

PHRASE-FINAL LENGTHENING AND STRESS-TIMED SHORTENING IN THE SPEECH OF NATIVE SPEAKERS AND JAPANESE LEARNERS OF ENGLISH

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ABSTRACT

This study is intended to describe and analyze the durational patterns of native Japanese speakers learning English, with a focus on two major prosodic effects: phrase-final lengthening and stress-timed shortening. To investigate the relative contribution of these effects, a production experiment was conducted, adapting the methodological framework of Beckman and Edwards (1990). The effects of three degrees of boundary strength (the boundaries separating the members of a compound; two phonological phrases; and two intonational phrases) on the two phenomena were analyzed. Native English speakers, beginning Japanese learners of English, and advanced Japanese learners of English were compared.

1. INTRODUCTION

1.1. Problem

Difficulties in acquiring the temporal organization of English have been observed among native speakers of Japanese (Mochizuki-Sudo & Kiritani, 1991). Those difficulties appear to be caused by distinctive differences between Japanese and English in multiple aspects. In addition to the inventory size of segment and syllable types, the two languages greatly differ in prosodic realization, including temporal organization. The typological categorization of timing systems is rooted in the idea that temporal organization is based on some unit of timing, and Japanese is said to be mora-timed, whereas English is stress-timed (Dauer, 1983). English timing is based on *stress accent* (i.e. on a local prosodic prominence that is lexically defined). One of the phonetic correlates of stress accent is duration, which is alternately stretched and reduced, interacting with the other two correlates, namely, fundamental frequency and amplitude. The unit of English timing is the stress foot, that is, a string containing a stress accent followed by zero or more unstressed syllables (Beckman and Edwards, 1990). On the other hand, the unit of Japanese timing is the mora (a syllabification unit): the duration of each mora is equal, abstracting away from the phrase-final lengthening effect that we will discuss later. The prosodic distinctions of Japanese is mainly conveyed by fundamental frequency (Beckman, 1986). These differences in the manipulation of the duration cue with respect to the other prosodic cues suggest that native speakers of Japanese will have considerable difficulty in learning English timing.

1.2. Two Hypothesized Effects on English Timing Patterns

Two crucial concepts concerning English temporal organization are *phrase-final lengthening* and *stress-timed shortening*. The phrase-final lengthening effect is usually defined as the lengthening of a rhyme (nucleus and coda) occurring before the boundary between prosodic constituents, roughly reflecting syntactic boundary strength (cf. Wightman et al., 1992 for English; Beckman & Pierrehumbert, 1986; Kaiki *et al.*, 1992 for Japanese).

The stress-timed shortening effect is an indication of the tendency toward “isochronous spacing of prosodically strong syllables; a stressed syllable in a polysyllabic word or stress foot is compressed in order to make the overall duration of its word or stress foot closer to that of a contrasting monosyllable (Beckman & Edwards 1990; 152).” Intervals between two stressed syllables are called “interstress intervals (ISIs).” The size of the stress foot is frequently used to denote the size of ISIs. The most prominent element in the stress foot is called the head of the foot. In the theory of isochrony, intervals between two heads are expected to be equalized. Consequently, the durations of stressed syllables will be shortened as the number of unstressed syllables between the two heads increases. This effect should characterize stress-timed languages.

1.3. Purpose of the Study

This study is intended to investigate the acquisition of phrase-final lengthening and stress-timed shortening by Japanese learners of English in comparison with native speakers of English. As Beckman and Edwards (1990) point out, in the experimental design, it is crucial to prevent the two effects from being confounded with each other. The production experiment of Mochizuki-Sudo and Kiritani (1991) is subject to this criticism. For the purpose of this study, the two effects will be strictly distinguished in experimental design. The durational patterns of native Japanese speakers learning English will be described and analyzed with respect to the transfer of the Japanese timing system to the timing system of their English speech.

2. EXPERIMENT

2.1. Subjects

The set of speakers included one control group and two experimental groups; each group consisted of four speakers (two males and two females). The control group (NS group) consisted of native speakers of American English. The first experimental group (the AJ group) consisted of advanced Japanese learners of English, and the second experimental group (the BJ group) consisted of beginning Japanese learners of English. In order to equalize proficiency across speakers in the same experimental

group, the Japanese participants were selected using several criteria: years of residence in the U.S. (3 years for the AJ; none for the BJ), age range (25-31 for the AJ; 22-25 for the BJ), language background, and previous learning experience.

2.2. Procedure

The subjects' assigned task was to read a list of randomized sentences. Each sentence was read twelve times, and the first and last two repetitions were omitted in the subsequent measurement of phonetic durations. The performances were recorded with high-quality equipment in the soundproof room of the UCLA Phonetics Laboratory for the AJ group and in the recording booth of the Doosiyasa Women's College in Japan for the BJ group.

The recorded data were converted from analog to digital at a 10 kHz sampling rate, and analyzed using Kay Elemetrics' Computerized Speech Laboratory (CSL) hardware and software. Since final lengthening mainly affects phrase-final syllables (Wightman, et al., 1992), and the relevant syllables had no consonantal coda, I measured the duration of stressed and unstressed vowels in both pre- and post-boundary positions for each prosodic level. All the measurements were carried on the waveform analysis, and wide-band spectrographs were additionally inspected in the cases of difficult segmentation.

2.3. Materials

The data sets for the production experiment are shown in (1-A, B, C). The two stressed vowels determining the size of ISI are indicated by acute accent marks; the analyzed stressed and unstressed vowels are denoted by bold-face and underline, respectively. The three sentence sets (1-A, B, C) test the three degrees of boundary strength predicted by the theory of prosodic hierarchy (see Hayes 1989 for a review): boundary strength is weakest for the set (1-A) and strongest for the set (1-C).

- (1)
- A. Boundary separates **members of a compound**
- I met **Léé**] Mótt last week.
 - I met **Léé**] D**e**Mótt last week.
 - I met **Léda**] Mótt last week.
 - I met **Léda**] D**e**Mótt last week.
- B. Boundary follows the **end of a phonological phrase**.
- My **pá**] zíps along in traffic.
 - My **pá**] posítions himself well in traffic.
 - My **pápa**] zíps along in traffic.
 - My **pápa**] posítions himself well in traffic.
- C. Boundary follows the **end of an intonational phrase**.
- My **pá**], góat lover though he is, would never buy one.
 - My **pá**], pagóda lover though he is, would never buy one.
 - My **pápa**], góat lover though he is, would never buy one.
 - My **pápa**], pagóda lover though he is, would never buy one.

For each set, the pair (a, b) strictly tests for two different degrees of stress-timed shortening (ISI = 0 vs. ISI = 1), holding phrase-final lengthening constant (i.e. putting a boundary in the same position relevant with respect to the pre-boundary noun). In the

same way, the pair (c, d) examines the difference between ISI = 1 and ISI = 2. The pair (b, c) strictly tests for phrase-final lengthening, holding the size of interstress interval constant (ISI = 1). The structure of the experimental design is summarized in **Table 1**. These pairs were compared in two-tailed t-tests.

test for	informative pairs	expected final lengthening	ISI size
phrase-final lengthening	(b) vs. (c) e.g. pá] <u>po</u> sítions vs. pápa] zíps	<i>yes</i> for stressed V in (b) and unstressed V in (c); <i>no</i> for unstressed V in (b) and stressed V in (c)	constant (ISI = 1)
stress-timed shortening	(a) vs. (b) e.g. pá] zíps vs. pá] <u>po</u> sítions (c) vs. (d) e.g. pápa] zíps vs. pápa] <u>po</u> sítions	constant (<i>yes</i> for stressed V) constant (<i>no</i> for stressed V)	ISI = 0 vs. 1 ISI = 1 vs. 2

Table 1: Sentence pairs tested for phrase-final lengthening and stress-timed shortening.

3. RESULTS & DISCUSSION

Vowel durations in each condition were statistically analyzed by using ANOVA and two-tailed t-tests. The effects of the two prosodic phenomena under consideration were examined separately.

3.1. Similar Patterns in the Three Groups

The results of the NS group reliably showed a major phrase-final lengthening effect before both phonological-phrase and intonation-phrase boundaries, but word-final lengthening effects varied across and within speakers. The data from a representative speaker, NS1, are shown in **Figure 1**, and the statistical results are summarized in **Table 2**. IF, PF, and WF are abbreviated for Intonational-Phrase Final, Phonological-Phrase Final, and Word Final boundaries.

Stressed V		WF	PF	IF
final lengthening	(b) vs. (c)	.059	p<.001	p<.001
stress-timed shortening	(a) vs. (b)	.697	.172	.022
	(c) vs. (d)	.118	.230	.435

Unstressed V		WF	PF	IF
final lengthening	(b) vs. (c)	.059	p<.001	p<.001

Table 2. Results of two-tailed t-tests in p-values for the data of NS1. The shaded cells indicate p-values above the critical value ($\alpha = 0.05$).

Similar patterns were observed in the data of all the four AJ speakers and the four BJ speakers.

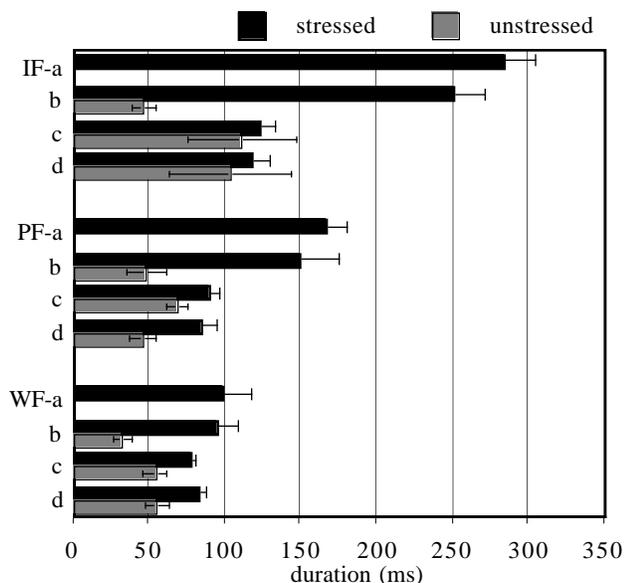


Figure 1: Mean durations of stressed and unstressed vowels of NS1.

3.2. Major Effects in Japanese Learners' Speech

The production data of the three groups showed considerable phrase-final lengthening and no stress-timed shortening, and these patterns were statistically confirmed. What factor differentiates the durational patterns of the three groups, if any? Further statistical analyses show the following two major peculiarities in the speech of Japanese learners.

First, less advanced Japanese learners make less durational contrast between lexically stressed and unstressed vowels than native English speakers. I assume this to be due to the negative transfer of Japanese “durational immalleability” (i.e. the fact that there is no durational contrast between pitch-accented and unaccented moras). The strong correlation between the speaker groups and the degree of durational contrast between stressed and unstressed vowels is shown by plotting the mean ratio of stressed V to an unstressed V adjacent to a prosodic boundary (i.e. not in a final lengthening context) for the set (1-C). The results are shown in Figure 2.

Second, less advanced learners made less hierarchical differentiation of boundary strength. Additional statistics was conducted in order to see how the different groups differentiate the three degrees of boundary strength by duration. For each sentence set, the means of stressed vowels in the environment (b) were compared with the means of stressed vowels in the environment (c): e.g. (b) *páj*, *pagóda* vs. (c) *pápa*, *góat* for the (1-C) set. This comparison allows us to measure the differentiation of boundary strength and the degree of final lengthening by holding the ISI size constant (ISI = 1). The three sentence sets designed for this study

reflect three degrees of boundary strength (WF < PF < IF). This order is expected to be systematically marked by the degree of final lengthening. The mean ratio of stressed vowels in the environment (b) to unstressed vowels in the environment (c) is compared across the three groups in Figure 3. The NS group clearly distinguishes the three degrees of boundary strength in the hypothesized order WF < PF < IF. Overall, the native speakers have more final lengthening for stressed syllables before stronger boundaries. This pattern is followed by the AJ group except AJ1. The patterns of the BJ group show more variations across the speakers. BJ1 seems to show almost native-like differentiation of the three levels, whereas the other three speakers do not. BJ2 makes no differentiation, and BJ3 and BJ4 make minor differentiation.

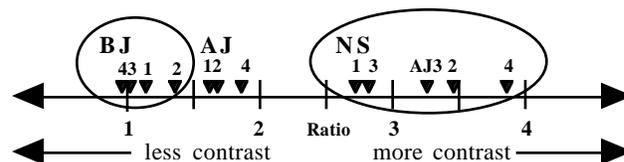


Figure 2: Ratio of mean durations. Stressed V in (c) *pápa*, *góat* were divided by unstressed V in (b) *páj*, *pagóda* for the (1-C) set.

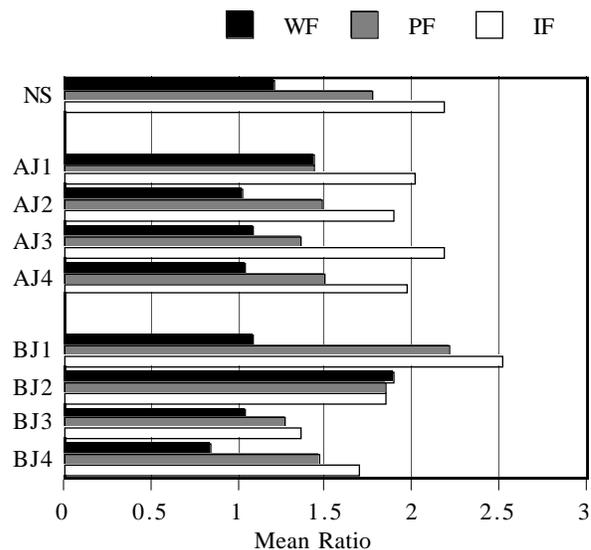


Figure 3: Mean ratio of stressed vowels in (b) to stressed vowels in (c).

However, the similar pattern in ratio does not imply a similar pattern in actual magnitude of lengthening. Figure 4 shows raw values of vowel durations in the three prosodic positions for the three speaker groups. In the environment (b), all native English speakers significantly increase the actual duration proportionally (WF < PF < IF). The same hierarchical differentiation is made in the environment (c) as well. This pattern is shown by only two Japanese speakers (AJ2 and AJ4). The other six Japanese speakers tend to over-apply final lengthening before smaller

boundaries. This results in a greater magnitude of lengthening before smaller boundaries and less hierarchical differentiation of boundary strength.

4. CONCLUSION

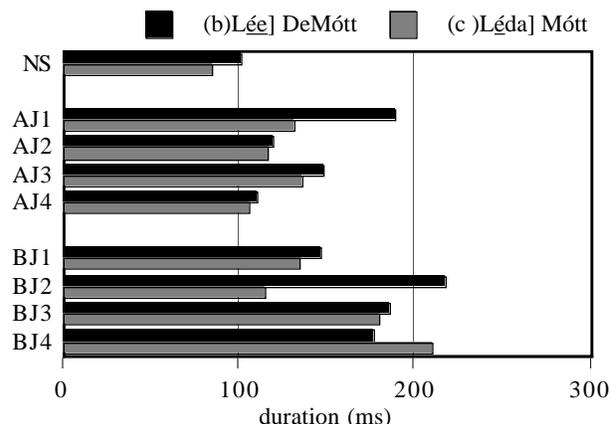
The detailed comparison of the three speaker groups demonstrates that Japanese timing patterns are influential in two ways. First, there is a primary negative transfer of mora immalleability, which is a Japanese specific feature. This constitutes a major difficulty in acquiring durational contrasts between lexically stressed and unstressed syllables in English. Second, there is a possible positive transfer of Japanese prepausal lengthening in larger boundaries, which may be a language-universal phenomenon.

To further explore the general mechanism of timing development in second language phonetics, we need cross-linguistic investigation of other cases, such as the English speech of second language learners whose first language is syllable-based (e.g. French) and the Japanese speech of second language learners whose first language is stress-timed (e.g. English)

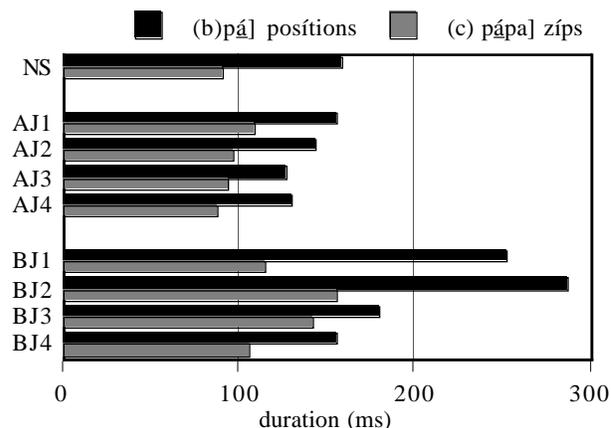
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A. Word Final



B. Phonological-Phrase Final



C. Intonational-Phrase Final

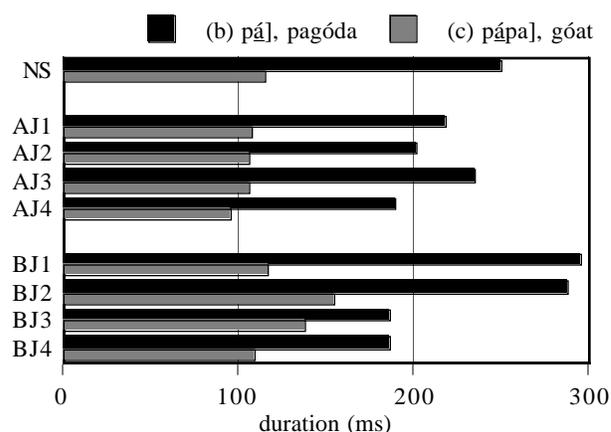


Figure 4: Mean durations of pre-boundary stressed vowels in the environments (b) and (c).