

The influence of L1 segment-tone combinations on the identification of sounds

Ann Wai Huen To^{1,2} and Mingxing Li²

¹The Education University of Hong Kong (Hong Kong, China), ²Hong Kong Baptist University (Hong Kong, China)

Learning a sound system involves learning the distributional probabilities of the sounds in it [1,2,3,4]. The rules of sound combinations in one's native language, i.e., L1 phonotactics, are widely shown to influence one's perception of sounds [5,6,7]. Sound perception is further influenced by whether a combination makes a real word in one's L1 [8,9,10], and an ambiguous segment (e.g., /d/ vs. /t/) can be perceived as a category that makes for a real word (e.g., English dash vs. *tash) [8]. Despite extensive studies on segments, relatively few have examined the influence of L1 phonotactics in terms of segment-tone combinations. For instance, Mandarin listeners were found to be more likely to judge an ambiguous F0 contour as a tone category when the resulting segment-tone combination corresponds to an existing Mandarin syllable than when it would result in a syllable of a tonotactic gap (i.e., an illegal segment-tone combination) in Mandarin [11,12].

The current study examines the potential influence of the rule of L1 segment-tone combinations on a listener's identification of sounds. Focusing on Cantonese phonology, the relevant segment-tone combinations are listed in **Table 1**, in which * marks a tonotactic gap in Cantonese. Of interest to this study is the co-occurrence pattern of the onsets [d] vs. [t] with Tone 2 (mid-rising) and Tone 3 (mid-level) respectively in two rimes [oe] and [ok]. Two experiments were conducted, recruiting 30 native Cantonese listeners, to examine the potential influences of the two patterns in **Table 1** on the listeners' identification of the onsets.

Experiment 1 focused on pattern (1). The stimuli were monosyllables with the rime [oe], in which the onsets involved a seven-step VOT continuum from [d] (Step 1) to [t] (Step 7), at equal intervals from 5 ms to 35 ms. The VOT range was decided based on a pre-test that found the VOT boundary as the mid-point (Step 4). For each VOT step, three F0 contours were superimposed respectively onto the rime [oe]: one corresponding to Tone 2 (T2), one to Tone 3 (T3), and one ambiguous between the two tones (T-ambiguous). After hearing a stimulus syllable (e.g., VOTStep1-[oe]-Tone2), a listener identified the onset as /d/ or /t/. The results, as illustrated in **Fig 1**, showed an influence of F0 (e.g., T2 vs. T-ambiguous vs. T3) on the identification of onset stops. At VOT step 6 (i.e., near the [t] end), for example, the rate of /t/ responses was higher when the F0 corresponds to Tone 3 than when it corresponds to Tone 2. Referring to pattern (1) in **Table 1**, Cantonese listeners were biased to judge an onset as /t/ when the segment-tone combination matches the Cantonese-legal syllable [toe-Tone3]; they were biased against /t/ when a combination is Cantonese-illegal. The results indicated that the listeners' perception was modulated by the pattern of segment-tone combinations in (1).

Experiment 2 focused on pattern (2), which differs from (1) in having a legal combination at one end instead of two. The stimuli were monosyllables with the rime [ok], involving the same seven-step VOT continuum and the same three F0 conditions as in Experiment 1, manipulated through the same process. Similarly, the listeners identified the onset as /d/ or /t/, and the results are illustrated in **Fig 2**. A tendency was observed for the rate of /t/ responses to be higher when the F0 corresponds to Tone 3 than Tone 2, showing the influence of L1 segment-tone combination. Compared with the averaged rates of /t/ responses from Experiment 1 (the yellow line), the crossover in **Fig. 2** shifted towards the left. This indicated the influence of pattern (2), in which [dok] (to the left end) does not combine with either Tone 2 or Tone 3.

These results showed that native Cantonese listeners are influenced by the rule of segment-tone combination in their L1 when identifying sounds. In general, this study suggested that a speaker of a tone language has detailed distributional probabilities of segments and tones in his/her L1 and that the lexical status of the relevant combinations may influence a listener's perception of sounds.

Table 1. Segment-tone combinations in Cantonese

Pattern index	Legal combinations and illegal combinations (marked with *)	
(1)	doe-Tone2 朵 a classifier *doe-Tone3	*toe-Tone2 toe-Tone3 唾 ‘saliva’
(2)	*dok-Tone2 *dok-Tone3	*tok-Tone2 tok-Tone3 托 ‘to carry’

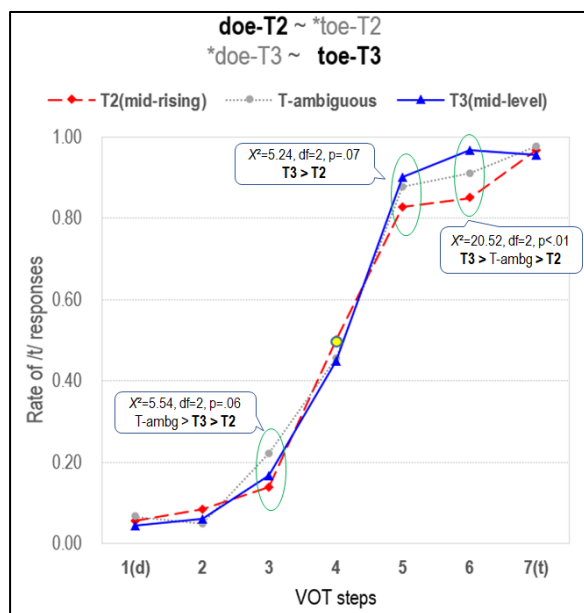


Fig 1. Rate of /t/ responses across different VOT steps and F0 conditions in Experiment 1

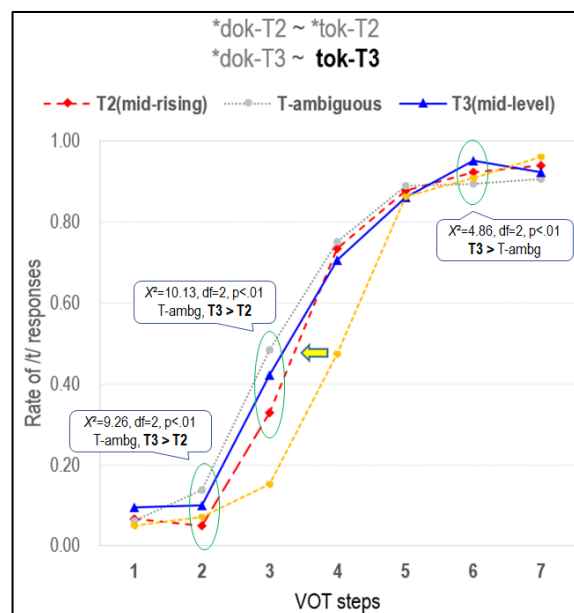


Fig 2. Rate of /t/ responses across different VOT steps and F0 conditions in Experiment 2

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