Internship proposal

Tongue posture stabilization of vowel production with altered auditory feedback

Supervisers: Takayuki Ito, Pascal Perrier, Morgane Bourhis
Contact: Takayuki Ito, takayuki.ito@gipsa-lab.grenoble-inp.fr
Location: GIPSA-lab / Grenoble-Alps University.

Background:
The control of tongue movements is crucial in speech production (Perrier 2012), since tongue is responsible for the fine shaping of the vocal tract which determines the spectral characteristics of speech sounds. Remarkably humans have the capacity to speak precisely in various conditions with various physical constraints, such as walking, running, biking, lying on the bed or sitting. The previous study showed that the tongue can respond quickly to stabilize speech posture for vowel production when the posture was perturbed by the external force (Ito et al. 2020). Since this quick compensatory response was induced faster than any possible cortical auditory feedback loop (< 140 ms for the movement change), it may rely on the sole use of somatosensory information, which would then be tuned toward efficient auditory correction. This hypothesis has been examined by showing that the compensatory response was induced regardless of auditory feedback availability (Bourhis et al. 2022).

Purpose:
The current project further investigates the proposed hypothesis by examining **whether the quick compensatory responses was similarly induced in the auditory conditions, in which the produced sound was played back by emphasizing or reducing the change of speech sound due to tongue perturbation using altered auditory feedback system.**

Method:

1) We will evaluate the tongue movement during speech production when the tongue shape is changed dynamically using the external perturbation force.
2) Electro-magetometer (Northan Degital: Wave) is used to record the tongue motion together with recording the produced sound.

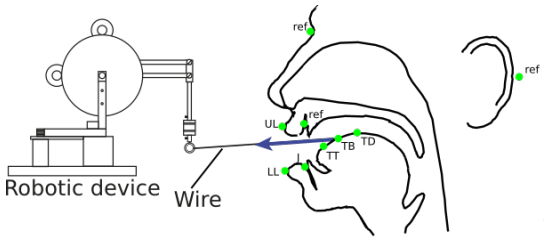

Figure 1: Experimental Setup

3) A robotic device (SenSable Technologies: Phantom 1.0) will generate a force to change the tongue shape during speech production. The robot will be controlled with Matlab and custom-made control driver (Fig. 1).
4) The produced vowel sound will be played back with real-time alteration of vowel characteristics using Audapter (Cai et al. 2011).
5) The acoustical and kinematic data are analyzed using Matlab for signal processing and R for statistical analysis.

Outputs:
The current internship is a challenging project to combining the method applied in the previous study using a robotic device and electo-magnetometor and altered auditory feedback. The student will learn sophisticated experimental and analysis method for psychophysiological experiment together with a physiological knowledge concerning human sensorimotor mechanism in speech. This internship is a part of ANR project (SpeechStab: ANR-21-CE28-0022). When the internship was successfully completed, the obtained result would be novel and stimulate further argument for future work.

Reference:
Bourhis M, **Perrier P**, **Savariaux C**, **Ito T**. Compensatory movement of the tongue for speech production with or without masking noise. In: *SMS 2022 - 8th International Conference on Speech Motor Control*. Groningen, Netherlands: 2022.

Cai S, **Ghosh SS**, **Guenther FH**, **Perkell JS**. Focal manipulations of formant trajectories reveal a role of auditory feedback in the online control of both within-syllable and between-syllable speech timing. *J Neurosci* 31: 16483–90, 2011.

Ito T, **Szabados A**, **Caillet J-L**, **Perrier P**. Quick compensatory mechanisms for tongue posture stabilization during speech production. *J Neurophysiol* 123: 2491–2503, 2020.

Perrier P. Gesture planning integrating knowledge of the motor plant's dynamics: A literature review from motor control and speech motor control. In: *Speech Planning and Dynamics*, edited by Fuchs S, Weirich M, Pape D, Perrier P. Peter Lang Publishers, 2012, p. 191–283.