



NATURALNESS JUDGMENTS FOR STRESSED VOWEL DURATION
IN SECOND LANGUAGE ACQUISITION

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ABSTRACT

This study examines the naturalness threshold of English stressed vowels for Americans and Japanese learners of English. Conversely, the naturalness threshold of Japanese accented vowels for Japanese speakers is compared to that of Japanese for American learners. Perception experiments demonstrated Americans are more sensitive to the shortening of a vowel both in English and Japanese than Japanese. As for the lengthening of a vowel, Japanese learners of English were found to be less tolerant of lengthening in English vowels. Likewise, in Japanese stimuli, the Japanese were less tolerant of lengthening than the Americans when a vowel was followed by a voiced consonant. In Japanese vowels followed by either a voiceless consonant or a flap, the Japanese were conversely more tolerant of lengthening than the Americans. We found certain factors, such as the phonemic vowel length distinction and a voice-conditioned effect, which exerted an influence on these judgments of naturalness.

little experimental research on judgments of naturalness for vowel duration in second language acquisition.

Sudo and Kiritani's study (1991) analyzed the inter-stress intervals in English of Japanese speakers from the viewpoint of both production and perception [2]. One of the results obtained in our experiments was a relatively broader range of "natural" durations for a stressed vowel in Japanese speakers than in American speakers. Two interpretations can be advanced to explain the above result. The broader range of "natural" durations for the Japanese may stem from their unfamiliarity with the target language or from some features in their native language relevant to judging naturalness. Since the linguistic materials in the experiment were only English vowels, we felt a need to run a similar experiment on Japanese vowels for the purpose of choosing between these two interpretations. In the present study, we compared two languages, English and Japanese, and attempted to find out whether the differences in naturalness judgments between Americans and Japanese are universal in second language acquisition or whether they are attributable to some specific features in the respective native language.

The purpose of the present study was to compare the threshold of naturalness of stressed vowels for native speakers of English, a stress-timed language, to that of second language learners of English whose native language was Japanese, a mora-timed language. Conversely, the threshold of naturalness of accented vowels in Japanese for native speakers of Japanese was compared to that for American learners of Japanese. These two "first" languages--with their different durational controls for vowels--were expected to exert a characteristic influence on the learners' judgments of naturalness for vowel duration in the respective "second" language. The idea of an interlanguage suggests that learners of a second language employ their unique system in judging naturalness, but not a random judgment, however different it is from the system of the target language. It will be useful for the improvement of not only the listening ability of second language learners but also their speaking ability, to determine any disparity in judgments of naturalness, because production patterns and perception patterns are closely related in language acquisition.

I. INTRODUCTION

Traditionally, in the teaching of English to Japanese students, emphasis has been put on writing and reading. As for speaking and listening abilities, teaching in Japan seems to focus on the production and perception of separate segments or phonemes. In real communication, however, prosodic features such as rhythm and intonation play a substantial role. Speech is more English-like to native speakers of English when the prosodic features are English-like in spite of Japanese-like pronunciation of separate segments, as compared to when separate segments are English-like and the prosodic features are Japanese-like. Actually, one conspicuous problem with the English of Japanese learners is the unnaturalness of their rhythm. Fujisaki, Hirose and Sugito (1986) state that stress influences F0, intensity, duration and formant frequencies in English, while factors other than F0 and intensity are not so relevant in the pitch accent of Japanese words [1]. Therefore, it seems likely that Japanese learners of English would not be accustomed to controlling segmental duration according to the stress pattern. Underlying this phenomenon, there should be a difference in the judgments of the naturalness of stress-related durational differences in vowels between Japanese learners and native speakers of English. However, there is

II. PERCEPTION EXPERIMENT

2.1 Methods

This perception experiment measured the influence of lengthening and shortening stressed vowels on the perception

of the naturalness of temporal patterns. Two languages, English and Japanese, were compared to determine how the linguistic behavior of learners of a second language is different from that of native speakers. The vowel durations were manipulated by means of LPC analysis and synthesis.

The subjects in this experiment were 63 Japanese college students who had never lived abroad and 14 American students who had had Japanese study of more than three years. The linguistic materials used in this experiment were the ten English sentences and ten Japanese sentences listed in Table I. The words with a target vowel are underlined in Table I. We prepared the ten sentences in each language so that the target word occurred in either a sentence-initial noun phrase or sentence-medial position.

The original English sentences were produced by an American male speaker from Massachusetts, and the Japanese sentences by a male speaker from Tokyo. These original sentences were digitized at a sampling rate of 10 kHz. Then the stimulus sentences were prepared by LPC analysis and resynthesis, which were carried out at a 5 ms frame interval. The duration of the target vowels in each of the twenty sentences was then varied in 11-17 steps, ranging from -100% to +195%. The two groups of subjects heard five repetitions of the different versions of each original sentence. All of the stimuli for a given sentence set were presented in random order in one block. After every tenth stimulus, a marker sound was inserted. The sentences were separated by an interval of 2s. The subjects were told the words in which the changes had been made, but not which sound segments had been manipulated. Their task was to judge whether the sentence sounded rhythmically natural or not (a two-way choice).

2.2 Results for the English Sentences

Table II shows the estimates for a 50% threshold of "natural" judgments for all of the sentences. In order to obtain estimates of the 50% threshold for "natural" judgments of the shortened and lengthened vowels, the responses were approximated by cumulative normal distributions. First, the data points were plotted on a normal scale. Next, we fitted a least-squared-error straight line to each relevant subset of these data points, and determined a 50% threshold for the natural duration of the vowels. As shown in Table II, the Japanese learners responded more sensitively to the lengthening of a stressed vowel in all of their judgments than the native speakers, the average percentage of "natural" judgments being 83% for the Japanese and 124% for the Americans. In the case of vowel shortening, however, the Americans responded more sensitively than the Japanese, the average being -63% for the former and -78% for the latter. In other words, the naturalness of the temporal pattern deteriorated with less of a shortening in the target vowel for the Americans compared to that required for the Japanese. We did not detect any clear effect of the position of the target word in a sentence on the judgments of naturalness.

In sum, these results indicate that Japanese learners of English are more tolerant of the shortening of a target vowel and are less tolerant of its lengthening than native speakers if the target vowel is any of the following: [I], [E], [æ] and

[ɔ]. The range of vowel durations perceived as natural was found to be broader for the Americans than for the Japanese, the average being 187% for the former and 161% for the latter. This broader range for native speakers of English results from their tolerance of the lengthening of a stressed vowel. In our 1991 study, we observed an opposite response to the vowel [i] between Americans and Japanese; the Japanese responded more sensitively to the shortening of this vowel and were more tolerant of its lengthening. Thus, this vowel seems to be treated differently by Japanese. Later in the Discussion, we will touch upon this vowel in more detail. In any case, it was not the case that learners are always more tolerant of durational changes in judging the naturalness of temporal patterns.

2.3 Results for the Japanese Sentences

Table III shows the estimates for a 50% threshold of "natural" judgments for all the sentences. The Americans responded more sensitively to the shortening of a stressed vowel in their judgment of naturalness for all of the sentences but two, the average percentage of "natural" judgments being -86% for the native speakers of Japanese and -78% for the Americans. In other words, the naturalness of the temporal pattern deteriorated with less of a shortening of the target vowel for Americans compared to that required for Japanese. This is the same tendency which we observed in the shortening of English vowels.

In the case of vowel lengthening, however, the two groups responded differently to different vowels in their tolerance of lengthening. Native speakers were more tolerant of lengthening than the Americans in the vowels which were followed by either a voiceless consonant or a flap. When a vowel was followed by a voiced consonant, however, the Americans were more tolerant of lengthening than the Japanese. The two subject groups can be considered to have a different voice-conditioned effect.

In terms of the effect of the position of a target word in a sentence, we observed the same tendency for the two groups of subjects. Both of the subject groups were less tolerant of lengthening when the target word was in sentence-medial position than in a sentence-initial noun phrase. In the case of vowel shortening, however, they were less tolerant of the shortening of the vowel in a sentence-initial noun phrase than that in sentence-medial position. It seems that a relatively longer duration for vowels in sentence-initial position is likely to be perceived as natural.

The range of vowel durations perceived as natural was slightly narrower for the Japanese than the Americans, the average being 174% for the Americans and 167% for the Japanese. However, we can observe that the relative range of vowel duration for the two subject groups depends on each vowel.

2.4 Results for Japanese Returnees

Further, an additional experiment was carried out on Japanese learners of English with more proficiency in the second language due to having lived overseas, in order to find out how such language experience influences the perception of both the native language and the second language. Nine

Japanese college students who had lived in an English-speaking country for more than three years (Returnees) served as subjects for the same perception experiments described above. As a whole, the estimates for the 50% thresholds of "natural" judgments in English for the Returnees were closer to those for the Americans than the other Japanese group. The second Japanese group exhibited judgments of naturalness which were closer to the native speakers than the first Japanese group. In addition, it should be noted that the Returnees exhibited "overshooting", i.e. they went beyond the tendency of the Americans. The range of vowel durations perceived as natural for the Returnees was also found to be closer to that of the Americans than the other Japanese group, the average being 161% for the Japanese, 171% for the Returnees and 187% for the Americans.

Turning to Japanese, we find that the Returnees' judgments of naturalness in Japanese were different from the other Japanese group. The Returnees' judgments of naturalness were somewhat in-between the other Japanese group and the non-native speakers. This suggests that proficiency in a second language exerts an influence even on the perception of a first language. This interesting finding awaits further study.

III. DISCUSSION

The present study showed how Americans and Japanese respond to durational changes in their judgments of naturalness both in their first language and second language. It was found that Americans are more sensitive to the shortening of a vowel both in English and Japanese than Japanese. Americans can be considered to be sensitive to shortening that makes the stressed vowel sound more like an unstressed vowel. On the other hand, Japanese are more tolerant of reduction in a stressed vowel.

Japanese learners of English were found to be less tolerant of the lengthening in the English vowels tested in the present study than the Americans. Likewise, in the Japanese language, the Japanese were less tolerant of lengthening than the Americans when a vowel was followed by a voiced consonant. Since Japanese has a phonemic vowel-length distinction, it seems natural that Japanese would be particularly sensitive to durational changes that would make a vowel cross the phoneme boundary between a short and long vowel. On the other hand, American speakers might be expected to ignore durational changes that lengthen a stressed vowel compared to Japanese. Another factor which functions in the case of perceptions of lengthening is a voice-conditioned effect. In Japanese vowels followed by either a voiceless consonant or a flap, Japanese are conversely more tolerant of lengthening than Americans. This tendency of Americans in their judgments of naturalness for the lengthening of vowels with such a phonetic environment can be considered to stem from the effect of a following voiceless consonant on the duration of a preceding vowel in English, i.e., a negative transfer from their native language. The two subject groups can be considered to have a different voice-conditioned effect.

In our 1991 study, we observed the opposite response to the English vowel [i]; American subjects responded more sensi-

tively to the lengthening of a target vowel [i], while the Japanese responded more sensitively to the shortening of the vowel. This result, together with the results we obtained in the present study, seems to suggest that Japanese learners of English classify English vowels into two groups, long vs. short vowels. In the case of the vowel [i], which they consider a long vowel, the learners are less tolerant of the shortening of the vowel and more tolerant of its lengthening than native speakers. They seem to think that this vowel needs to be long. This perception pattern observed for Japanese reflects their English production patterns in which they employ the durational differences between the so-called long and short vowels in place of the tense-lax opposition.

The results in English and Japanese indicate that learners of a second language do not necessarily exhibit a broader range of "natural" durations for a stressed vowel than native speakers. In other words, learners are not always more tolerant of durational changes than native speakers. Learners of a second language seem to judge naturalness on the basis of their own measures in their interlanguage, which is not a simple transfer from their first language.

In the present study, we studied the judgments of naturalness for durational changes in first and second languages. We found some specific factors such as the phonemic vowel length distinction and the voice-conditioned effect which exerted an influence on the judgments of naturalness. These results will contribute to a more efficient teaching of the second languages as well as a better understanding of the human perception system.

ACKNOWLEDGMENT

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Table I. Linguistic materials for the perception experiments

- English: 1. The bag I bought was expensive.
 2. I bought the bag yesterday.
 3. The back of the car was completely destroyed.
 4. I will back the car into the garage.
 5. The glasses Pete broke were expensive.
 6. Pete broke the glasses yesterday.
 7. Med students have to study very hard.
 8. John is a med student at Harvard University.
 9. "Bidding" is the only way to get the painting.
 10. We are bidding a good price for the painting.
- Japanese: 1. Bagu wo hajimete kinou katta. (I bought a harness yesterday for the first time.)
 2. Hajimete bagu wo kinou katta. (For the first time, I bought a harness yesterday.)
 3. Baka to kinou Taro ga itta. (Taro said fool yesterday.)
 4. Kinou baka to Taro ga itta. (Yesterday Taro said fool.)
 5. Garasu wa kinou Taro ga watta. (Yesterday Taro broke the glass.)
 6. Taro ga kinou garasu wo watta. (Taro broke the glass yesterday.)
 7. Medo ga tatanai to Taro wa itta. (Taro said the outlook is vague.)
 8. Taro wa medo ga tatanai to itta. (Taro said the outlook is vague.)
 9. Biden wo nokosazu to chichi wa itta. (The father said he would not leave an inheritance.)
 10. Chichi wo biden wo nokosazu to itta. (The father said he would not leave an inheritance.)

Table II. Estimates (percentage changes in vowel durations) for 50% thresholds of "natural" judgments, and the range of "natural" durations (lengthened thresholds minus shortened thresholds)

Subjects	% changes in vowel duration																			
	Bag	IBag	2	Back	1	Back	2	Glasses	1	Glasses	2	Med	1	Med	2	Bidding	1	Bidding	2	Average
Americans	93	100	147	147	147	147	172	129	111	88	140	117	117	124	140	117	117	117	124	124
Lengthening	-61	-89	-41	-50	-50	-50	-63	-64	-53	-53	-79	-78	-78	-63	-79	-78	-78	-78	-63	-63
Shortening	154	189	188	197	197	197	235	193	164	141	219	195	195	187	219	195	195	195	187	187
Japanese	79	76	89	95	95	95	92	72	86	79	87	74	74	83	87	74	74	74	83	83
Lengthening	-62	-75	-59	-66	-66	-66	-75	-83	-74	-80	-90	-116	-116	-78	-90	-116	-116	-116	-78	-78
Shortening	141	151	148	161	161	161	167	155	160	159	177	190	190	161	177	190	190	190	161	161

Table III. Estimates (percentage changes in vowel durations) for 50% thresholds of "natural" judgments, and the range of "natural" durations (lengthened thresholds minus shortened thresholds)

Subjects	% changes in vowel duration																				
	Bagu	1	Bagu	2	Baka	1	Baka	2	Garasu	1	Garasu	2	Medo	1	Medo	2	Biden	1	Biden	2	Average
Americans	90	121	97	63	101	60	73	69	151	133	96	101	60	73	69	151	133	96	101	133	96
Lengthening	-53	-74	-73	-65	-60	-100	-77	-94	-85	-99	-78	-60	-100	-77	-94	-85	-99	-78	-60	-99	-78
Shortening	143	195	170	128	161	160	150	163	236	232	174	161	160	150	163	236	232	174	236	232	174
Japanese	52	44	103	79	113	86	68	52	124	86	81	52	44	103	79	113	86	81	124	86	81
Lengthening	-70	-82	-80	-86	-62	-78	-90	-123	-83	-101	-86	-70	-82	-80	-86	-62	-78	-90	-101	-83	-86
Shortening	122	126	183	165	175	164	158	175	207	187	167	122	126	183	165	175	207	187	187	167	167