VARIABILITY IN CANTONESE SPEAKERS' PRODUCTIONS OF ENGLISH VOWELS

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1. INTRODUCTION

Research on second language (L2) phonetic learning has often emphasized the effects of the first language (L1) sound system on the acquisition of the second. Some work on consonant and vowel production, for instance, focuses on generalizations of the type "Speakers of language *x* have difficulty producing segment *y* when acquiring language *z*." While many of the difficulties that occur in L2 acquisition can indeed be attributed to L1 influences, static accounts of L2 speech do not offer much insight into the *process* of phonetic learning. In the first place, L2 production patterns are not static: the accuracy of some L2 segments, including vowels has been observed to improve in longitudinal research, even without focused instruction [1]. Moreover, generalizations like the one above belie considerable variability both between speakers from the same L1 background and within individual L2 learners when different productions of the same item are compared [2]. Flege's Speech Learning Model (SLM) sees L2 segmental learning as a context-dependent, approximative process whereby learners acquire increasingly better representations of at least some L2 categories over time as a result of experience with language input [3]. This investigation considers the ways in which an evaluation of variability in L2 speaker performance can shed light on the SLM and other models that address the L2 acquisition process. It focuses on English high vowel productions of speakers of Hong Kong Cantonese who are relatively homogeneous with respect to linguistic and social background, but who differ in their length of Canadian residence (LOR). While [ɪ] and [ʊ] occur in closed syllables in Cantonese, they are regarded as allophonic variants of [i] and [u], respectively [4]. Therefore, Cantonese learners of English must learn to produce two vowel distinctions in a phonetic environment in which they do not contrast in L1. In addition, the absence of coda /d/ in Cantonese means that they must also learn to produce all four vowels in a completely new environment. The issues to be considered here are as follows: (1) To what extent is English high vowel acquisition context-dependent for Cantonese speakers, and, in particular, are high vowels produced less intelligibly before /d/ than before other consonants? (2) How much interspeaker variability is evident in high vowel productions, and is that variability related to LOR? (3) What is the relationship between intraspeaker variability in high vowel productions and LOR? and (4) Is there variability in vowel productions across words with the same rhyme?

2. METHOD

2.1 Participants

The participants were 18 native speakers of Cantonese who had been born and raised in Hong Kong. Their mean age of arrival in Canada was 18 yr (range 15-25 yr), and their mean LOR was 4.9 yr (range: 9 months to 6.9 yr). All were attending or had recently attended English-speaking post-secondary institutions in Canada, and all passed a pure-tone hearing screen.

2.2 Test Items

The test items were 30 common English CVC words likely to be very familiar to the speakers. The words contained rhymes consisting of the vowels /i/, /ɪ/, /u/, and /ʊ/ in open syllables or before /t/, /k/, and /d/. Because of the types of rhymes represented and the need for relatively high frequency words, it was not possible to generate a stimulus set such that equal numbers of each rhyme were represented; nor was it possible to match words across rhymes in terms of initial consonants. While most of the words were common nouns, verbs, or adjectives, two were proper names ("Sue" and "Luke").

2.3 Speaking Task

Individual recording sessions were conducted in an audiometric booth using studio-quality digital recording equipment. Words were elicited via a picture-naming task without modeling, so that the productions could be assumed to be based on long-term representations developed through experience with English. Each participant named a randomly-ordered set of drawings, each of which depicted one of the target words. The first letter of each word was provided as an additional cue. Items were first elicited in a practice session, during which the participants guessed each item and produced it in a carrier sentence ("The next word is ___.") If the response was not the target word, the speaker guessed again until the correct word was produced. After all target words had been elicited once, the pictures were shuffled for recording. Each participant then recorded the entire deck three times, with a shuffle after each run-through.

2.4 Vowel Intelligibility Assessment

Four phonetically-trained assistants carried out a vowel intelligibility assessment in a sound-treated room. During multiple individual listening sessions, they focused on the vowel in each word and determined which Canadian English vowel was closest to the one produced. As in previous work, narrow phonetic transcriptions were not used. Responses were registered by clicking computer buttons marked with symbols for the English vowels / i ɪ e u ʊ o / and "other."

3. RESULTS

3.1 Effects of Context

Table 1 shows mean correct identifications, pooled over judges, for the vowels in each rhyme. Because scores on the

two open-syllable vowels, /i/ and /u/, were at or near ceiling, these items were excluded from statistical analyses. The lowest scores, 33% and 52%, were observed on /ɪ/ and /ʊ/ before /k/. Separate one-way repeated measures ANOVAs for front and back vowels yielded significant effects of rhyme on vowel intelligibility in both cases, $Fs(5, 85) = 21.07$ and 12.67, respectively, $ps < .001$. Post hoc Bonferroni tests were used to compare intelligibility across rhymes. Overall, /i/ was more accurately identified in all three CV rhymes than was /ɪ/. Moreover, both front vowels were produced just as intelligibly before /d/ as before /t/ and /k/, even though Vd rhymes do not occur in Cantonese. For the back vowels /u/ was more intelligible before /k/ than before /t/, while the opposite was true for /ʊ/. In addition, /u/ was more intelligible than /ʊ/ before /k/, but not in the other contexts. Finally, /ʊ/ was more intelligible before /d/ than before /k/.

Table 1. Mean %-ID by rhyme and numbers of speakers (of 18) who reached criterion on each rhyme.

Rhyme	% ID	Reached Crit.	Rhyme	%ID	Reached Crit.
i	100	18	u	99	17
it	82	11	ut	70	4
ik	93	15	uk	88	14
id	97	17	ud	62	6
ɪt	44	2	ʊt	69	5
ɪk	52	0	ʊk	33	1
ɪd	55	4	ʊd	86	14

3.2 Between-speaker Variability

To facilitate between-speaker comparisons, a total of 85% correct judgments was adopted as the criterion for "acquisition" of a particular rhyme. Table 1 gives the number of speakers who reached criterion on each rhyme. This total varied from a high of 18/18 speakers for open-syllable /i/ to a low of 0 speakers for /ɪk/. Though the number of rhymes reaching criterion did not correlate significantly with LOR in Canada, the intelligibility of rhymes with /ɪ/ and /ʊ/ did show significant positive correlations with LOR, $rs = .61$ and $.74$, $ps < .01$. For most of the individual /ɪ/ words ('chick,' 'kid,' 'lid,' 'hit,' this statistical relationship held ($p < .05$). For the /ʊ/ words, positive correlations were also observed, but statistical significance was reached in only one of seven possible words ('cook').

3.3 Within-speaker variability

Variability within speakers was assessed by computing two consistency indices based on the three productions of each word. The ALL+ index was the number of times each judge evaluated all three productions of a word correctly, summed over all words. The ALL- index was a parallel total for consistently incorrect judgments. Pearson correlations (r) between the ALL+ and ALL- indices and LOR were .379 (ns) and -.589 ($p < .05$), respectively. Thus, there was a non-significant tendency for speakers to produce more words with correct vowels all three times as LOR increased. At the same time, however, there was a significant tendency for them to produce fewer words with incorrect vowels all three times as a function of LOR.

3.4 Differences Across Words

Despite the general patterns noted in sections 3.1 and 3.2, vowel accuracy sometimes varied according to word, even when the rhyme was the same. For instance, mean scores on 'kid' and 'lid' were 75% and 35% respectively, and on 'put' and 'foot' they were 77% and 60%. While the initial consonants in these words might have influenced vowel accuracy, other accounts are possible. To explore this phenomenon further, nine pairs of words with identical rhymes were selected on the basis of word frequencies from the Michigan Corpus of Academic Spoken English (MICASE) database. For each speaker, mean scores were computed for higher and lower frequency words. A paired comparison revealed that the higher frequency words exhibited significantly more intelligible vowels (80%) than the lower-frequency words (66%), $t(17) = 6.76$, $p < .001$.

4. DISCUSSION

The results of this study are consistent with a view of L2 segmental acquisition as a context-dependent, approximative, frequency-based process. The following outcomes were observed: (1) As posited by the SLM, vowel intelligibility was context-dependent. However, vowels were not produced less intelligibly before final /d/ than before other consonants, despite the absence of final /d/ in Cantonese. (2) Greater L2 experience (assessed in terms of LOR) was statistically associated with better intelligibility of /ɪ/ and /ʊ/ productions. (3) Intraspeaker variability was also tied to LOR such that speakers with longer residence tended to produce fewer words with consistently wrong vowels. This finding suggests a destabilization of previously non-native-like vowel representations as a function of L2 experience. (4) Vowels were not produced equally well in different words with the same rhyme. Although the reason for this finding cannot be firmly established, higher-frequency words tended to have more intelligible vowels. This outcome provides further support for the view that experience with L2 input played a role in the learners' L2 vowel acquisition.

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