Somatosensory function in speech perception

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Background:

There are long-standing interests in speech communication studies concerning the nature of representations and processing in speech production and perception. The main concerns in this debate are how listeners extract and learn to produce such fundamental linguistic elements as consonants and vowels (or the distinctive features that compose them) from the acoustic signal [see review in Diehl et al. (2004)]. Although three major sets of theories (or representations) have been considered to date: motor theory (Liberman et al., 1967), auditory theory (Guenther et al., 1998; Diehl et al., 2004), and perceptuo-motor theory (Schwartz et al., 2012), the possible role of the somatosensory system has been largely overlooked in these theoretical reviews.

Somatosensory function is conventionally investigated together with motor function, mostly in speech production studies. However, one intriguing role of somatosensory function is its contribution to 'speech perception' in the absence of motor processing. For example, the identification of speech sounds is altered when a robotic device stretches the facial skin as subjects listen to computer-generated stimuli without any voluntary speaking motion (Ito et al., 2009). Air puffs to the cheek that coincide with auditory speech stimuli alter subjects' perceptual judgments (Gick and Derrick, 2009). While speech processing is clearly auditory in nature, the somatosensory system appears to contribute to the perceptual processing of speech sounds. Exploring possible somatosensory influence on speech perception can provide new insights for the linkage between speech production and perception.

Purpose of the study:

The long-term goal is to understand orofacial somatosensory function in speech motor control, learning and perception.

The current project will **explore in detail the nature of the dependence of speech perceptual function on somatosensory information** through psychophysical experiment. The work is of both theoretical and practical importance. Any significant somatosensory contribution to speech perception would provide for better understanding of the relationships between speech perception and speech production representations and processes. The current project will specifically test **the idea that the effects of somatosensory function on speech perception develop through learning.** The specific plan is to assess changes in somatosensory effects on perception using an experimental model of speech motor learning that entails adaptation to altered auditory feedback.

Method:

1) The current project will apply a facial skin stretch perturbation as a main tool of somatosensory stimulation. The stimulation is generated using a robotic device (SenSable Technologies: Phantom 1.0) controlled with Matlab and custom-made control driver (Fig. 1).
2) The study uses software-based altered auditory feedback system, which was originally developed by Cai et al. (2011), for speech motor adaptation task. The software is written in C.
3) The stimulus presentation in speech perception test is controlled using Matlab with psychophysics toolbox.
4) The acoustical data and the participant's responses are analyzed using Matlab for signal processing and R for statistical analysis.

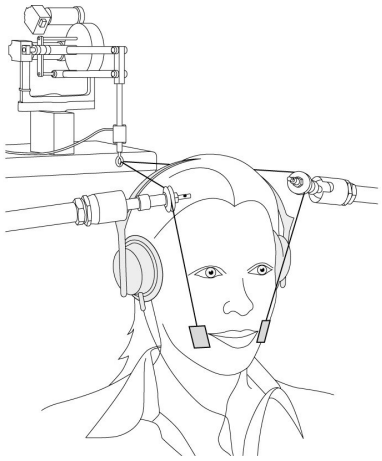

Figure 1

Reference:

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