



Minimum Long Quantity in Perception and Long Quantity in Production between Japanese and Finnish

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Abstract

Minimum long segments of quantity in 120 discrimination tests at the word level were compared between a binary (Test A) and tripartite choices (Test B), and with production test results, utilising the same syllable structures. In the perception test, the materials were eight kinds of bisyllabic synthetic nonsense words. These structures were used in the production test for purposes of comparison with the results from the perception test, in which three kinds of pitch and intensity variance patterns were added to create another condition. Seven Finnish and Japanese subjects participated in the two perception tests and three speakers of each language in the production test.

The results in the perception tests manifested testing methodology. The Finnish reached the minimum durational point of long vowels/consonants in less time than the Japanese, but had relatively wider conditional variations, particularly in the vowels, than the Japanese in both tests A and B, although these variations (SD) were more stable than in Japanese. The word-structural differences had more effect than the prosodic conditional differences in differentiating between short and long segments in both Finnish and Japanese in both tests A and B. The minimum long segmental durations in both perception tests were shorter than the long segments in the production test. There was a tendency for more correlation in Finnish than in Japanese between perception and production.

1. Introduction

In this study I compare the results acquired by tripartite and binary choices in perception tests and investigate whether there is a correlation between production and perception of minimum long quantity.

Japanese and Finnish can be compared in terms of the durational differences of linguistically distinctive short/long vowels and short/long consonants. Finnish can have bisyllabic real words comprising eight different kinds of syllable structure with combinations of phonologically short/long vowels and short/long consonants – CVCV, CVCVV, CVVCV, CVVCVV, CVCCV, CVCCVV, CVVCCV, and CVVCCVV. Japanese can have seven of these, the exception being CVVCCVV.

Utilising these eight kinds of syllable structure, Isei-Jaakkola [1] conducted 120 discrimination tests at the word level to investigate the perceptual boundary ranges of quantitative distinctions, short/long, of vowels/consonants between Finnish and Japanese utilising bisyllabic synthetic nonsense words (Test B). She also used three kinds of pitch and intensity variance patterns in the variable syllable structures. Seven subjects for both Japanese and Finnish participated in these tests to differentiate short from long

segments. In terms of the minimum long segments, her results showed (1) the Finnish reached the minimum durational point of long vowels/consonants in less time than the Japanese, but the Finns had wider prosodic conditional variations than Japanese, and (2) the word structural differences had more effect than the prosodic conditional differences in differentiating between short and long segments in both Finnish and Japanese.

In this study (Test A), only the testing methodology has been changed, utilising exactly the same materials as in Test B.

Isei-Jaakkola [2] measured the absolute durational differences between Finnish and Japanese long vowels/consonants: /aa, mm, pp, ss/ (see Table 1), utilising the same syllable structures as in the perception test. She also showed the large durational variations in these long segments depending on the syllable structure. The number of word tokens was 720. The Finnish long consonantal durations were shorter than those of the Japanese counterparts, but not in the vowels. These durations will be compared with the minimum long segments in the perception tests.

Table 1: *The long vowels and word-medial long consonants between Finnish and Japanese.*

	Finnish	Japanese	Difference
aa	199.3	180.5	-0.2 (F. < J.)
mm	137.3	161.4	-24.1 (F. < J.)
pp	188.3	206.4	-18.1 (F. < J.)
ss	168.2	172.4	-4.2 (F. < J.)

Hence, this study will consider the following questions whether there are differences between these language speakers in terms of long quantity of perception (minimum long segments) and production.

(1) Are there differences according to the testing methodology between binary or tripartite choices in the perception tests between Finnish and Japanese?

(2) Is there a correlation between perception and production between Finnish and Japanese?

2. Experimental procedure

2.1. Experimental conditions

For the perception test (Tests A and B), stimuli were created from bisyllabic nonsense words based on the above syllabic structures. Stimuli were produced using an Infobox speech synthesizer. V was always /a/ and the alternative Cs were /p, m, s/ in synthetic words like /papa, mama, sasa/, etc. The number of vowel stimuli (50-200 ms) was 16 and the number

of corresponding consonants was 12 for word-medial /p-pp/ (90-200 ms), 11 for /m-mm/ (60-160 ms) and 13 for /s-ss/ (80-200 ms) with a 10 ms incremental increase for all four phonemes. In each word, only one segment had these incremental increases, the other segmental durations within each word remaining unchanged. In addition, the vowel in the first and second syllable had unchanged F0 (100 Hz → Level) and changed F0 (120 Hz/95 Hz → HL, 95 Hz/120 Hz → LH), and unchanged intensity (26 dB → Level) and changed intensity (29/26 dB → SW, 26/29 dB → WS). Hence there were five conditions in eight different syllable structures amounting to 120 test sets for vowel and consonant distinctions.

2.2. Subjects and responses

Seven Japanese subjects who are Tokyo dialect speakers and seven Finnish speakers from Helsinki and its surroundings participated in the discrimination tests and were asked to choose one out of two choices (short or long). The number of word responses was thus 1,680 (23,520 word responses). This response number was the same in the tripartite choices (Test B).

3. Results and analyses

3.1. Structural differences

Figures 1, 2, 3, and 4 illustrate the mean Finnish and Japanese minimum long vowels/consonants (ms) in four syllable structures by binary and tripartite choice in the perception tests.

Figure 1 shows that the CVVCV - CVVCVV structure in both the binary and tripartite choices had the longest vowel duration of all structures in both Finnish and Japanese.

Figures 2 – 4 show that the minimum long consonantal durations depend on the prosodic variants in four different syllable structures. The duration of /mm/ was relatively stable compared to /pp, ss/, regardless of syllable structure.

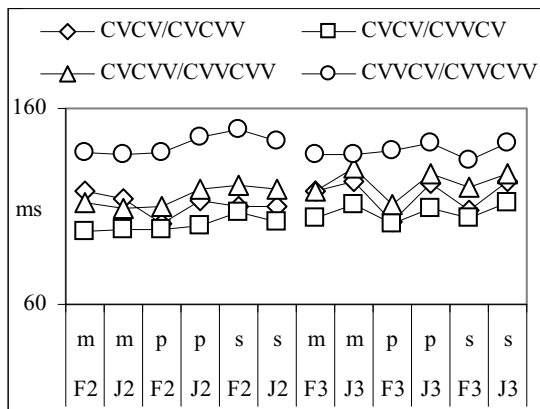


Figure 1: Minimum durations (ms) of long vowels /aa/ depend on four syllable structures in Finnish and Japanese, surrounded by the consonants /m, mm, p, pp, s, ss/ in the perception tests. F2 = the binary choices by the Finnish speakers. J2 = the binary choices by the Japanese. F3 = the tripartite choices by the Finnish. J3 = the tripartite choices by the Japanese.

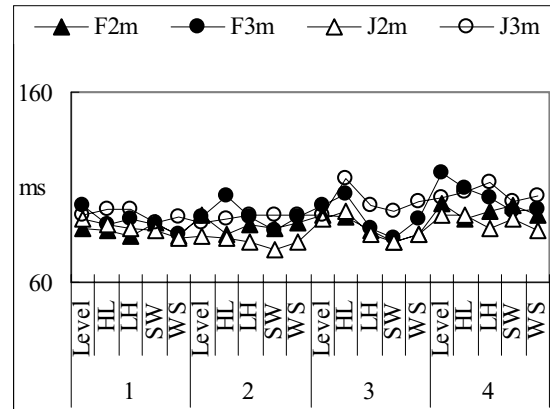


Figure 2: Minimum durations (ms) of long consonants /mm/ in five prosodic conditions according to the four different syllable structures in Finnish and Japanese. F2m = the binary choice of the word-medial Finnish /m-mm/. F3m = the tripartite choices of the word-medial Finnish /m-mm/. J2m = the binary choice of the word-medial Japanese /m-mm/. J3m = the tripartite choices of the word-medial Japanese /m-mm/.

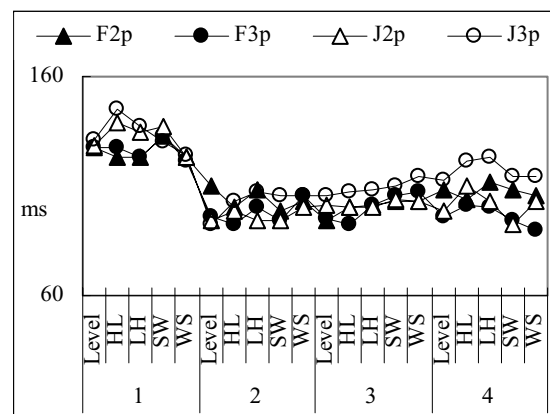


Figure 3: Minimum durations (ms) of the long consonants /pp/ in five prosodic conditions according to the four different syllable structures in Finnish and Japanese. F2p = the binary choice of the word-medial Finnish /p-pp/. F3p = the tripartite choices of the word-medial Finnish /p-pp/. J2p = the binary choice of the word-medial Japanese /p-pp/. J3p = the tripartite choices of the word-medial Japanese /p-pp/. 1 = CVCV-CVCCV, 2 = CVCVV-CVCCVV, 3 = CVVCV-CVVCCV, 4 = CVVCVV-CVVCCVV.

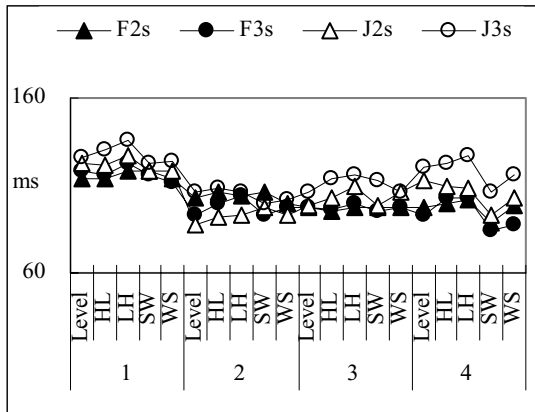


Figure 4: Minimum durations (ms) of the long consonants /ss/ in five prosodic conditions according to the four different syllable structures in Finnish and Japanese. F2s = the binary choice of the word-medial Finnish /s-ss/. F3s = the tripartite choices of the word-medial Finnish /s-ss/. J2s = the binary choice of the word-medial Japanese /s-ss/. J3s = the tripartite choices of the word-medial Japanese /s-ss/.

In terms of the minimum long vowels, the standard deviations (SD) in the binary choices were larger than in the tripartite choices, except for the Finnish LH /p-pp/, in each syllable structure. The SDs were relatively smaller in Japanese than those in Finnish.

In terms of the minimum long consonants, SDs were generally larger in the tripartite choices than in the binary choices in each syllable structure, except for the Finnish SW and WS in /mm/ and the Japanese SW in /mm/.

3.2. Prosodic differences

Figures 5, 6, 7, and 8 illustrate the overall mean durations of the Finnish and Japanese minimum long vowels/consonants in four syllable structures within each prosodic variant.

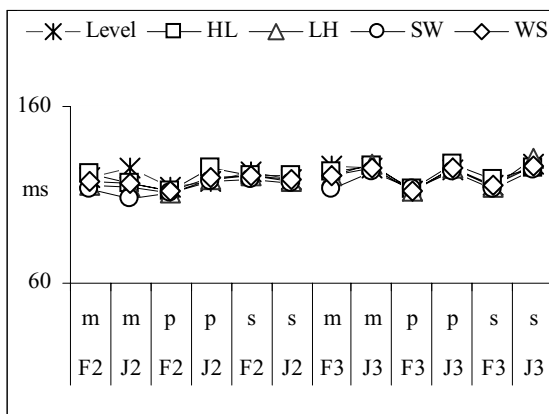


Figure 5: Minimum durations (ms) of the long vowels /aa/ in four different syllable structures surrounded by /m, mm, p, pp, s, ss/ in Finnish and Japanese.

Figure 5 illustrates the minimum long vowel durational variations, according to the syllable structure in each prosodic variant and the surrounding consonants. The variation is much smaller than in the various syllable structures (see Figures 1). Figures 6 – 8 show the minimum long consonantal durations in four different syllable structures within the same prosodic variant. The duration of /mm/ was relatively stable compared to /pp, ss/, regardless of the syllable structures. The variations depending on the syllable structures within each prosodic variant are smaller than those in the prosodic variants within each syllable structure.

In terms of the minimum long vowels, the standard deviations (SD) in the binary choices were larger than in the tripartite choices in Finnish for all cases, but not in Japanese. SDs between the binary and tripartite choices showed no significant differences or identifiable patterns.

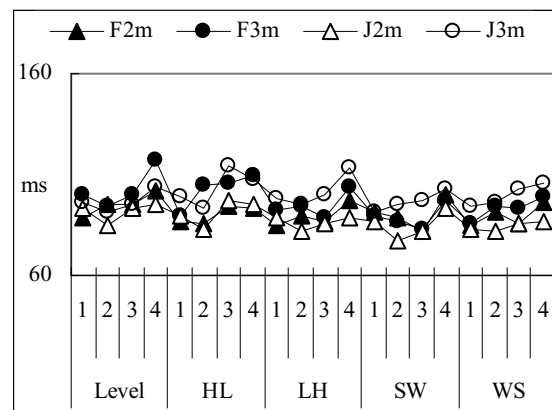


Figure 6: Minimum durations (ms) of the long consonants /mm/ in four different syllable structures according to five prosodic conditions in Finnish and Japanese.

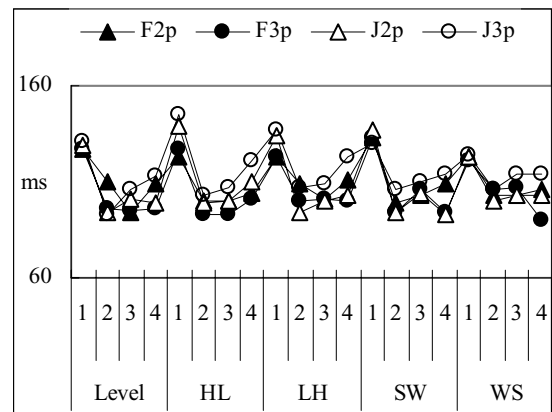


Figure 7: Minimum durations (ms) of the long consonants /pp/ in four different syllable structures according to five prosodic conditions in Finnish and Japanese.

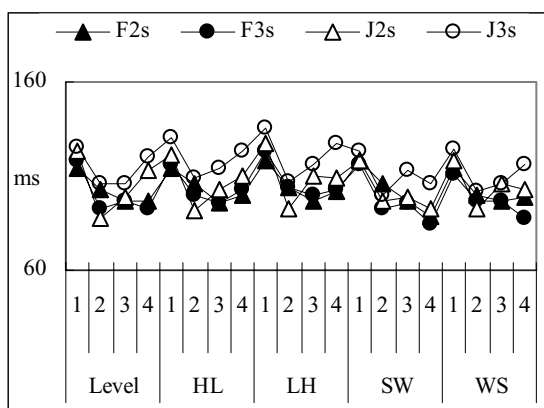


Figure 8: Minimum durations (ms) of the long consonants /s/ in four different syllable structures according to five prosodic conditions in Finnish and Japanese.

In terms of the minimum long consonants, SDs were in all cases greater in the tripartite choices than in the binary choices in Finnish, but those in Japanese did not show any particular pattern deriving from the prosodic conditions. The consonantal SDs were smaller than those of the vowels in both Finnish and Japanese.

3.3. A correlation between perception and production

Table 2 shows the minimum long segmental durations for vowels and consonants in the binary and tripartite choices of the perception tests. These values indicate that the minimum long segmental durations in the perception were much shorter than the long segmental durations in production (cf. Table 1). Also, the minimum long segmental durations in the binary choices were shorter than those in the tripartite choices, except for the vowel /aa/ (F2a) and the consonant /pp/ (F2p = F3p).

The minimum long segmental durations were longer in Japanese than in Finnish, but the duration of /mm/ was shorter in Japanese than in Finnish in both the binary (F2m) and tripartite choices (F3m) in the perception tests. The duration of /mm/ was much shorter in Finnish than in Japanese in the production test, demonstrating that the segmental duration of /mm/ of three consonants in the production test was the reverse of the result in the perception test.

Table 2: The minimum long segmental durations (ms) in the perception tests.

F2a	116.7	J2a	118.1
F3a	116.2	J3a	125.8
F2m	101.4	J2m	97.1
F3m	117.1	J3m	114.3
F2p	132.9	J2p	138.6
F3p	132.9	J3p	145.0
F2s	118.6	J2s	127.1
F3s	122.9	J3s	135.7

Table 3: The coefficient of correlation between perception (minimum long) and production.

		2	2	3	3
		Finnish	Japanese	Finnish	Japanese
Vowels	m	-0.98	-0.72	-0.95	-0.36
	p	-0.79	-0.30	-0.68	-0.16
	s	-0.88	-0.62	-0.82	-0.71
Consonants	mm	0.29	-0.16	0.22	0.42
	pp	0.23	-0.59	0.03	-0.51
	ss	0.00	-0.79	-0.31	-0.66

Comparing the (minimum) long segments between binary (2) and tripartite (3) choices, there was a tendency for a stronger correlation between the perception and production in Finnish than in Japanese as for vowels, but not for consonants, as shown in Table 3.

4. Conclusions

From the above observations, I can draw the following conclusions as a general tendency: (1) the Finns reached the minimum durational point of long vowels/consonants in less time than the Japanese, but they had wider prosodic conditional variations than the Japanese in both Tests A and B; (2) the word-structural differences had more effect than the prosodic conditional differences in differentiating between short and long segments in both Finnish and Japanese in both Tests A and B, but (3) the minimum long segmental durations were relatively shorter in the binary choices (Test A) than in the tripartite choices (Test B). These observations may well raise the question of testing in the perception test. And (4) the minimum long segmental durations in the perception tests were much shorter than the long segments in the production test. In addition, (5) there was a tendency for a stronger correlation between the perception and production in Finnish than in Japanese as for vowels, but not for consonants.

5. References

- Isei-Jaakkola, T., 2003a. Perceptual boundaries of quantity in Finnish and Japanese under the variants of pitch, amplitude, and syllable structures. *Proceedings of the 15th International Congress of Phonetic Sciences Barcelona*. 1727-1730.
- Isei-Jaakkola, T., 2003b. Quantity comparison of Japanese and Finnish in various word structures. *Proceedings of EUROSPEECH 2003 – GENEVA*. 85-88.