The Perception and Production of Cantonese Syllable-final Stops in Mandarin Speakers: An Analysis of Perceptibility Scale

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Abstract Based on the Optimality Theory (Prince, A., & Smolensky, P., 1993), constraints related to Perceptibility Scale (Jun, 2004) are proposed as being PRES(pl([-k˺])) >> PRES(pl([-p˺])) >> PRES(pl([-t˺])). This universal ranking refers to the salience of unreleased syllable-final stops in the place of articulation. Targeting on Mandarin speakers' perception and production of Cantonese syllable-final stops ([-p˺], [-t˺] and [-k˺]), current study attempts to testify the applicability of this constraint ranking.

Stimuli and Experimental procedure

In Cantonese phonology (Cheung, 2002), only [ɛ], [a] and [ɐ] can be collocated with all target segments ([-p˺], [-t˺] and [-k˺]). Since vowels [ɛp˺], [ɛt˺] and [ɛk˺] can only be used in limited syllables in spoken Cantonese, such tokens were not be considered. Thus, 12 tokens with [a]/[ɐ] as nucleus and [-p˺]/[-t˺]/[-k˺] as coda were selected as stimuli from Chinese Character Database: With Word-formations Phonologically Disambiguated According to the Cantonese Dialect[1]. The production of these 12 tokens by a male native Cantonese speaker were collected with an Audio-Technica AT2020 microphone in a soundproof booth of a phonetics lab. All syllables were digitised at 22050 Hz and 75 dB then normalised for peak intensity (99% of the full scale) and duration (390.46 ms) via Praat (Paul Boersma & David Weenink, 2018).

By adopting Bi-level Diagram (Perceptual Level and Operative Level) from Silverman (1992) and WEE Lian-Hee (2014), 19 Mandarin speakers (9 males and 10 females) were recruited and assessed through AXB Identification Test and Monosyllable Repetition Test. The experiment was conducted via E-prime (Version 2.0) and the order of stimuli was randomised for every subject. In AXB Identification Test, participants were instructed to focus on the coda of experimental syllables and were trained to read IPA transcription of targets. After hearing the recording of target ([CV-p˺], [CV-t˺] or [CV-k˺]), they were required to identify targets from the IPA transcriptions of [CV-p˺]-[CV-t˺], [CV-p˺]-[CV-k˺] or [CV-t˺]-[CV-k˺] displayed on a screen. In Monosyllable Repetition Test, participants were instructed to repeat each of 12 target syllables after hearing the stimuli. Participants' productions were scored independently by five trained phoneticians as target-like production (1) or non-target-like production (0) for further statistic analysis.

Statistic analysis

The transformed scores (0 or 1) from raw identification and production data were fit in a generalised linear mixed effects model (Stefan Th. Gries, 2009) using the 'lme4' R package (Bates D, MaÈchler M, Bolker B & Walker S, 2015) in R (R Core Team, 2018). To identify the respective influence from different fixed effects on identification and production accuracy, post-hoc pairwise comparisons among different parameters of each fixed effect were conducted by releveling the reference level in the same model. Moreover, the correlation test was used to measure the relationship between identification accuracy and production accuracy.

Result and Discussion

Results suggested that target [-p˺] represented the highest identification accuracy at 88.16% followed by the figures for target [-t˺] (63.82%) and [-k˺] (67.11%). For production results, target [-p˺] obtained the highest accuracy rate at 57.89%, while the figures for target [-t˺] and [-k˺] were 11.84% and 22.37% respectively. Moreover, a positive correlation ($\rho=0.469$, $p < 0.05$) was

[1] Chinese Character Database: With Word-formations Phonologically Disambiguated According to the Cantonese Dialect was developed by The Chinese University of Hong Kong and can be retrieved from http://humanum.arts.cuhk.edu.hk/Lexis/lexi-can/.

identified between identification and production accuracy.

At Perceptual Level, identification results can be described by the constraint ranking as PRES(pl([-p˺])) >> PRES(pl([-t˺]))，PRES(pl([-k˺])). The reasons for this new ranking could be: ①Phonetically, target [-k˺] is perceptually less salient with proceeding central-low vowel [a] (Kochetov, A., & So, C. K., 2007). Stimuli used in current study took [a] and [ɐ], which are central-low vowel, as the nucleus. This could result in the lower perception rate of target [-k˺] and lead to the ranking of PRES(pl([-p˺])) >> PRES(pl([-k˺])). ② Phonetic variations of [-t˺] and [-k˺] is developing in current Cantonese. According to Chen (1999), Zee (1999) and Carol K. S. To, Sharynne Mcleod & Pamela S. P. Cheung (2015), [-t˺] and [-k˺] tend to merge and become phonetic variations especially when the nucleus is [a]/[ɐ]. This support the result of equal ranking between PRES(pl([-t˺])) and PRES(pl([-k˺])) in the current study.

At Operative Level, production of targets performs the same pattern as perceptual ranking and results in the ranking of PRES(pl([-p˺])) >> PRES(pl([-t˺]))，PRES(pl([-k˺])). The positive correlation between identification and production accuracy indicates that production accuracy increases as the identification figure goes up. This suggests that more perceptually salient segments are better preserved in production.

To conclude, the universal ranking of Perceptibility Scale can reflect language users' performance in unreleased syllable-final stops [-p˺], [-t˺] and [-k˺]) only to some extent. Both identification and production rankings in the current study match partially such ranking. However, the result may suggest that vowel context, phonetic variations of targets and the perception-production relationship could affect the re-ranking of constraints related to Perceptibility Scale.

Keywords Cantonese syllable-final stops, perception and production, Perceptibility Scale, Functional Optimality Theory

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