Temporal location of perceptual cues for Cantonese tone identification

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Background: In connected speech, speech sounds often have varied phonetic realizations due to influences from adjacent sounds. *Anticipatory* and *carryover coarticulation* refer to effects from a subsequent sound and that of a preceding sound respectively. Previous studies on tone languages find that the magnitude of effects from the two directions is asymmetric. In bisyllabic nouns of Thai, anticipatory tonal effects are dominant (Gandour et al 1992). However, in Vietnamese (Brunelle 2009) and Mandarin Chinese (Xu 1997), carryover effects are of a greater magnitude. In Cantonese, a language with six lexical tones listed in Table 1, carryover effects are so strong that in a disyllabic sequence σ_1-σ_2, F0 transition from the tone of σ_1 to σ_2 takes up 50% of σ_2, resulting in a great magnitude of F0 variation across different tonal contexts (Wong 2007). The second half of σ_2, however, has less varied F0 curves that are similar to those produced in isolation.

Goals of this study: Based on Wong's (2007) results from tone production, the current study investigates the role of coarticulatory effects in Cantonese tone perception. Three research questions are put forward: (i) Is the period of transition a necessary component for tone identification of σ_2? (ii) Are tonal perceptual cues concentrated in a particular portion of the syllable? (iii) Are the answers to these questions the same for all six tones in Cantonese?

Table 1. Cantonese tone minimal sextuplets used as target syllables

			si	sɛ	fu
1	high level	55	詩 poetry	些 some	呼 to exhale
2	high rising	25	史 history	寫 to write	苦 bitter
3	mid level	33	試 to try	瀉 diarrhea	富 wealth
4	low falling	21	時 time	蛇 snake	符 to match
5	low rising	23	市 market	社 society	婦 woman/wife
6	low level	22	是 to be right	射 to shoot	負 to load

Table 2. Symbols representing the first/second half of the vocalic portion of the first/second syllable in a disyllabic sequence

σ_1		σ_2	
α	β	γ	δ

Methodology: Twenty-four native Cantonese speakers were recruited for a forced-choice tone identification task. Target syllables are contained in the carrier sentence [jɐw^{23} kɔ^{33} kiw^{33} ($\underline{\sigma_1}$) ($\underline{\sigma_2}$) kɛ^{33} jɛ^{23}] 'There is something called ($\underline{\sigma_1}$) ($\underline{\sigma_2}$).' To ensure that the starting point of the vocalic portion of the syllable can be clearly marked, all target syllables have voiceless onsets. σ_1 and σ_2 can be any bisyllabic combination of the words in Table 1. Stimuli are manipulated into four types: **(A)** unmanipulated, thus α, β, γ and δ in Table 2 are all kept in the signal; **(B)** either α or β is removed as a control for the effect of manipulation; **(C)** γ, the period of F0 transition, is zeroed out; **(D)** δ, the steady part of the tone contour, is zeroed out. Each subject is presented with randomized stimuli of all four types, and is always asked to identify the tone of σ_2 by choosing one of the six tones in their orthographic form.

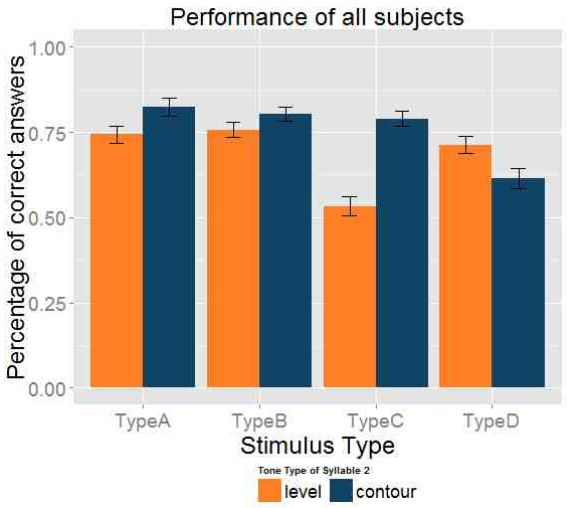

Figure 1. Accuracy rate across all stimulus types

Results: Results in Figure 1 show that the temporal location of perceptual cues is different for level and contour tones. The perception of level tones (Tone 1, 3, 6) suffers most in Type C, in which the first half of σ_2 (γ) is zeroed out. However, the identification of contour tones (Tone 2, 4, 5) is significantly affected in Type D, in which the second half of σ_2 (δ) is zeroed out. Confusion patterns across subjects are similar. Possible reasons and their implications on other tone-related phonological phenomena will be discussed.

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