish durational ratio between /s/ and /ss/ was longer than the Japanese counterpart but the Japanese comparative ratios between /p/ and /pp/ and /m/ and /mm/ were longer than the Finnish counterparts.

When vowels, short or long, were positioned in the first syllable or in the second syllable and in different syllable structures, there were significant durational variations as shown in Figures 1 and 2.

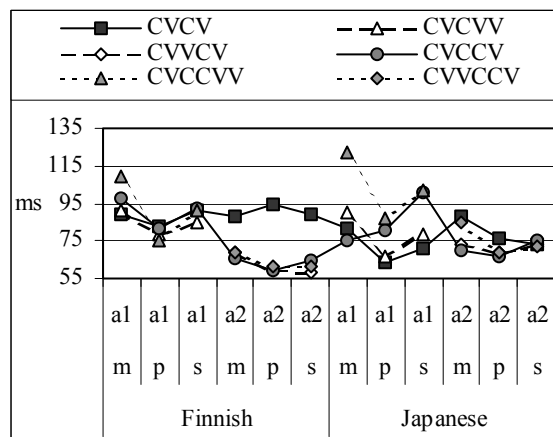


Figure 1: Mean durational comparisons of a1 and a2 in Finnish and Japanese, according to their positions and syllable structures. a1=/a/ in the first syllable, a2=/a/ in the second syllable.

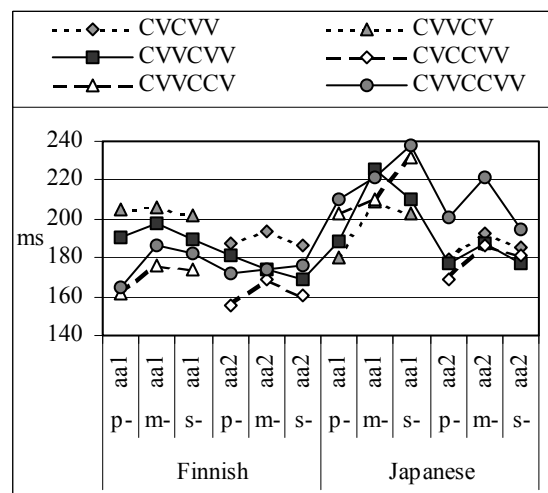


Figure 2: Mean durational comparisons of aa1 and aa2 in Finnish and Japanese, according to their positions and syllable structures. aa1=/aa/ in the first syllable, aa2=/aa/ in the second syllable.

The overall variations between the two languages were particularly higher in Japanese aa2 than Finnish aa2. The

variations of aa1 within each language were higher in Japanese than Finnish, but aa2 had the opposite result. There was a tendency for CVVCCVV structured words that have relatively high values in the variance compared to the other word structures in Japanese and Finnish. Thus, the vowel durational variations depended on surrounding consonants and their quantity. Japanese had higher variations than Finnish. Particularly the Japanese /a/ in the first syllable had a very high value. In all cases the variances between a1 and a2 and between aa1 and aa2 largely depended on the word structure and preceding and following consonants.

The overall mean durations of these consonants varied greatly depending on their positions and syllable structures as well as vowels, as shown in Figures 3-5. I presume that a plosive duration comprised a closure part and a VOT. The closure part and VOT were added to get the duration for the plosives /p, pp/.

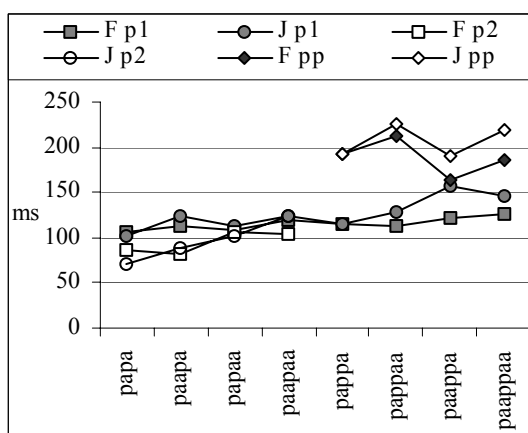


Figure 3: Mean durational comparisons of /p/ and /pp/ and their difference in Japanese and Finnish. p1=/p/ in the first syllable, p2=/p/ in the second syllable.

The variations of the closure part between the word-medial /p/ and word-medial /pp/ became greater according to the following syllable structures: /pappaa/ < /pappaa/ < /paapaa/, except for /paapaa/. Also, there was no significant difference between the Japanese word-initial /p/ (145.4 ms) in /paapaa/ and the Finnish word-medial /pp/ (149.8 ms) in /paapaa/. The differences in the closure part of /p/ and /pp/ between the two languages were: p1 → Finnish (20.2 ms) < Japanese (57.2 ms), p2 → Finnish (26.4 ms) < Japanese (52.4 ms), pp → Japanese (37.7 ms) < Finnish (50.0 ms).

The overall mean values between Finnish VOT (12.7 ms) of word-initial /p/ were nearly the same as for the Japanese counterpart (13.0 ms). Also, the overall mean values between Finnish VOT (12.4 ms) of word-initial /pp/ were approximately the same as for their Japanese counterpart (12.3 ms). However, the overall mean values between Finnish VOT of word-medial /p/ (15.5 ms) were longer than their Japanese counterpart (11.9 ms). This was true in three structures: /paapa/, /papaa/, and /paapaa/ than their Japanese counterparts, while the VOTs in the other syllable structures looked almost the same in the two languages.

The comparative durational ratios of the closure part between word-medial /p/ and /pp/ were higher in Japanese than in Finnish. The Finnish variances of the closure part of /p/ were shorter than for the Japanese counterpart parts, but the durational difference of /pp/ was longer in Finnish than in Japanese. Thus, the differences of durational comparative ratios between p2 and pp between Japanese and Finnish were mainly the differences of respective closure part durations.

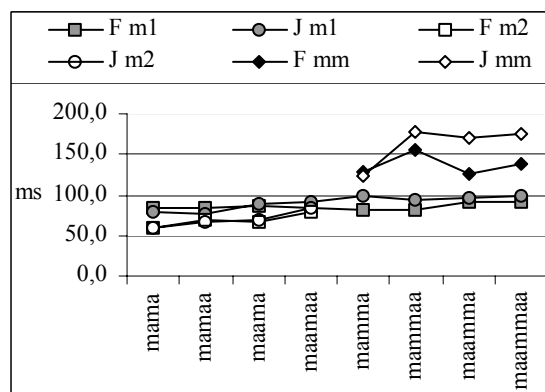


Figure 4: Mean durational comparisons of /m/ and /mm/ and their difference in Japanese and Finnish. m1=/m/ in the first syllable, m2=/m/ in the second syllable.

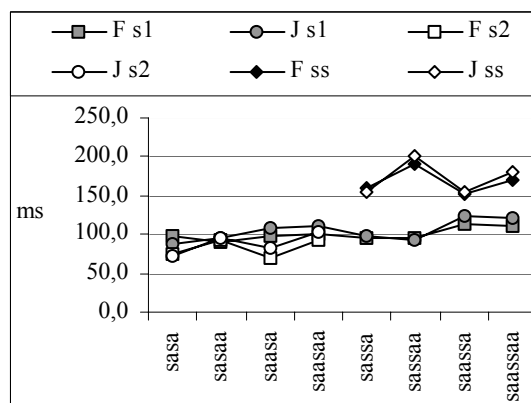


Figure 5: Mean durational comparisons of /s/ and /ss/ and their difference in Japanese and Finnish. s1=/s/ in the first syllable, s2=/s/ in the second syllable.

The variations of /m/ were rather stable in both languages. However, the variations of Finnish /mm/ varied largely depending on word structure. Also, the variations of both /s/ and /ss/ varied largely depending on word structure in both languages. Finnish and Japanese /ss/ showed similar patterns according to the word structures. Also, Finnish /ss/ particularly had very high values in the variation, compared to other word structures and also compared to the Japanese counterpart.

### 3.2. Lexical durational patterns

The overall mean lexical durations were acquired by adding

segmental durations. The results showed that the temporal distributions of segments within each word had a tendency that the first syllable was slightly longer than the second syllable. There were no findings of remarkably significant differences in temporal distributions of segments within each word between Japanese and Finnish. Also, these lexical durational ratios were translated into three patterns and illustrated in Figures 6-8. For the comparison purpose, moraic increase model pattern (M) that was based on mora-counting concept was adopted in the figures. Here, the moraic increase model pattern implies that the length of a word increases in proportion to the number of morae. Also, CVCV words were a base to count each word durational ratio.

In terms of word durations, the durational increase was closer to M in Japanese than in Finnish. The Japanese word durational patterns were almost similar to M in all word structure. Also, Japanese and Finnish showed the same patterns according to the gradual increase of segment in all /pa(a)p(p)a(a)/, /ma(a)m(m)a(a)/ and /sa(a)s(s)a(a)/ structure words, except for the Japanese /maama/.

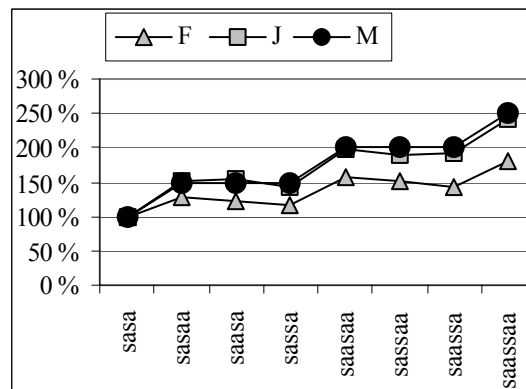


Figure 8: Lexical durational ratio comparisons in /sa(a)s(s)a(a)/.

#### 4. Conclusions

In terms of vowels at the segmental level, Finnish mean durations of /a/ and /aa/ were shorter but their mean durational ratios between /a/ and /aa/ were higher than their Japanese counterparts. The overall mean durations of /aa/ in both the first syllable and the second syllable were longer in Japanese than Finnish. In terms of consonants at the segmental level, the overall mean durational values of all consonants were higher in Japanese than in Finnish. However, these ratios differed largely depending on whether short segment occurred either in word-initial or in word-medial position in comparison of short and long segment. And the variations of all consonants between these two languages were relatively small.

The above results and analyses showed the differences not only between languages but also the environments – word structure and surrounded vowels or consonants and quantity combinations. In conclusion, Japanese segmental ratios between short and long vowels and consonants are longer than those of Finnish only when all segments are pooled. However, this was not necessarily true when observing their positions in different structures. The Finnish lexical durational increasing ratios were smaller than in Japanese. This result shows that the Japanese mora was almost isochronical than Finnish in any syllable structures, although the increasing word ratios were rather stable in both languages. Finnish had the similar decreasing patterns within the same structure words with different combinations of vowels and consonants. This might shed light on a possibility that Japanese tends to be mora-timed and Finnish to be more syllable-timed or foot-timed rather than mora-timed.

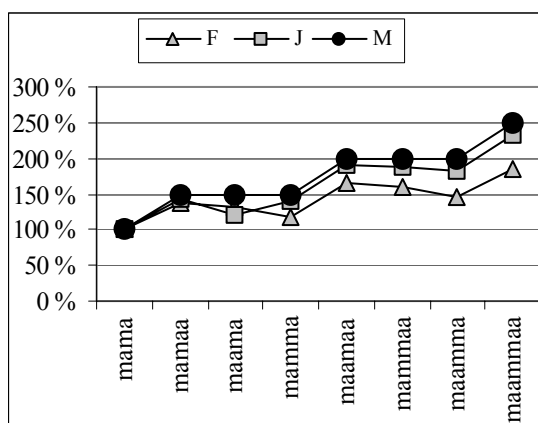


Figure 6: Lexical durational ratio comparisons in /ma(a)m(m)a(a)/. F=Finnish, J=Japanese, M=Moraic increasing model pattern.

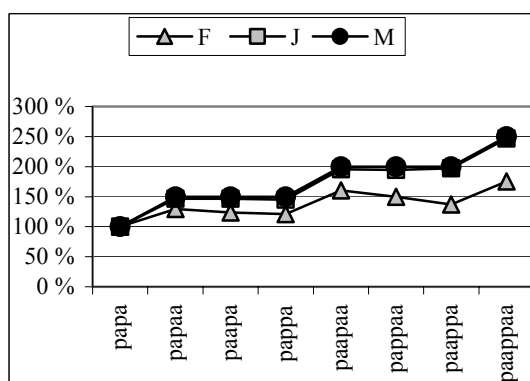


Figure 7: Lexical durational ratio comparisons in /pa(a)p(p)a(a)/.