

A Perceptual Study on Unreleased Stop Codas in Cantonese: Duration and Transition

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Background: Vowel and nasal coda in some Sino-Tibetan languages has been tested to support the complementary rule [1, 2] that the duration and transition of coda interact with the nucleus that contrasts in duration. According to the rule, long vowel nuclei are usually followed by short codas and short vowel nuclei with long ones. Affected by the duration, short codas are weaker and less clear than long codas.

To test the generality of this rule, this study evaluates the duration and transition across three stop codas in Hong Kong Cantonese: /-p/, /-t/, and /-k/. The duration of a stop coda is hypothesized as the silent interval following the coda, which has been proven not a pause [3, 4]. However, the interaction of duration and transition is uncertain in both perception and production aspects.

Methods: [Duration] Acoustic analysis was conducted on 2 near minimal sets of /a: a/ ([a: ə]) contrast with different stop codas produced in two-morpheme (X+/tʃai/ (仔), a diminutive suffix) and sentence conditions, a diminutive suffix). And then a 4-alternative (3 codas and one syllable without coda) forced identification experiment was done by another 22 native young speakers (12 female, 10 male). The stimuli were synthesized from the recordings of /tʃa:p²²/ (雜, messy), /tʃa:t³³/ (紮, to tie), /tʃa:k³³/ (窄, narrow), /tʃap⁵⁵/ (汁, juice), /tʃat⁵⁵/ (質, quality), /tʃak⁵⁵/ (側, lateral), which were modified in 7 equally spaced steps of duration: from 0 to 212.4 (msec), which is the average duration of silent intervals following /a: a/. And two dummy syllables(/tʃa: ³³/ (炸) & /tʃa: ⁵⁵/ (渣)) were presented randomly. **[Transition]** The frequencies of F1 and F2 were compared using an acoustic vowel chart, whose duration was standardized into 20 points. Following the identification experiment of duration, participants then completed a preliminary task with natural sounds, as well as a 4-alternative forced identification task and an AX task with synthesized sounds whose transitions vary as 6 continua (2*vowel and 3*coda) of 11-steps to answer the last two questions. Data were divided into two groups by the results of the preliminary task, indicating the ability to discriminate /-t/ and /-k/ recedes in some individuals (put into Group B).

Results: [Duration] The acoustic analysis shows the proportion of nuclei and codas is complimentary. In perception, the accuracy rates (see Figure 1) and the average points¹ indicate cues vary between the two groups. Data from Group A show all three factors play a role in perception and the average points for codas rank /-p/ > /-k/ > /-t/ and the short vowel earns more points on average. Group B gets similar results while all mean values are lower than Group A. However, transition compensation is found in both groups. **[Transition]** There is co-articulation but it does not cause the neutralization of vowels. Acoustic data prove it possible for transitions to compensate for the absence of silent intervals at Step 1. The identification data of both groups find phoneme boundaries in the continua /-p/ - /-t/ and /-p/ - /-k/, but Group B did worse in all continua. Both groups have difficulty doing the identification task of /-t/ - /-k/ continua whose accuracy rates fluctuate around 50%. None of the continua shows these stop codas are perceived categorically, according to the results of AX tasks that there are not any statistically significant peaks.

Discussion: Silent interval is proven in this study as one of the perceptual cues of stop codas instead of a pause in Cantonese and obeys the complementary rule both in perception and production aspects.

The interaction between the duration and the transition can be told in two aspects. The first one is the compensation of transitions for the absence of silent intervals. The second one is the merger of coda /-k/ into /-t/. Although this is not a research focus on sound change, the merger of the codas is another proof, indicating that the duration of silent interval affects spectral cues. The coda /-k/ is merging into /-t/, which goes faster after /a:/ when the duration of the coda is short and also goes faster in Group B.

The perceptual mode of these stop codas in Cantonese is in no way categorical according to the results of this study. This may indicate that the categorical perception mode

¹ 1 point for 'none coda' choice, 2 points for choosing the wrong codas, and 3 points for choosing the correct one

is bound with VOT instead of other features of a stop. Further research should be conducted using the same designs and methods of previous works, making the results more comparable and help drawing a more general picture of perception modes.

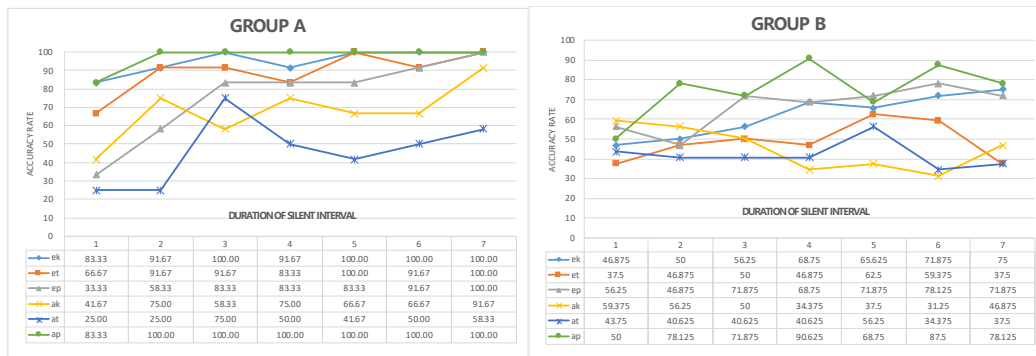


Figure 1. The accuracy rate of the identification experiment for the duration.

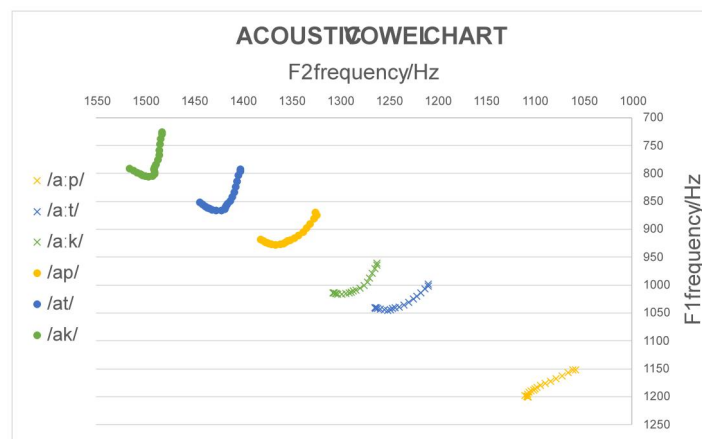


Figure 2. The acoustic vowel chart of /a:p a:t a:k ap at ak/, whose x-axis is F2 frequencies of vowels in reversed direction and the y-axis is F1 frequencies of vowels in reversed direction.

References

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