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Naturalness Judgments for Stressed Vowel Duration in English and Japanese

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Introduction

Sudo & Kiritani's study(1989) reported a 50% threshold for "natural" judgments for an English stressed vowel whose duration was manipulated by the LPC analysis-synthesis technique. We observed a broader range of "natural" durations for a stressed vowel with Japanese than for American speakers.

In the above-mentioned experiment, there were seven sets of sentences, and the stressed vowels used were [i] and [ɔ]. The duration of the stressed vowel in each of the seven sentences was varied in 7 steps from -47% to +79% of its original duration. The "natural" judgments of the sentences deteriorated for both the American listeners and the Japanese listeners as the vowel duration underwent a change. We obtained the estimates for a 50% threshold of "natural" judgments by approximating the data of the "natural" judgments by the cumulative normal distribution and determining the threshold values by the method of least squares(Table I). The range of vowel durations perceived as natural was narrower for the Americans in all the sentences but one, the average being 93% for the Americans and 119% for the Japanese.

Two interpretations can be advanced to explain the above results. The broader range of "natural" durations for the Japanese may stem from their unfamiliarity with the target language or from their general insensitivity to durational changes in 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. Therefore, in this study, we attempted to distinguish these two possibilities.

Method

Twelve Japanese who had never lived abroad served as subjects. The linguistic materials used in this experiment were the two English sentences and two Japanese sentences shown below. We prepared the two sentences in each language so that the target word occurred in a different position in each sentence.

English: 1. The bɔx is made of red crystal.
2. The present is the bɔx made of crystal.

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Japanese: 1. Bokushi wa kinou Taro ni atta.(The priest met Taro yesterday.)
2. Taro wa kinou Bokushi ni atta.(Taro met the priest yesterday.)

The original English sentences were produced by an American male speaker from Massachusetts, and the Japanese sentences by a male speaker from Tokyo. The durations of the underlined stressed vowels in the above sentences were manipulated by editing a wave form on the computer display. More concretely, we determined a cycle on the wave form by visual inspection and then manipulated the duration of the vowel by either repeating or deleting the cycle on the wave form. The durations of the stressed vowels were varied in 14 to 16 steps as follows:

English sentence 1: -93% to +107% (-13 pitches to +15 pitches: 16 steps)
2: -93% to +107% (-13 pitches to +13 pitches: 16 steps)

Japanese sentence 1: -87% to +90% (-7 pitches to +7 pitches: 15 steps)
2: -85% to +106% (-6 pitches to + 7 pitches: 14 steps)

We prepared a tape recording in which each of the different versions of the original sentences was repeated five times. All of the stimuli for a given sentence set were presented in random order in one block. The task of the subjects was to judge whether the sentences sounded rhythmically natural or not. It was a two-way choice. They were told which segment was manipulated.

Results

Figures 1-4 show the results for the influence of the duration of the stressed vowel on the perception of the naturalness of the temporal pattern of the English sentence. We can observe both in English and Japanese that the temporal naturalness of the sentences deteriorated as the vowel underwent a change. The more change the vowel underwent, the greater the deterioration. We did not detect a marked difference in the range of "natural" durations between the English vowel and the Japanese vowel. When we look at the pattern of the responses, we can observe that the subjects responded less sensitively to the shortening of a stressed vowel than to the lengthening of a stressed vowel in their judgment of naturalness for all of these sentences. Also, the peak of the "natural" judgments can be observed over the range of the original vowel durations and the shortened dura-

tions. We can detect the above response patterns in both of the sentences with the target word in a sentence initial noun phrase or in sentence medial position.

In order to obtain estimates of the 50% threshold for the "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. The ranges of the vowel durations sounding natural were 137% and 125% for the English sentences 1 & 2, and 135% and 136% for the Japanese sentences 1 & 2. Therefore, it can be said that the difference between English and Japanese results was much smaller than the difference between the American speakers and the Japanese speakers which we observed in our previous experiment, which employed only English vowels. This result seems to support one of the two possible interpretations noted for our previous paper, namely, the general insensitivity of our Japanese subjects to durational changes when judging naturalness. Recall that in our 1989 study the American subjects exhibited a narrower range of "natural" durations for a stressed vowel than the Japanese. In order to validate this interpretation, further research on American speakers' responses to these linguistic materials is now being carried out.

References

1) M.Mochizuki-Sudo and S. Kiritani: "Perception of Interstress Intervals by Americans and Japanese Learners of English", Report of the Spring Meeting of the Acoustical Society of Japan, 331-332, 1989.

Table 1. Estimates for a 50% threshhold of "natural" judgments.

Subj. \ Sentence		1 (Dog)	2 (Doggy)	3 (Dog)	4 (Doggy)	5 (Pete)	6 (Peter)	7 (Peterson)	Average
American	lengthening	35	43	25	39	53	42	39	39
	shortening	−34	−40	−39	−48	−41	−55	−118	−54
	range	69	82	64	87	94	97	157	93
Japanese	lengthening	24	61	30	53	123	96	75	66
	shortening	−82	−51	−51	−46	−23	−49	−64	−52
	range	106	114	81	99	146	145	139	119

(%)

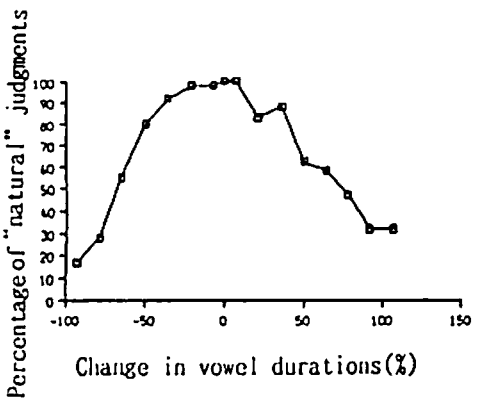

Fig. 1. Percentage of "natural" judgments for "The box is made of red crystal".

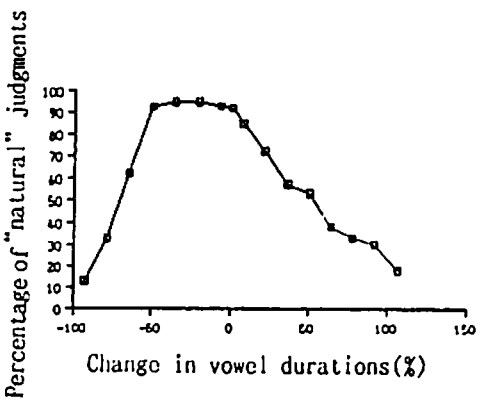

Fig. 2. Percentage of "natural" judgments for "The present is the box made of crystal".

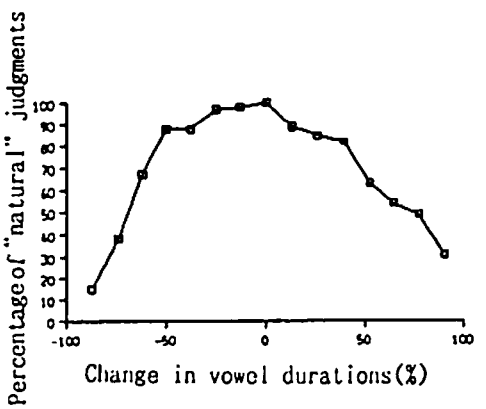

Fig. 3. Percentage of "natural" judgments for "Bokushi wa kinou Taro ni atta".

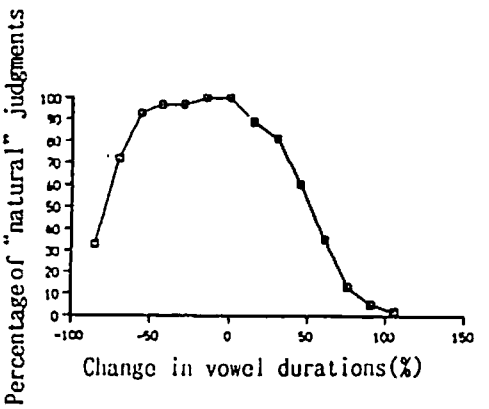

Fig. 4. Percentage of "natural" judgments for "Taro wa kinou Bokushi ni atta".