Acquisition of L2 Length Contrasts

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1. Introduction

A question that currently receives much attention in the study of the acquisition of second language (L2) phonology is: can new phonological structure be acquired? By phonological structure, we are referring not only to segments and syllables, but also stress and tone. Recent work by Brown (2000) on the acquisition of segmental phonology suggests that L2 learners are not merely struggling with L2 phonemes that are absent in their first language (L1), rather it is the novel features of the L2 that are presenting the learners with difficulty: the features present in the L1 grammar of the learner influence the perception and acquisition of L2 phonology. An examination of the acquisition of the English /l/ vs. /r/ distinction by Chinese and Japanese speakers revealed that the Chinese speakers were able to acquire the English contrast while the Japanese speakers were not, in spite of the fact that both Chinese and Japanese lack /l/ and /r/. Brown (2000) assumes that the feature [CORONAL] allows the distinction between the two liquids in English, and argues that the reason for the difference between the two groups of learners can be traced down to differences in the features present in each L1: the Chinese speakers had the feature [CORONAL] elsewhere in their L1 inventory and thus were able to properly construct the representations required to distinguish /l/ and /r/. The Japanese speakers, on the other hand, lacked the feature [CORONAL] in their L1 inventory and thus were unable to represent the novel contrast, resulting in an inability to distinguish between the two phonemes. Furthermore, Matthews (1997) demonstrates that training on the /l/ vs. /r/ contrast does not result in improved perception. It seems, then, that if the relevant feature required to construct the phonological representation for a novel phoneme is present in the learner's L1, s/he will be able to re-deploy it and successfully acquire the new L2 contrast. If the required feature is absent, however, the contrast cannot be acquired: that is, new phonological structure cannot be triggered in L2 acquisition.

While current work (Archibald in progress) is examining Brown's (2000) conclusions in a broader perspective by examining acquisition of segmental structure, syllable structure, and tone by L2 learners, here we report on a case study focusing on the acquisition of Japanese vowel and consonant length contrasts by a native speaker of English. Japanese maintains length contrasts in both the consonantal (/t/ vs. /tt/) and vocalic (/a/ vs. /a:/) inventories (Han 1994, 1962; Homma 1981, 1973). English, on the other hand, contrasts monomoraic and bimoraic vowels, a contrast that approximates the Japanese vowel length distinction with an added complication of vowel quality differences, but crucially English does not distinguish between long and short consonants. The question, then, is: can English speakers acquire length contrasts in a second language? Two possibilities present themselves in answer to this question. The first predicts that native speakers of English will be unable to acquire Japanese geminate and single consonant contrasts due to the fact that English does not contrast consonant length. These same speakers would, however, successfully acquire Japanese vowel length contrasts, since English has monomoraic and bimoraic vowels, thus the feature for vowel length is present in the L1 grammar. The second possibility predicts that native speakers of English will be able to acquire the length contrasts found in Japanese for both consonants and vowels owing to the fact that their L1 maintains a length contrast.

Previous work by Han (1992) provides empirical evidence of native English speakers' difficulty in dealing with geminate and single stop contrasts in Japanese, noting that these speakers often fail to produce the appropriate contrasts, and that when they succeed in doing so, the timing of the geminate stop closure differs significantly from that of a native speaker. Han's (1992) results are summarized in Tables 1 and 2 below. It is useful to note that due to individual differences among speakers for rate of

speech, it is not the actual closure duration measurements that are to be compared, but the ratio of single vs. geminate stop produced by each speaker.

Table 1: Native Japanese Speakers

	/tt/ vs. /t/	/pp/ vs. /p/	/kk/ vs. /k/
Mean Ratio	3.00	2.71	2.80

Table 2[1]: American Speakers of Japanese as a Second Language

Subject	[tt] vs. [t] 1	[tt] vs. [t] 2	[tt] vs. [t] 3	[tt] vs. [t] 4	[tt] vs. [t] 5	[pp] vs. [p] 1	[pp] vs. [p] 2	[kk] vs. [k]1	[kk] vs. [k] 2	[kk] vs. [k] 3
A	1.37	1.55	2.10	1.48	1.26	2.03	1.73	1.45	2.27	1.71
B	2.57	3.35	2.76	2.97	2.27	3.56	2.75	2.55	4.02	1.94
C	1.21	1.85	1.01	1.01	1.50	2.40	1.89	1.75	1.65	1.08
D	1.00	1.18	0.90	1.06	0.93	1.10	.098	0.99	1.22	1.14
Mean	1.54	1.98	1.69	1.63	1.49	2.27	1.84	1.68	2.29	1.47
	1.67					2.06		1.81		

(adapted from Han 1992: 118)

The present study seeks to expand upon Han's (1992) work by examining the acquisition of all Japanese length contrasts.

2. Research Methodology

Only one subject provided data for this investigation: a 22-year old female native speaker of Canadian English who was student at the University of Calgary. The speaker has been a resident of Calgary, Alberta, for the past ten years, prior to that she resided in Edmonton, Alberta. In addition to English, this speaker is also fluent in French and speaks some Spanish: she began acquiring French at the age of five through a French immersion education program, and she began acquiring Spanish at the age of 18 when she began her studies at the university. Although she is not monolingual, her competence with these other languages is not expected to affect her acquisition of Japanese due to the large typological differences that have been observed; particularly, neither French nor Spanish makes use of length contrasts for either consonants or vowels. The subject began acquiring Japanese in a university classroom setting at the age of 22. Classes were held four times a week, for one hour each class, with an additional hour per week spent on drill exercises that emphasized grammatical use of the linguistic structures of the Japanese language. Very little attention was given to pronunciation; the instructor made minimal comments about long vowels (referring to them as "stretched"), and even fewer comments about geminate consonants (describing the production of these as "swallowing the first part of the sound"). Prior to beginning classes, the subject's linguistic knowledge of Japanese was extremely limited: due to exposure to examples from various linguistics classes, she knew that Japanese had a five vowel system (in terms of vowel quality), long and short vowel contrasts, and single and geminate consonant contrasts; however, any other knowledge of the language or its structures was nonexistent.

Data was collected at two time intervals: once after four months of classroom exposure to Japanese, and again after six months of classroom exposure. For each data set, measurements of consonant and vowel duration were taken in order to examine the subject's timing control of Japanese length contrasts. A mean ratio was calculated for each length contrast, and these were compared against those produced by native speakers of Japanese. Additionally, vowel formant (F1 and F2) values were recorded in order to examine the subject's accuracy in producing Japanese vowels;

[1] Here A, B, C, and D each refer to one of the four speakers who provided the data for Han's (1992) study; the numbers which accompany each contrast type (i.e., 1, 2, 3…) refer to the individual test sentences used to elicit the length contrast, so that the table organizes the mean ratios for each subject by test sentence.

specifically, we were looking not only for evidence of substitution of English vowels, but also for evidence of spectral differentiation between long and short vowels.

Fifteen Japanese sentences were designed to elicit the targeted contrasts. These were written in hiragana script, in order to divert the subject's attention to decoding meaning from the text, rather than focusing on proper pronunciation. To avoid unnatural pauses (and any lengthening that may have resulted) in the reading, only words that were present in the subject's working vocabulary were used; hence the absence of minimal pairs in the data. Another unfortunate result of this vocabulary familiarity condition is that a small number of tokens containing geminate consonants and/or long vowels were deemed appropriate for elicitation. It should be noted here that an additional sentence was presented in the second round of recording to elicit tokens of a geminate consonant (/ss/) that were not deemed appropriate to the first round of recording due to the aforementioned vocabulary restraint. Each sentence was read three times and recorded using a Sony TCD – D100 DAT recorder and a Sony ECM - MS908C electret condenser microphone. The data were then re-digitized at a sampling rate of 22.2 kHz using Soundscope 8 One Channel Analyzer. Wide-band spectrograms were made of the sentences, and measurements were taken from these.

3. Results

Table 3 below summarizes the subject's production of geminate and single consonants in Japanese at Time I; Table 4 summarizes the subject's production of long and short vowels in Japanese at Time I.

Table 3: Mean Consonant Closure Duration Ratios

	Single	Geminate	Ratio
/t/ vs. /tt/	0.085	0.332	3.91
/p/ vs. /pp/	0.098	0.392	4.00
/k/ vs. /kk/	0.086	0.333	3.87
/␣/ vs. /␣␣/	0.171	0.291	1.78
/n/ vs. /nn/	0.102	0.291	2.85
/m/ vs. /mm/	0.088	0.296	3.36

Table 4: Mean Vowel Duration Ratios

	Short	Long	Ratio
/a/ vs. /a:/	0.118	0.295	2.50
/i/ vs. /i:/	0.106	0.341	3.22
/␣/ vs. /␣:/	0.082	0.219	2.67
/␣/ vs. /␣:/	0.114	0.351	3.08
/␣/ vs. /␣:/	0.148	0.339	2.29

A two-tailed *t* test revealed that the subject consistently produced geminate consonants that were significantly longer than the corresponding single consonants ($p \leq 0.001$) and long vowels that were significantly longer than the corresponding short vowels ($p < 0.05$). The durational ratios produced do not, however, match up with those produced by native Japanese speakers (see Table 1 above); in fact, these ratios vary considerably from segment to segment and across segment classes. Furthermore, some troubling variation was found in the tokens produced; that is, we note that for some segments, the longest token of a short vowel or single consonant is just as long or longer than the shortest token of the corresponding long vowel or geminate consonant. It should also be noted that this kind of variation was found to be more frequent among the vowels than among the consonants.

These results suggest that the subject has acquired a length contrast in her Japanese, as she consistently produced geminate consonants and long vowels that of a significantly longer duration than their single/short counterparts. She does not, however, have native-like control of the timing of Japanese length contrasts, which are language-specific (Lahiri and Hankamer1988, Esposito and Di Benedetto 1999): not only is there variation among the segment classes with respect to the durational ratios produced, but we also find variation among the tokens produced of any one given phoneme.

Turning now to vowel quality, we see in Table 5 below that the subject showed evidence of L1 interference in that her Japanese long vowels were produced with a different vowel quality than the corresponding short vowels; two-tailed *t* tests revealed this difference to be significant ($p < 0.05$)[2]. She did not, however, merely substitute English vowels: two-tailed *t* tests showed that the measurements obtained differed significantly from measurements of her English vowels ($p < 0.05$). One exception to this should be noted: the subject was observed to substitute English vowels /uw/ and /□/ for Japanese vowels /□:/ and /□/, respectively ($p \geq 0.083$).

Table 5: Mean F1 and F2 of Japanese Vowels

	F1 - Native	F1 – Non-Native	F2 - Native	F2 – Non-Native
/a/	1046	855	2075	1870
/a:/	1046	985	2075	1630
/i/	354	413	2886	2783
/i:/	354	376	2886	2991
/□/	367	507	2060	1772
/□:/	367	473	2060	1941
/□/	655	653	2209	2309
/□:/	655	717	2209	2361
/□/	659	625	977	1208
/□:/	659	579	977	912

As indicated above, a second recording was taken after 2 additional months of classroom exposure to Japanese. The measurements from this session indicate that the subject's performance did not change significantly within this time interval, as two-tailed *t* tests showed that the timing control of most length contrasts did not change significantly (for /t, kk, □□, n, nn, m, mm, a:, i:, □, □:, □/ $p > 0.05$). Where a significant change was detected (for /tt, p, pp, k, □, a, i, □:, □, □:/ $p < 0.05$), it did not result in an improvement to the mean ratio. Furthermore, two-tailed *t* tests showed that vowel quality did not change significantly for most vowels (for /a:, i:, □:, □, □:, □, □:/ $p > 0.05$). Again, where a significant change was detected (for /a, i, □/ $p < 0.05$), it did not result in a more native-like vowel.

4. Discussion

Although the results detailed above clearly indicate that the subject has not mastered Japanese length contrasts, they still suggest that she has acquired some notion of contrastive length, as she is able to consistently produce an appropriate distinction in segment duration for both consonants and vowels. These facts lead us to propose that native-like acquisition of novel segments requires two distinct types of information: an appropriate phonological representation must be constructed, in order to allow segments to be distinguished phonemically, and correct phonetic implementation strategies must be learned for proper articulation of particular segments. This distinction allows us to capture and account for the behaviour observed in the data: the subject was maintaining a length contrast for both consonants and vowels, thus indicating that she had built the required phonological representation; she did not, however, implement the length contrast in a native-like fashion, suggesting that she had not yet mastered the correct phonetic implementation strategies.

Recall from section 1 above that this research was carried out in an attempt to address the question of whether native English speakers would be able to acquire length contrasts in a second language. Two possibilities were discussed, and the present findings support the latter of the two: the feature for vowel length, present in the L1 grammar, can be re-deployed in order to construct appropriate phonological representations for L2 consonant length.

[2] Significance for vowel quality was determined on the following basis: if either or both of the F1 and F2 values reached significance, then the long vowel was deemed to be of a significantly different quality than its short counterpart. Since both the F1 and F2 are used in identifying the vowel in acoustic space, a significant change to either or both would result in the production of a different vowel.

Naturally, the findings of the case study reported here lead to interesting questions for further research. Certainly, it would be valuable to repeat this exercise with a larger sample. An examination of learners' perceptual abilities with respect to novel length contrasts would also be of interest, as this would further shed light on L2 phonological acquisition. Also informative would be investigations of the durational range produced by native speakers, as these would assist us in assessing the variation produced by learners such as our current subject.

References

Brown, Cynthia. 2000. The interrelation between speech perception and phonological acquisition from infant to adult. In John Archibald, ed. *Second Language Acquisition and Linguistic Theory*. Blackwell, 4 – 63.

Esposito, Anna, and Maria-Gabriella Di Benedetto. 1999. Acoustical and perceptual study of gemination in Italian stops. *Journal of the Acoustical Society of America* 106 (4), 2051 – 2062.

Han, Mieko. 1994. Acoustic manifestations of mora timing in Japanese. *Journal of the Acoustical Society of America* 96 (1), 73 – 82.

Han, Mieko. 1992. The timing control of geminate and single stop consonants in Japanese: a challenge for nonnative speakers. *Phonetica* 49, 102 – 127.

Han, Mieko. 1962. The feature of duration in Japanese. *Study of Sounds* 10, 65 – 80.

Homma, Yayoi. 1981. Durational relationship between Japanese stops and vowels. *Journal of Phonetics* 9 (3), 273 – 281.

Homma, Yayoi. 1973. An acoustic study of Japanese vowels: their quality, pitch, amplitude, and duration. *Study of Sounds* 16, 347 – 368.

Lahiri, Adhiti, and Jorge Hankamer. 1988. The timing of geminate consonants. *Journal of Phonetics* 16, 327 – 338.

Matthews, John. 1997. The influence of pronunciation training on the perception of second language contrasts. In Jonathan Leather and Alan James eds. *New Sounds 97*. University of Klagenfurt Press.