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A preliminary study on Cantonese tone production by young heritage speakers

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Abstract

This study investigated the production of six Cantonese tones by heritage language (HL) children in Vancouver, Canada. Twenty-five Cantonese heritage speakers (HSs) aged between 2;1 and 6;0 participated in the production experiment. Data collected from children in Hong Kong (homeland) at the same ages and native speakers aged between 15;09 and 16;07 were included for analysis. Results showed that HSs have not fully acquired all six lexical tones, in particular the tonal contrasts, by 6;0. HL children's overall pattern of the pitch contours was similar to that of homeland children, but with smaller tonal distinctions between similar tone pairs relative to reference speakers. An ongoing tone merging phenomenon appeared among the observed HL children. More interestingly, a "high-low" template, resembling the pitch pattern of English trochaic words, was found in the production of two HL children respectively at age 3;1 and 5;0. These findings are consistent with the idea that language variation exists in the acquisition of HL. Furthermore, the onset of schooling leads to the shift in language dominance from the HL to the majority language, which influences the production of HL.

Index Terms: tone production, heritage speakers of Cantonese, heritage language

1. Introduction

Heritage language (HL) is a newly recognized form of bilingualism, which has attracted growing research interest in recent years. Heritage speakers (HSs) hear and speak their HL as well as the majority language sequentially or simultaneously in early childhood. Several studies investigated HL phonology in Chinese, focusing on the acquisition of vowel system and tones, but most of them were on Mandarin (e.g. [1, 2]) and primarily focused on teenagers or adult speakers (e.g. [3, 4]). Research on young children, in particular those at the early stage of language development, is still lacking.

The Government of Canada reports that 208,935 people emigrated from Hong Kong to Canada during the period of 1980 – 2016 [5]. The most recent census also indicates that 565,270 Canadians speak Cantonese as their mother tongue, and it is the second spoken first language among the non-official languages in Canada [6]. Among these, 191,940 are in Vancouver, providing a valuable pool of potential participants for the studies on the acquisition of Cantonese by HSs [7]. This study makes use of this data pool in Vancouver to investigate the production of the six Cantonese tones by HL children, aiming to fill the research gap on tone acquisition by heritage young children. The production pattern in the present study is also compared to those reported among the young children and reference speakers in Hong Kong.

1.1. Acquisition of Cantonese tones

Cantonese is a tonal language with a complex tone system. It has six lexical tones contrasting in both pitch height and pitch contour: T1 [55] high level tone, T2 [25] high rising tone, T3 [33] midlevel tone, T4 [21] low falling tone, T5 [23] low rising tone, and T6 [22] low level tone [8, 9].

In terms of heritage Cantonese, previous studies provided some useful insights on tone acquisition. [3] conducted a series of perception experiments using the word identification paradigm, comparing different Cantonese tone processing abilities of adult HSs in Vancouver and homeland speakers in Hong Kong. Bottom-up (using only acoustic information), top-down (using degraded signals), and interaction between the two (mispronounced words in neutral and biasing contexts) were examined in her study. The author found that HSs performed worse than homeland speakers in all three aspects and homeland speakers outperformed HSs in using acoustic information, suggesting that the two groups used different listening strategies in tone identification. Another study investigated the perception of tonal contrasts by school age HL children in the U.S. and those in Hong Kong [4]. Two tone pairs were included in the perception experiment: a distinct (easy) contrast T1 [55] vs T4 [21] and a similar (difficult) contrast T2 [25] vs T5 [23]. The authors found that HL children performed worse than those in Hong Kong for both contrasts, suggesting that HSs may pay less attention to pitch differences as phonemic cues, which could be why they performed worse than homeland speakers even for the easy contrast. Moreover, age predicted accuracy for both participant groups, and HSs with some level of Chinese literacy were more accurate in perceiving tones. However, the variance in the HSs' scores remained largely unexplained. The abovementioned studies could not give clear predictions on the production and perception of Cantonese tones by heritage children, especially at the early stages of language development (before 6;0).

1.2. Phonology of heritage language

Previous studies suggested that compared to other linguistic domains, phonological development of HSs appears to be less vulnerable with native-like performance possible [10, 11]. HL experience for the HL speakers plays a significant role in the HL development and the cross-linguistic interactions [1]. Phono1ogical advantages have been found in both speech production and perception. The production advantages appear to require a greater degree of HL experience while perception advantages can be observed even after many years without extensive HL experience [1, 12].

Furthermore, with the wide variability in the ultimate attainment of HSs and the contact between the two or more languages, some recent studies suggested that HL acquisition may relate to language variation and change. [13] investigated the tonogenetic patterns of Korean stops acquired by Korean

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HSs in Toronto and compared the pattern with homeland speakers in Seoul. A similar reduction of Voice Onset Time contrast between the lenis and aspirated stops in both groups was revealed. With crucial differences in that for heritage speakers, the merger was reported to slow down and possibly reverse its direction in younger speakers while the merger progresses at a constant rate from the oldest to the youngest speakers in Seoul. Regarding Cantonese HSs, [14] compared vowel productions by Cantonese HSs in Toronto and homeland speakers in Hong Kong. A vowel merger in progress of /y/ ~ /u/ was found in young HSs but not in homeland speakers. The author also suggested that the variation and change among the young HSs reflected on both transmission and diffusion.

To sum up, the present study examined the Cantonese tone production by young HSs in Vancouver, aiming to conclude their tone patterns across age groups and compare them with that of reference speakers in Hong Kong. Based on the special issues of the HL acquisition, this study predicted that HSs share a similar tone developmental pattern with the monolingual children in the initial stage of language development and face limitations as L2 learners when they start to be exposed to the majority language of the society. Also, the variation in the attainment of HSs affected by linguistic and social factors was predicted to exist in tone acquisition among young HSs.

2. Method

2.1. Participants

Twenty-five HL children aged between 2;1 and 6;0 participated in the production experiment. The participants were born and raised in Vancouver, Canada. They were divided into four yearly age groups. Table 1 details the background of the participants, including the age and the number of speakers in each age group. All the participants reported having no hearing or speech problems. Forty Hong Kong Cantonese speakers aged between 2;l and 6;0 from the data collected cross-sectionally in the previous study were used for comparison [15]. They were children in five kindergartens in Hong Kong, speaking Cantonese as their first language at home. Ten native speakers, aged between 15;09 and 16;07, who did not merge any tones were also included as reference speakers.

Table 1: *Breakdown of the HL participants.*

Age group (years; months)	Numbers of participants
2;1 – 3;0	5
3;1 – 4;0	5
4;1 – 5;0	10
5;1 – 6;0	5
Total	**25**

2.2. Materials

The tone production experiment was a picture-naming task. 30 colored pictures, each accompanied by its name in Chinese character(s), were used to elicit 30 monosyllabic Cantonese words (6 tones × 5 words). 19 of the words were adopted from the Hong Kong Cantonese Articulation Test (HKCAT) [16], a standardized Cantonese articulation test with norm reference on the acquisition of consonants, vowels, and tones in Hong Kong. In addition, 11 words were supplemented for certain tones (especially T5 and T6). All words, such as "faa1 *flower*, daan2 *egg*, sei3 *four*, mun4 *door*, jyu5 *rain*, daai6 *big*", were familiar for Cantonese-speaking children.

2.3. Procedure

All participants were paid to attend the production experiment with parental consents. A detailed language background questionnaire was filled in by the parents of the children. The experiments were conducted in a recording booth in a university in Vancouver. Two phonetically-trained experimenters, who were native speakers of Cantonese and confirmed to clearly distinguish the six lexical tones in both production and perception, facilitated the test. Following the instructions in HKCAT, the experimenter elicited the production by asking questions such as "ni1 go3 mat1 ye5 lei4 gaa3? *What is this?*" while pointing to the picture. Children were instructed to name the target words in isolation twice. No time restriction was imposed. If the participants really could not produce the item, they would repeat the target word after the experimenter. The two clearest repetitions of each item were chosen for analysis.

2.4. Data analysis

The acoustic measurements of fundamental frequency (F0) were done through the automatic F0 tracking using ProsodyPro [17] in Praat [18] on 30 equidistant points along the tone contour. All data were measured in semitones. Manual pulse fixing was done to ensure data validity. In order to quantify the differences between similar tone pairs across age groups, following [15], ratios of average F0 height were calculated for evaluations of level tone contrasts (T1, T3, and T6). The magnitude of rise and the inflection point for rising tone pair (T2 and T5), and the magnitude of fall for the low tone pair (T4 and T6) were measured as well. Paired sample t tests were also used to compare the differences between the tested values of each tone pair for each age group.

3. Results

Figure 1 shows the average pitch contours of the six lexical tones produced by HL children and homeland children aged 2;1-6;0, as well as the reference speakers. Overall, HL children shared a similar pitch contour pattern with homeland children and reference speakers, displaying six tone categories. However, different patterns were observed regarding the high-level tone and some similar tone contrasts. First of all, T1 produced by HL speakers had a falling contour which appeared steeper than both homeland and reference speakers. Second, the direction of the onsets of T2 and T5 contours of HL speakers showed a reverse of the reference pattern. Third, the offsets of T4 and T6 were observed to be much closer in HSs productions compared to both homeland and reference speakers'.

Further evaluations focused on HL children according to age group. Only reference speakers were included for comparisons. Figure 2 indicates a variance of pitch patterns across age groups compared to the reference pattern. The pitch contours could no longer be divided into six categories clearly as shown in Figure 1, especially in aged 2;1-3;0 and 3;1-4;0. Except for T1, an obvious neutralization of tonal contrast was found in the production of 2;1-3;0. Also, among the young children (2;1-4;0), there was an overlap on pitch contour of the rising tones (T2 vs T5) and that of the low tones (T4 vs T6). Even by age 5;0, the overlapping pitch contours still existed in the low tone pair (T4/T6). Further examinations were conducted to investigate these similar tone contrasts.

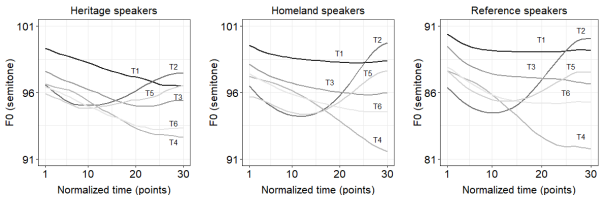

Figure 1: *Mean pitch contour of the six Cantonese tones across 30 measurement points produced by HL children (left), homeland children (middle), and reference speakers (right).*

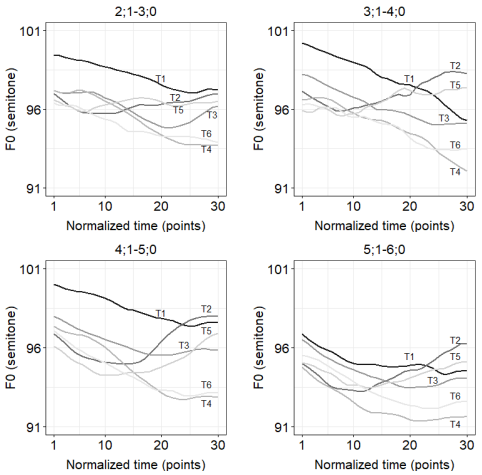

Figure 2: *Mean pitch contour of the six Cantonese tones across 30 measurement points produced by HL children across age groups.*

3.1. The level tones

The three level tones T1, T3, and T6 contrast in F0 height. There was a larger F0 difference between T1 and T3 in HL children productions compared to that between T3 and T6. The same acoustic patterns were found in the productions of homeland children and the reference speakers (see Figure 1). The ratio of T1/T3 and that of T3/T6 were calculated respectively to further compare the distinctions between these two level-tone contrasts. Results showed that HL children in all age groups produced a larger ratio of T1/T3 than that of T3/T6, which was consistent with the ratio pattern of the reference speakers (see Figure 3). A paired-sample t test revealed that, generally speaking, the ratio of T1/T3 was significantly larger than that of T3/T6 (t (1, 34) = 2.371, p = .024) in reference productions. Within each age group, a significant larger distinction between ratio of T1/T3 than that of T3/T6 was found in children aged 2;1-3;0 (t (1, 4) = 3.254, p = .031) only, suggesting that older Cantonese HL children produced smaller distinction between the level tone contrast. The F0 ranges of children aged 3;1-4;0, 4;1-5,0, and 5;1-6;0 were narrower compared to that of children aged 2;1-3;0 (see Figure 2).

3.2. The rising tone pair

The pitch contour of the two rising tones T2 and T5 normally goes from a slight dipping to a rising slope. Regarding the dip in the first half of the pitch contour in T2 and T5, the inflection point, which refers to the position of minimum F0 value, was calculated for comparison. As shown in Figure 4 (left), HL children aged from 3;1 to 6;0 as well as the reference speakers produced T2 with an earlier inflection point compared to T5. Paired-sample t test further indicated that the minimum F0 value of T2 appeared significantly earlier than that of T5 in productions of reference speakers (t (1, 9) = -3.767, p = .004). However, no significant differences were found in all age groups of HL children, suggesting that even though older children (3;1-6;0) shared the same pattern with the reference speakers, the difference was not significant.

In addition to the inflection point, the magnitude of rise (the F0 difference between the offset of the tone at the 27th measurement point and the 10th measurement point) was calculated to examine how steep the rising slope was. Figure 4 (right) showed that HL children in all age groups produced T2 with a larger difference between the two measurement points than that of T5, suggesting a steeper rising slope in the contour of T2 than that of T5. All age group of HL children had the same pattern as the reference speakers. Paired-sample t test revealed a significant slope difference between T2 and T5 in productions of reference speakers (t (1, 9) = 7.451, p < .001). However, no significant slope differences were found in each age group of HL children. Considering the results of the inflection point and magnitude of rise, it is difficult for HL children to acquire the contrast between T2 and T5; plus, they have not fully acquired the rising tone pair even by age 6;0.

3.3. The low tone pair

The magnitude of fall, referring to the F0 difference between the 27th measurement point and the 15th measurement point, was used to compare the distinction between the two low tones T4 and T6. Figure 5 reported that all age groups produced T4 with a larger magnitude of fall from midpoint towards the end of the pitch contour compared to T6. This suggested that same pattern of reference speakers appeared in HL children. Paired-sample t test further revealed that the F0 difference between two measurement points in T4 was significantly larger than T6 produced by reference speakers (t (1, 9) = 3.798, p = .004). However, no significant differences were found within each age group of HL children. These results suggested that even the older HL children still failed to produce the low tone contrast.

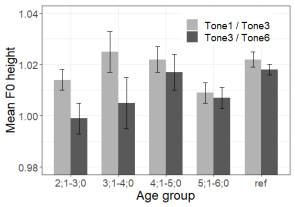

Figure 3: *Ratios of average F0 height for T1/T3 and T3/T6 across age groups. Error bars indicate the standard errors.*

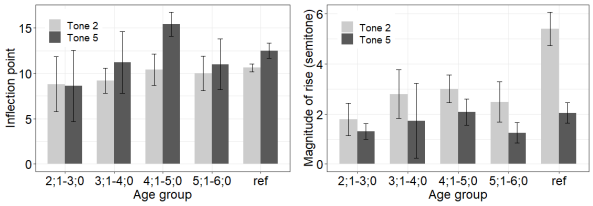

Figure 4: *Inflection point (left) and magnitude of rise in semitone (right) for T2 and T5 across age groups. Error bars indicate the standard errors.*

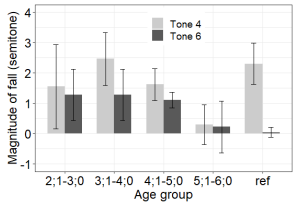

Figure 5: *Magnitude of fall in semitone for T4 and T6 across age groups. Error bars indicate the standard errors.*

3.4. Error patterns

Based on the abovementioned analysis, results varied across age groups among HL children. In the heritage recordings, some reduplicated words were produced by the children simultaneously in addition to the monosyllabic target words. Figure 6 displayed the pitch contour of a reduplicated word "ce1ce1 *car*" produced by an HL child at age 3;1 (left) and that of "faa1faa1 *flower*" produced by another child at age 5;0 (right). In both productions, two high level tones [T1T1] were produced as a high-level tone [T1] followed by a mid-level tone [T3], exhibiting a pattern resembling the pitch pattern of English trochaic words.

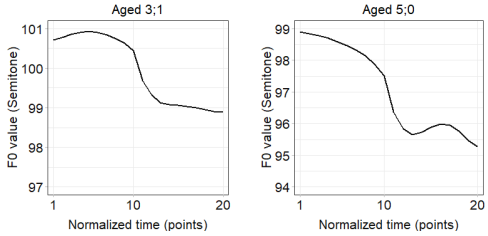

Figure 6: *Pitch contour of "ce1ce1" (left) and "faa1faa1" (right) produced by Cantonese HL children.*

4. Discussion

This study evaluated the production of the six Cantonese tones by HL children in Vancouver. Considering the acoustic features of the similar tone pairs separately according to age group, the tone production of HL children differed from that of reference speakers even at age 6;0. For example, even though the older HL children (3;1-6;0) produced T2/T5 pair and T4/T6 pair with a similar pattern with reference speakers', the differences between the acoustic features of these two contrasts were not significant. This concurs with the findings regarding Cantonese monolingual children in Hong Kong that young speakers have not fully acquired all Cantonese tones at age 6;0 [15]. In addition, a merging phenomenon is taking place in tone acquisition by Cantonese HL children. For instance, the direction of HL children's first half of the T2/T5 pitch contour was the reverse of the homeland and reference pattern. These findings provide evidence in addition to the reduction of VOT in Korean [13] and Cantonese /y/ ~ /u/ merger [14], supporting that language variation and change may be happening in terms of Cantonese tone system among HSs as well. This ongoing change also indicated instances of tone mergers which are occurring among young Cantonese speakers in Hong Kong [19]. It was reported that some young Cantonese speakers merge T2 with T5, T3 with T6, and T4 with T6 in their production and perception, even though the merging is at the beginning stage. The tonal mergers were also observed among second language (L2) learners such as South Asians in Hong Kong [20]. HSs may share similar patterns with homeland children in the initial stage of language development, and they may also face similar limitations as L2 learners of the language when they start to be exposed to the majority language of the society [21]. Complex language inputs may be a possible factor contributing to the ongoing tone merging among HL children in Vancouver.

The special error pattern appeared in the production of two HL children brings to mind the "high-low" template adopted by Cantonese-English bilingual children at 2;0 and 2;6 in Hong Kong when producing reduplicated words [22]. A similar interaction between the Cantonese and English prosodic systems was also observed in a case study of a Cantonese HL child who moved to the US at 16 months [23]. Furthermore, adult HSs were also reported to adopt English 'correspondence rules' in stress patterns to produce Cantonese words [14]. Regarding the two HL children who adopted the "high-low" template in this study, it can be summarized that the error pattern appeared at their school age time when the language experience of HL and the majority language begins to diverge substantially. Thus, possible factor contributing to the occurrence of this phenomenon may be the shift in language dominance from the HL to majority language in the society, which is English in Vancouver. According to the language background, the child aged 3;1 has enrolled in daycare at 1;5, and the child aged 5;0 has enrolled in kindergarten at 3;0. Both of them were systematically exposed to English in schools or other social activities. The main language input for them may change from Cantonese to English or to Cantonese-English, causing an interaction of the Cantonese and English prosodic system. HSs production of Cantonese tones may be influenced by such interaction.

The sample size of this study was small, which could be a reason why the statistical comparisons for most of the age groups were not significant, although the size of the 4;1-5;0 group was comparable to the reference speakers. More data for each age group is being collected to corroborate the findings discussed in this preliminary study. Also, other methods such as auditory analysis will be added in further study for more comprehensive investigation.

In conclusion, this study investigated the production of Cantonese tones by HL children aged between 2;1 and 6;0 in Vancouver. HL children's overall pattern of the pitch contours were similar to that of homeland children, but with smaller tonal distinctions relative to reference speakers. Examinations on similar tone pairs revealed an ongoing merging phenomenon in the rising tone pair (T2 vs T5) and the low tone pair (T4 vs T6). Regarding the individual error pattern, a "high-low" template, resembling the pitch pattern of English trochaic words, was reported to be adopted by a child at age 3;1 and another child at age 5;0. These findings support that phonological language change is happening among HSs. Furthermore, the onset of schooling may lead to a shift in language dominance from the HL to the majority language, which influences the production of HL. Study on the perception of Cantonese tones is undertaken to further explore the acquisition of tone system by Cantonese HL children.

5. Acknowledgements

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