

CATEGORICAL PERCEPTION OF POSTALVEOLAR SIBILANTS BY TAIWAN AND BEIJING MANDARIN SPEAKERS

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1 Introduction

This study addresses the question of how dialect-specific phonetic variation affects speech perception. Previous studies have pointed out that the contrast between dental and retroflex sibilants tends to be lost in connected speech in Taiwan Mandarin, while the contrast is maintained in Beijing Mandarin [1, 2]. A study on speech perception has demonstrated that, concomitantly, Taiwan Mandarin speakers have a broader/weaker category for the retroflex sibilants relative to the dental sibilants [1]. In this study, we tested whether the perception of retroflex sibilants by Taiwan Mandarin speakers relative to the other class of sibilants in the inventory of Mandarin phonemes is also affected. Specifically, we compared Taiwan and Beijing Mandarin speakers on their perception of two postalveolar sibilants, retroflex [ʂ] and alveopalatal [ç].

2 Methods

2.1 Design

We used an ABX discrimination task as well as an identification task to test the categorical perception of the contrast between retroflex [ʂ] and alveopalatal [ç]. Stimuli were drawn from a 10-step continuum from retroflex [ʂa] to alveopalatal [ça]. In the ABX discrimination task, participants compared two test items that were separated by one step (e.g. step 1 vs. step 3). In the identification task, participants were asked to label a single test item either as retroflex or alveopalatal.

2.2 Participants

10 Taiwan Mandarin speakers and 7 Beijing Mandarin speakers participated in the study. All were living in or visiting Vancouver at the time of the study. All participants in the Taiwan Mandarin group self-reported living in Taiwan until adolescence. Similarly, all participants in the Beijing group self-reported living in Beijing until adolescence. Participants were paid \$5 for their participation.

2.3 Stimuli

The 10-step continuum was constructed by resynthesizing naturally produced tokens of [ʂa] and [ça]. The syllables were broken into frication noise and vowel portions, and separate continua were constructed for each. Then, the two continua were combined together to create a syllable continuum. For the frication noise, after the duration and the intensity were normalized, the PSOLA method was used to interpolate a stepwise transition from [ʂ] to [ç]. Figure 1 shows the LPC spectra of frication noise at steps 1, 4, 7, and 10: from step 1

to step 10, the weight of the spectra gradually shifts towards higher frequencies. For the vowel, after duration and intensity were normalized, STRAIGHT was used to interpolate a stepwise transition from [(ʂ)a] to [(ç)a]. Figure 2 shows the first two formants of steps 1, 4, 7, and 10, measured at 10 ms and 100 ms: from step 1 to step 10, the F1 onset gradually goes down and the F2 onset gradually goes up.

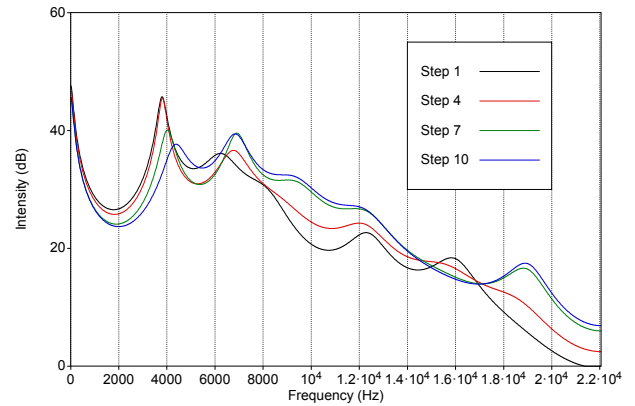


Figure 1: LPC spectra of resynthesized frication noise

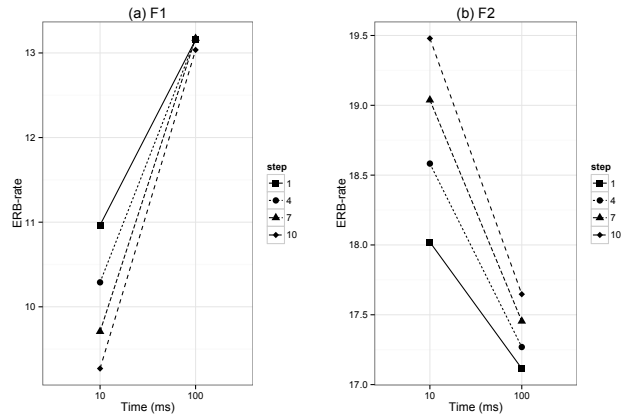


Figure 2: Formant transition of resynthesized vowel

2.4 Procedure

All participants did the ABX discrimination task first and the identification task second. Instructions were given in Mandarin in written form. For the ABX discrimination task, participants heard three syllables and were asked to decide whether the last syllable was identical to the first one or the second one. There were eight blocks in this task. Each block contained 32 trials (8 ABX triads in 4 different orders). For

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the identification task, participants heard a single syllable and were asked to identify it as either retroflex [ʂa] or alveolopalatal [ʧa]. Category labels were shown in *Zhuyin* for Taiwan Mandarin speakers and *Pinyin* for Beijing Mandarin speakers. There were eight blocks in the task, each consisting of 10 trials, one per step on the continuum. Trials within a block were presented in random order.

3 Results

For the discrimination task, responses to each unique triad were converted into sensitivity scores (*d* prime). Figure 3 shows the mean *d* prime scores by language group. Participants in both groups show the highest sensitivity for the trials comparing step 5 and step 7. A repeated-measures ANOVA was conducted with language group as a between-participant factor and pair as a within-participant factor. The analysis yielded a significant effect of pair ($F(7, 105)=21.45$, $p<0.001$) but not language group ($F(1, 15)=1.68$, $p=0.21$). There was no interaction between the two factors ($F(7, 105)=1.02$, $p=0.41$).

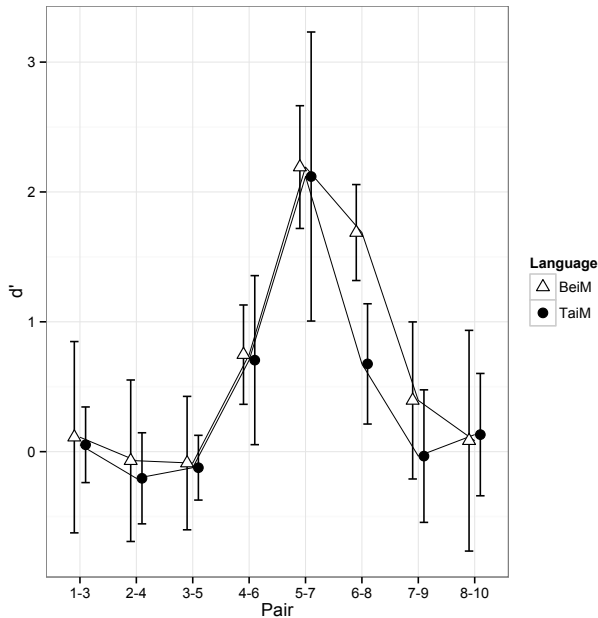


Figure 3: *d* prime (with 95% CI)

For the identification task, the proportion of /ʧa/ responses was calculated for each step on the continuum. Figure 4 shows the mean proportion of /ʧa/ responses by language group. For both groups, the proportion of /ʧa/ responses is close to 0 in steps 1-5, jumps to around .5 at step 6, then increases to close to 1 in steps 7-10, indicating a perceptual boundary between retroflex [ʂa] and alveolopalatal [ʧa] at step 6. Note that both Taiwan and Beijing Mandarin speakers show the same identification curve.

4 Discussion

The results of this study show that both Taiwan and Beijing Mandarin speakers perceive the contrast between retro-

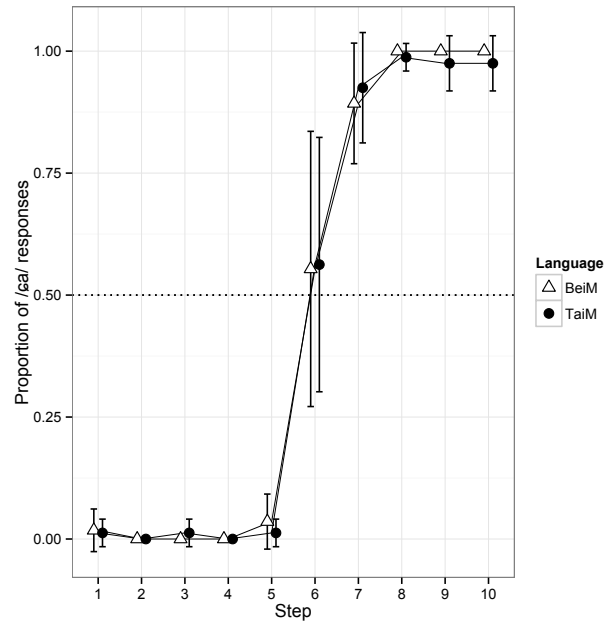


Figure 4: Proportion of /ʧa/ responses (with 95% CI)

flex [ʂa] and alveolopalatal [ʧa] in a categorical fashion, and there is no difference between the two language groups in where they place the boundary. It has been claimed that Taiwan Mandarin speakers have broader/weaker category for retroflex sibilants because of the merger between retroflex and dental sibilants in their dialects [1]. In contrast to previous studies showing a perceptual effect of this merger, the present study demonstrates that the weak category does not affect the perception of retroflex [ʂ] relative to alveolopalatal [ʧ]. A possible explanation for the seemingly conflicting results is that Mandarin speakers rely on different perceptual cues when they process different classes of sibilants. For example, studies have demonstrated that Mandarin speakers rely on frication noise to process dental and retroflex sibilants, but formant transitions to process alveolopalatal sibilants [3]. Therefore, it is possible that the merger affects the processing of cues from frication noise, but not from formant transitions. More research is needed to establish whether this is actually the case.

References

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