ACOUSTIC REALIZATION OF LEXICAL ACCENT AND ITS EFFECTS ON PHRASE INTONATION IN ENGLISH SPEAKERS' JAPANESE

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ABSTRACT

This study investigated acoustic manipulation of Japanese prosody by English speakers. It examined how English speakers who are fluent in Japanese realize Japanese lexical accent, and whether they transfer acoustic features associated with English word stress to Japanese lexical accent. The study showed that the more fluent speakers of Japanese used F0 to indicate lexical accent without increasing mora duration, whereas less fluent speakers did not, but instead increased the duration of accented vowels.

The study also showed that the English speakers were unable to produce non-accented words, and instead placed an accent in a word, which triggered downstep and hence wrong phrase intonation.

Keyword:L2 acquisition, prosody, rhythm, accent, F0

1. INTRODUCTION

This study investigates acoustic realization of lexical accent in relation to Japanese speech rhythm, and its effects on phrase intonation in English speakers' Japanese. Acquisition of second language (L2) prosody is not easy for language learners, because each language uses a different phonological rhythmic unit and employs a different strategy to control prosodic features. Learners also have already acquired temporal organization of their first language and tend to transfer those habits to L2.

Prosodic organization of Japanese and English differs. Japanese is a pitch accent language and its speech rhythm is based on the mora. Word duration and even pause duration are proportional to the number of morae [3, 5]. Also, durational adjustment between neighboring segments seems to work within a mora, i.e. a /CV/ unit, rather than a unit across a mora boundary, i.e. a /V-C/ unit [1, 6]. Japanese accent is manifested as a sharp fall of the fundamental frequency (F0) from the accented mora to the following mora. In addition, the presence or absence of accent does not affect vowel or mora duration, or vowel quality. English is a stress accent language and the unit of speech rhythm is the foot. Stressed vowels often have higher F0s, are typically longer and are often associated with higher intensities. Raw intensity may not always be a reliable indicator of lexical stress, but it plays an important role in predicting prominence in actual utterances [4]. Further, stress is actually a property of intensity distribution across the frequency spectrum [2, 8]. Unstressed vowels normally have low F0s, are shorter, weaker and are reduced to a schwa–like quality. There is a tendency for each foot to be equal, and the mora does not play any significant role in English phonology.

This paper examines how native English speakers manipulate acoustic features associated with Japanese lexical accent. The study investigates (i) whether English speakers of fluent Japanese are able to control mora duration, (ii) whether English speakers transfer acoustic features of English stress accent to realize Japanese pitch accent, and (iii) how their lexical accent influences phrase intonation.

2. EXPERIMENTS

2.1. Methods

Four adult English speakers took part in the experiment: an Australian female (speaker A), two English male speakers (speakers B & C), and an American male speaker (speaker D). They have lived in Japan for between 11 years and over 30 years at the time of recording, and all speak very fluent Japanese. The subjects were asked to pronounce seven pairs of bi-moraic Japanese words listed in (1) and (2) below, five times each. Each pair of test words consisted of the same sound sequences /$C_1V_1C_2V_2$/ that showed contrast either by (1) the position of lexical accent, or (2) the presence or absence of lexical accent. The test words were marked as (a) 1st mora accented, (b) 2nd mora accented, or (c) a non-accented word, i.e. no sharp pitch fall in the word.

(1) (a) '*kami* 'god' – (b) *ka*'*mi* 'paper'
(a) '*kasa* 'umbrella'– (b) *ka*'*sa* 'volume'
(2) (a) '*kama* 'sickle' – (c) *kama* 'kiln'
(a) '*kamu* 'to bite' – (c) *kamu* 'to blow nose'
(a) '*kame* 'turtle' – (c) *kame* 'jug'
(a) '*kasi* 'lyrics' – (c) *kasi* 'fish market'
(a) '*kasu* 'scum' – (c) *kasu* 'to rent'

The test words were presented in random order in the carrier sentence 'korewa *test word* no desu' ('This belongs to *test word*'.), written in Japanese orthography with the lexical accent position marked in the text. Mora duration, the peak F0 of accented vowels and the lowest F0 of unaccented vowels were measured for each of the Japanese test words. Even though vowel type affects F0 [7], vowel type was not controlled in the experiment, in order to avoid non-sense words. As a control one male and three female adult native Japanese speakers from the Tokyo area also recorded the same utterances.

The English speakers also pronounced pairs of English disyllabic words with differing lexical accent positions: (a) one word with the accent on the first syllable, and (b) the other word with the accent on the second syllable [see (3)]. The test words were presented in the carrier sentence 'I say *test word* now'. The subjects pronounced each sentence five times, in random order.

(3)

'*permit*	(noun)	-	*per*'*mit*	(verb)
'*subject*	(noun)	-	*sub*'*ject*	(verb)
'*contract*	(noun)	-	*con*'*tract*	(verb)
'*differ*	(verb)	-	*de*'*fer*	(verb)
'*decrease*	(noun)	-	*de*'*crease*	(verb)

The peak F0 of accented vowels and the lowest F0 of unaccented vowels were measured in each English test word, and the results were used as a control to compare with their Japanese utterances.

However, the English speakers failed to produce the non-accented Japanese words correctly, even though the reading text clearly indicated that the words were non-accented. Instead, in most cases they placed the lexical accent on the second mora and pronounced type-2c words as if they were type-1b words. Therefore, in the analysis the type-2c words with the accent on the second mora were treated as type-1b words, and the data from the few correctly pronounced type-2c words were eliminated from the analysis. The samples were digitized at a sampling rate of 48 KHz, and analyzed using Praat. Statistical analysis was performed by SPSS.

2.2. The results

2.1.1. Accentuation and mora duration

The durations of the first mora /ka/ and the second mora /C_2V_2/ (where /C_2/ was either /m/ or /s/ followed by a vowel) were compared, with or without the lexical accent. The presence or absence of accent on the mora did not significantly alter the average duration of the first mora /ka/ in the Japanese speakers' utterances (Fig. 1). The accent effect on duration of /C_2V_2/ was statistically significant ($p<.0001$) in their utterances, but the increase was very small compared with the English speakers (Fig. 2). English speakers A and B controlled the mora durations well and there was no effect of lexical accent on mora durations in their utterances for /ka/ and /C_2V_2/. However, speakers C and D showed a significant effect of lexical accent on the durations of both /ka/ and /C_2V_2/ ($p<.0001$) (Figs. 1 & 2).

Figure 1: Effect of accent position on mean durations of the first mora /ka/. Jp = mean of all words for all Japanese. A~D = mean of all words for each English speaker. | = SD.

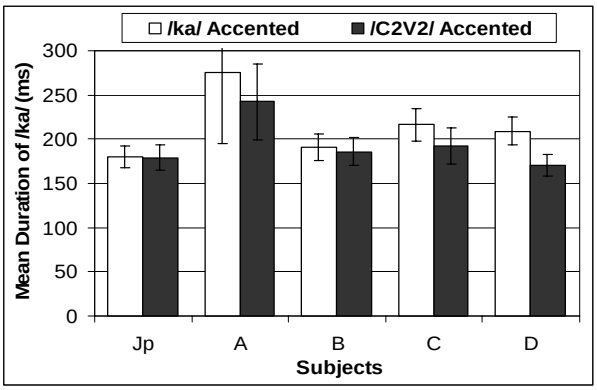
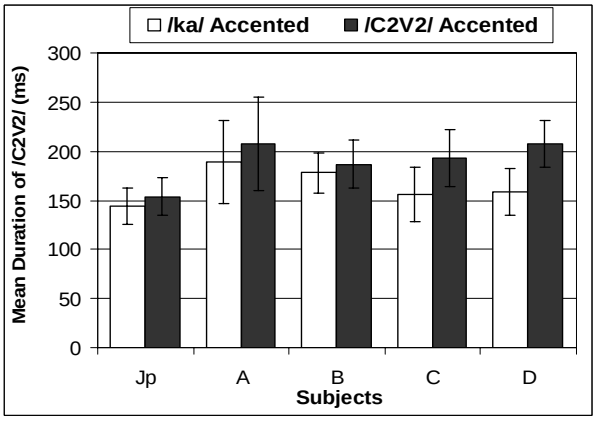


Figure 2: Effect of accent position on mean durations of the second mora /C_2V_2/. Jp = mean of all words for all Japanese. A~D = mean of all words for each English speaker. | = SD.

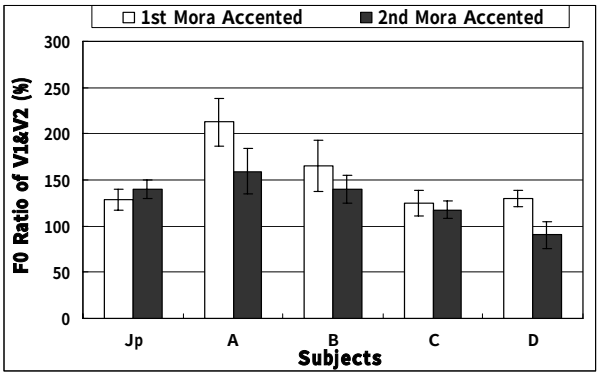


2.2.2. Lexical accent and the F0 in English speakers' Japanese utterances

Figure 3 shows the F0 ratios of the first and the second vowels of all words for each English speaker, and an average for all Japanese speakers. The peak F0 of accented vowels and the lowest F0 of unaccented vowels were measured, and the ratio of V_1/V_2 was obtained in order to minimize differences between the speakers, especially any sex difference. With the Japanese speakers, when the first mora was accented the peak F0 of the first vowel was on average 128.3% of the lowest F0 of the unaccented second vowel. When the second mora was accented,

the highest F0 of the accented second vowel was on average 140.2% of the lowest F0 of the first vowel.

Figure 3: Mean F0 Ratios between V_1 & V_2 by all Japanese (Jp) and individual English speakers (A~D). | = SD.



English speakers A and B showed a much greater increase of F0 for accented vowels compared with the F0 ratios of the Japanese speakers, and roughly the same amount or slightly more when the second syllable /C_2V_2/ was accented (Fig. 3). However, for speakers C and D, the F0 increase of accented mora was very small. In particular for speaker D, the supposedly accented second mora often had lower F0 than the unaccented first mora.

The F0 results showed that speakers A and B, who controlled speech rhythm well, showed greater F0 increase for accented vowels, whereas speakers C and D, who increased accented mora durations, showed less F0 increase for accented vowels. The F0 measurements also indicated that speakers C and D did not use the F0 to indicate the lexical accent in Japanese. In fact, the pitch contours of the whole utterances of speakers C and D were much flatter compared with typical utterances by the Japanese speakers, especially for type (1b) words, but Japanese speakers judged that the second mora of C and D speakers' utterances was accented. The second mora may have been accented because: (i) the F0 did not fall sharply after the first mora, implying that the first mora was not accented, or (ii) the duration of the second mora tended to be longer than the first mora.

2.2.3. Lexical Accent and the F0 in English

The relationship between lexical accent and F0 in English was examined for the English speakers. The ratio between the peak F0 of the vowel of the accented syllable and the lowest F0 of the vowel of the unaccented syllable were measured. The results were compared with the F0 ratios of the same speakers' Japanese test words (see Figures 4 and 5). The results showed that the F0 ratios of the English speakers' Japanese and English utterances were significantly different ($p<.001$) in most pairs. However, there was no significant difference for speaker D when the first syllable was accented (Fig. 4), or for speaker A when the second syllable was accented (Fig. 5).

Figure 4: Effect of accent position on mean F0 ratios of accented V1 and unaccented V2 in Japanese and English words by English speakers. | = SD.

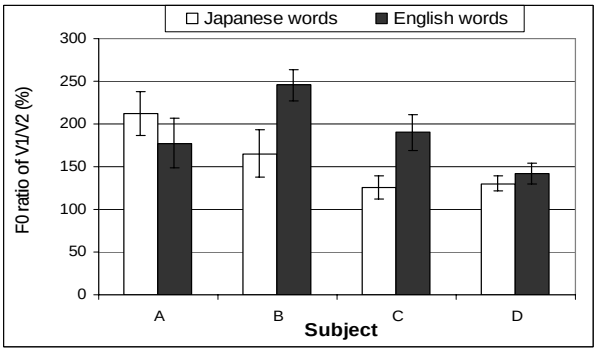
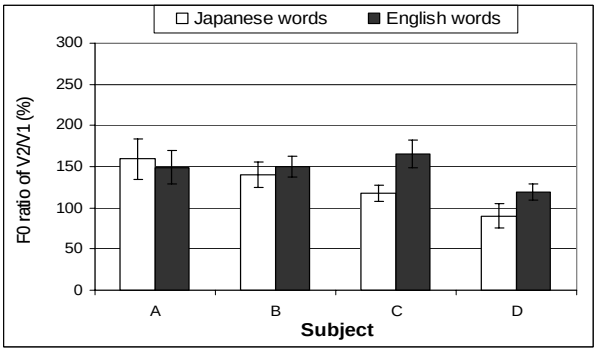


Figure 5: Effect of accent position on mean F0 ratios of unaccented V_1 and accented V_2 in Japanese and English words by English speakers. | = SD.



All English speakers generally used F0 increases to indicate lexical accents when speaking English. However, speaker A, who controlled Japanese mora duration well in the first experiment, increased F0 more in Japanese when the first syllable was accented, and did not show any language difference when the second syllable was accented. Speaker B, the other speaker with good Japanese mora duration control, used more F0 increase in English in both accent positions. These results suggest that speaker A controlled F0 increase and vowel duration independently to express Japanese lexical accent. In contrast speaker B suppressed F0 in Japanese compared with his English utterances, even though he used greater F0 increases than native Japanese speakers (see Fig. 3). Speakers C and D, who indicated Japanese lexical accent by increasing accented mora duration (see Figs. 1 & 2), reduced pitch range in Japanese compared to their own English utterances. The three speakers (B, C & D) probably subconsciously know that F0 increase means durational increase, and therefore they tried to

suppress their F0 in order to maintain the mora rhythm. Speaker D used different tactics by increasing the duration of accented morae (see Figs. 1 & 2). It is likely that he tried to balance the F0 increase and constant mora duration by suppressing the F0, but deliberately increased the mora duration in order to indicate lexical accent (Fig. 5).

2.2.4. Lexical accent and phrase intonation

The study showed that even the good speakers (A & B) used more F0 change to express lexical accent in Japanese, and their utterances sounded different from the native Japanese speakers. The English speakers also had problems with lexical accent placement, and in particular they were unable to produce non-accented words (see 2.2.1). The presence or absence of lexical accent affects the F0 of following utterances. The presence of lexical accent triggers downstep of the immediately following pitch, but a phrase without lexically accented syllables shows a natural decline of pitch. The failure of the English speakers to produce the non-accented words implies that the intonation contour of a phrase shows downstep, which is quite different from native Japanese speakers' naturally declining intonation of a phrase with non-accented words.

Figure 6: A typical F0 contour of the Japanese phrase /atsui kamao akeru/ uttered by a male native Japanese speaker.

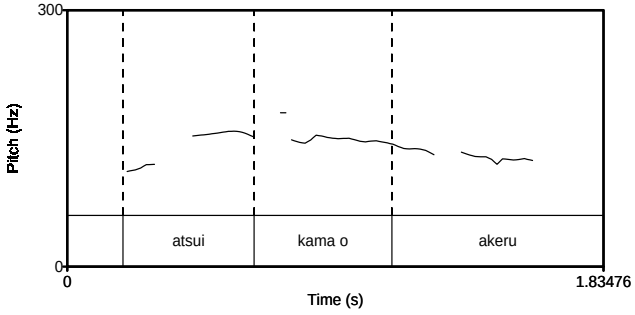
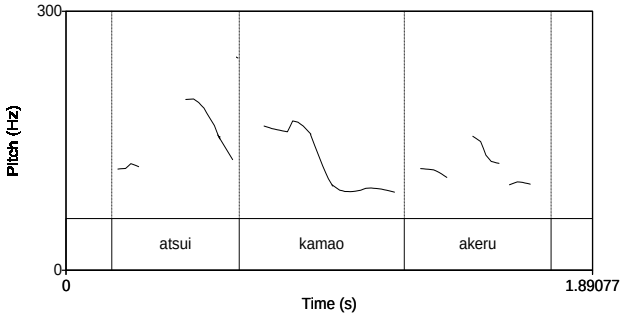


Figure 7: A typical F0 contour of the Japanese phrase /atsui kamao akeru/ uttered by a male English speaker B.



Figures 6 and 7 show typical F0 contours for the phrase *atsui kama-o akeru* '(I will) open a hot kiln' (all words are non-accented) uttered by a male native Japanese speaker and native English speaker B, respectively. For the Japanese speaker there was only a natural decline of the F0, whereas English speaker B placed an accent on the second mora of all words, which showed clear downstep. The English speakers with good control of mora rhythm used larger F0 increases in lexical accent and could not produce non-accented words, which signified English accent. Moreover, the English speakers used different phrasing from Japanese speakers. They often placed an accent (e.g. both *kama* and the particle *-o* were accented in Fig. 7) in every word rather than placing one accent in a phrase. Therefore this might be the main cause of foreign accent in their Japanese.

3. CONCLUSIONS

The results indicated that generally the English speakers used narrower pitch range to control mora duration when they spoke Japanese. The speakers with poorer Japanese ability increased mora duration to indicate a lexical accent, instead of increasing the F0. The speakers with good mora duration control still used more F0 change for lexical accent than Japanese speakers. Also, the English speakers' failure to produce non-accented words caused very different phrase intonation from the Japanese speakers.

4. ACKNOWLEDGEMENT

The study was supported by The Japanese Ministry of Education, Culture, Sports, Science & Technology, Grant-in-Aid for Scientific Research (C) No. 19520369.

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