

Perioral reflex in speech motor control and adaptation

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Background:

Feedback control of human motor system consists of multiple layers of compensatory mechanisms according to response latency. Reflex is the fastest neural response for the compensation against external disturbance, and is precisely regulated in amplitude for posture control and/or impedance control in human skeletal system (Marsden et al., 1972; Agarwal and Gottlieb, 1977). The perioral reflex is induced in the lip muscle and hence the reflex may play a role in speech motor control. The previous studies showed that the amplitude of the perioral reflex also suppressed prior to speech production (McClellan and Clay, 1994) and changed during speech production (Estep and Barlow, 2007). However, its functional role is unknown yet in detail. Since lip compensatory movement in speech production is functionally regulated depending on the task utterances (Kelso et al., 1984; Shaiman and Gracco, 2002), the perioral reflex may also be similarly regulated for speech production, and its regulation mechanism may be shaped through speech motor learning.

Given that speech articulatory movement is achieved in bilateral motion, the perioral reflex might be controlled according to sensory input arising from both side of the face. Since most of the previous studies had applied unilateral stimulation in order to specify the sensory origin, it is still unknown how sensory inputs equally arising from both side of the face drive the perioral reflex. We have recently developed novel somatosensory stimulation method associated with facial skin deformation (Ito and Ostry, 2010). Given that the skin stretch perturbation can stimulate both side of facial target equally and can induce successfully the perioral reflex (Ito and Gomi, 2007). Using this novel stimulation method may give us new insight of sensory organization for the perioral reflex.

Purpose of the study:

The current studies will revisit to **the investigation of functional role of the perioral reflex for speech production**. The project will specifically test **the idea that the perioral reflex can be controlled according to speech utterances and can be shaped through speech motor learning**. The study will apply novel somatosensory stimulation method, that is, skin stretch stimulation in order to elicit the perioral reflex. The specific plan is to assess if the amplitude of perioral reflex is changed according to speech utterances. The project also examined if the perioral reflex is modulated between before and after speech motor learning task. We will clarify the underlying mechanism of the perioral reflex by observing how the reflex is involved in speech production.

Method:

- 1) The current projects 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.

- 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 study record electromyography from the lip muscle and articulatory motion data (Optotrak or Wave system).
- 5) The acoustical data and the participant's responses are analyzed using Matlab for signal processing, R for statistical analysis.

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