

Cross categorical temporal feedback in English voicing contrasts

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Abstract

To maintain accuracy and precision, the speech motor control system is adaptive and incorporates both auditory and somatosensory feedback. This has been demonstrated in several studies in which auditory feedback of a talker's own voice was perturbed in real-time. For example, when the fundamental frequency or vowel formants are shifted up or down in frequency, subjects compensate by changing the corresponding acoustic parameters in the direction opposite to the perturbation. In the present study, we examine the role auditory feedback plays in the maintenance of the temporal characteristics of consonants. In particular, we examine if acoustic feedback plays a role in the control of voice-onset time (VOT).

Fourteen female undergraduate students whose native language is Canadian English participated in two experimental sessions. The first session had two phases. In one phase, talkers produced either 100 utterances of the word 'tipper'. In the other phase, they produced 100 utterances of the word 'dipper'. In both phases, talkers received normal auditory feedback. These utterances were then analyzed to measure the VOT and duration of the first syllable. The mean VOT for each word was calculated for each talker. Five utterances of each word were chosen for each talker as exemplar tokens. The criteria used to choose these utterances were minimum difference in VOT from that talker's mean.

The second experimental session consisted of two phases. In one phase, talkers produced 100 utterances of the word 'tipper'. For the first 20 utterances, talkers received normal feedback. For the next 40 utterances, talkers heard one of their exemplar tokens of the word 'dipper' gated to the onset of their production. Thus, when a talker said 'tipper', she heard herself say 'dipper'. For the final 40 utterances, feedback was returned to normal. The other phase of the experiment involved the talker producing 100 utterances of the word 'dipper'. The design of this phase was identical to the other phase except that exemplar tokens of the word 'tipper' were used when the feedback was altered.

The utterances produced in the second session were analyzed to measure VOT and duration of the first syllable. Talkers compensated for the altered auditory feedback, lengthening, the VOT for /t/ by an average of 10 ms when they heard feedback with /d/. Similarly, talkers reduced the VOT for /d/ by an average of 2.5 ms when they heard feedback with /t/. Thus, when talkers received feedback with a cross-categorical change in VOT, they compensated by altering VOT by approximately 20% in both conditions.

This partial compensation is similar to results reported in formant and pitch perturbation studies. Moreover, the duration of the first syllable remained unchanged over the course of the experiment. Thus, when talkers increased VOT, they reduced the duration of the vowel by a similar amount. This suggests that motor planning is based on a syllabic unit, which is in agreement with the previous studies of compensatory shortening. Taken together, the results imply that talkers compensate for errors in articulatory timing by planning changes at the syllable level, rather than altering the VOT independently.