



Tongue posture stabilization by reflex mechanism for speech production

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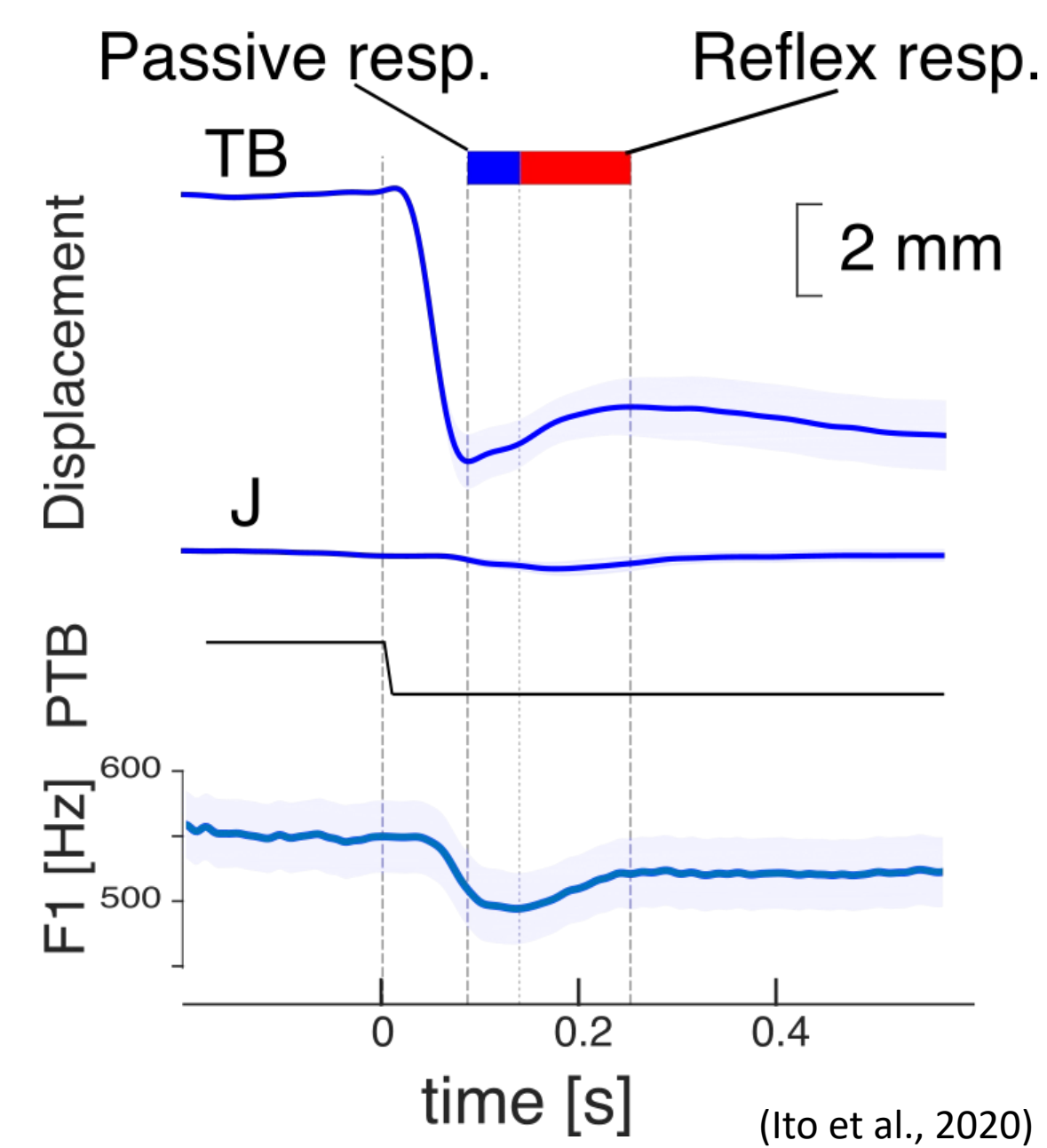
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Introduction

The stability of tongue posture control is important to produce speech sounds with enough accuracy. Stretch reflex is known as one mechanism that contributes to the stability of human sensorimotor control. When a muscle is stretched by unknown disturbance, the muscle makes a quick contraction to maintain the posture (and then keep its length constant). Although this quick reflex has been quite extensively investigated in limb system, the extent to which it contributes to the motor control of the tongue remains unknown.

While a previous study failed to induce stretch reflex in the tongue (Bratzlavsky and van der Ecken 1974, Neilson et al., 1979), we have found behavioral evidence that the tongue shows relatively quick reaction of motion in response to external mechanical perturbation (Ito et al., 2020). Although the latency of this behavioral response was in the range of reflex delay, the involvement of reflex mechanism is still uncertain due to lack of neurophysiological evidence.

This study aims to show **neurophysiological evidence of the tongue stretch reflex during vowel production by the recording of the tongue muscle activity.**



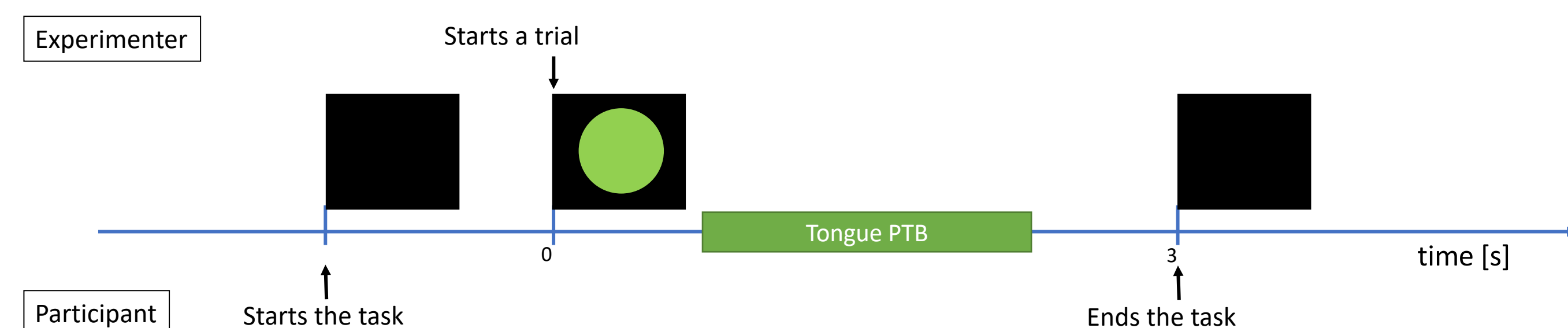
Method

Participants:

- Eight native speaker of French.

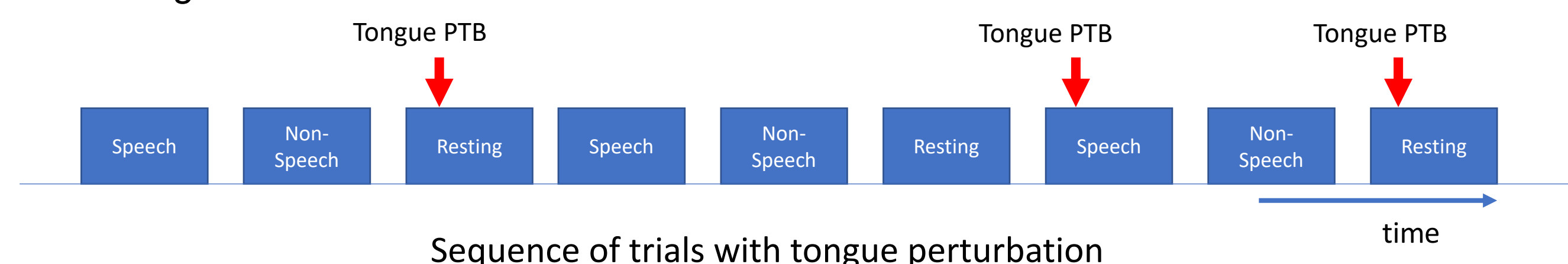
Experimental procedure:

Sequence of one trial



Session 1: Speech task

- Participants were asked to carry out one of the following task.
 - Speech task: Sustain the vowel /i/
 - Non-speech task: Produce the muscle activation of the tongue at the same level of the one in production by monitoring filtered muscle activation.
 - Resting task



Session 2: Reaction task

- Produce the vowel /i/.
- Produce a maximum contraction when the perturbation was perceived.

Session 3: Vowel production task (No tongue PTB session)

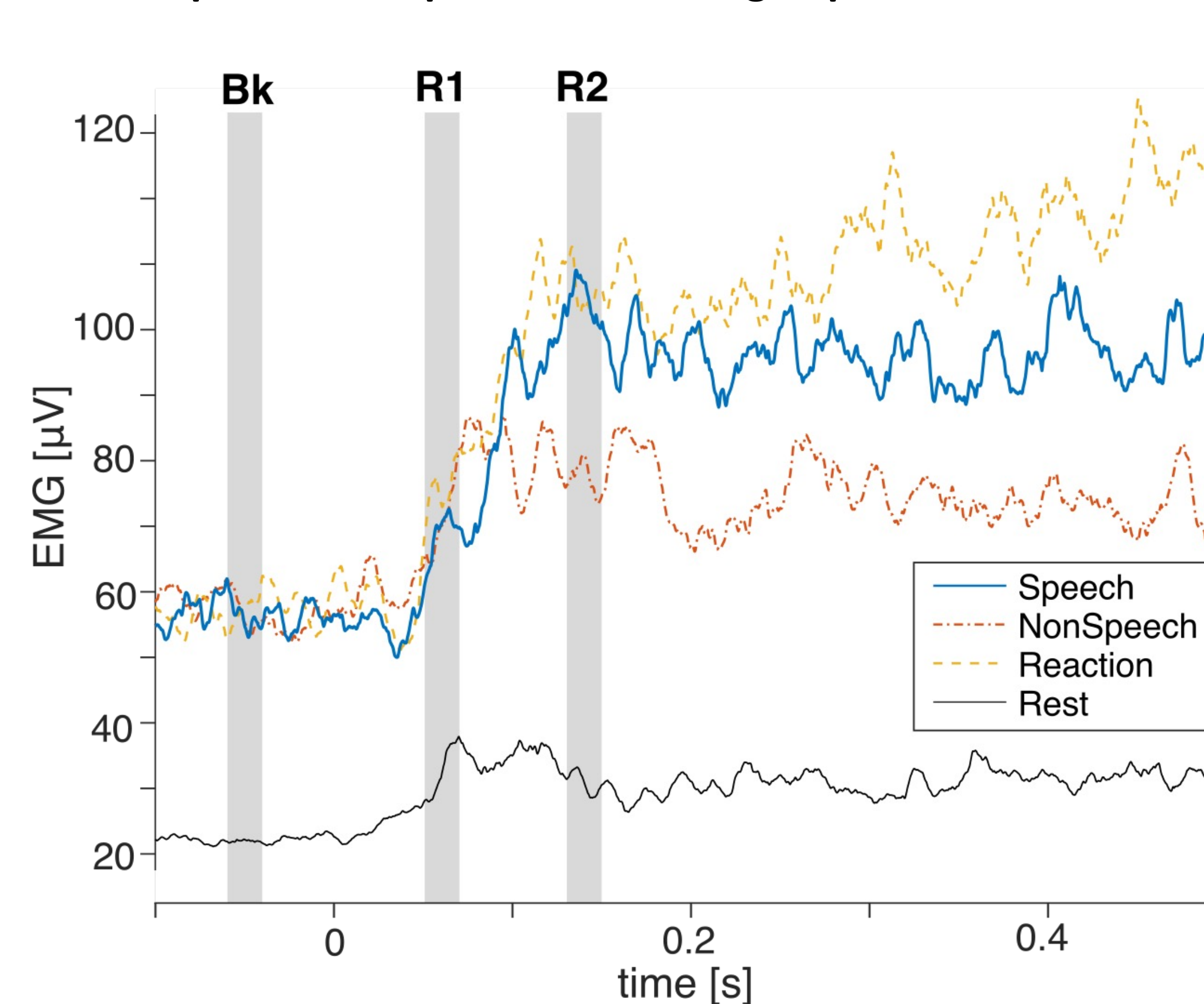
- Sustain the vowels /i/, /e/, /ε/, /a/ and /u/ five times each.

Data analysis:

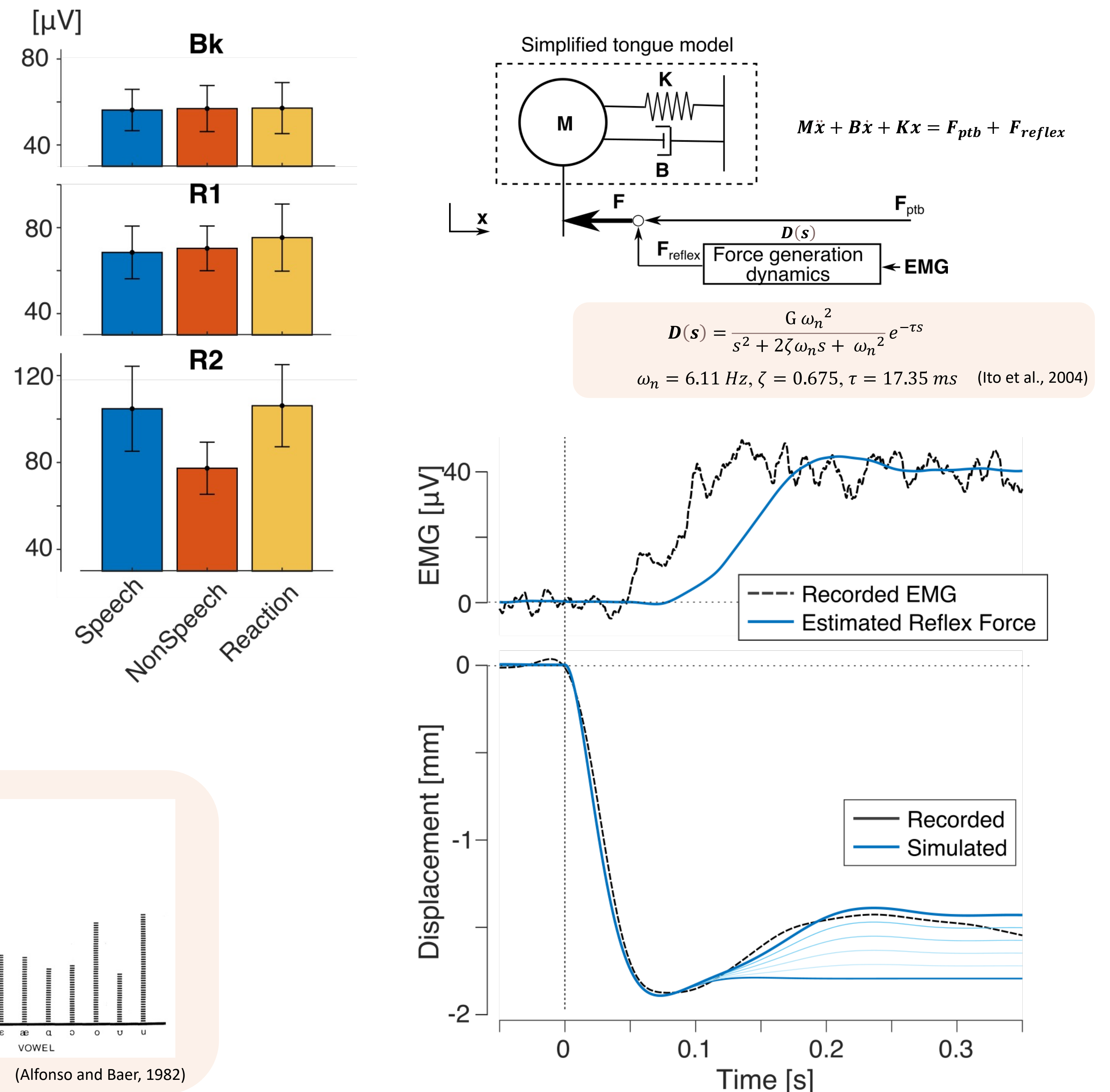
- EMG data was filtered by 30-2000 Hz band-pass filter, rectified and smoothed.
- All data was aligned at the perturbation onset.
- Amplitude was detected using 10 ms temporal window.

Results

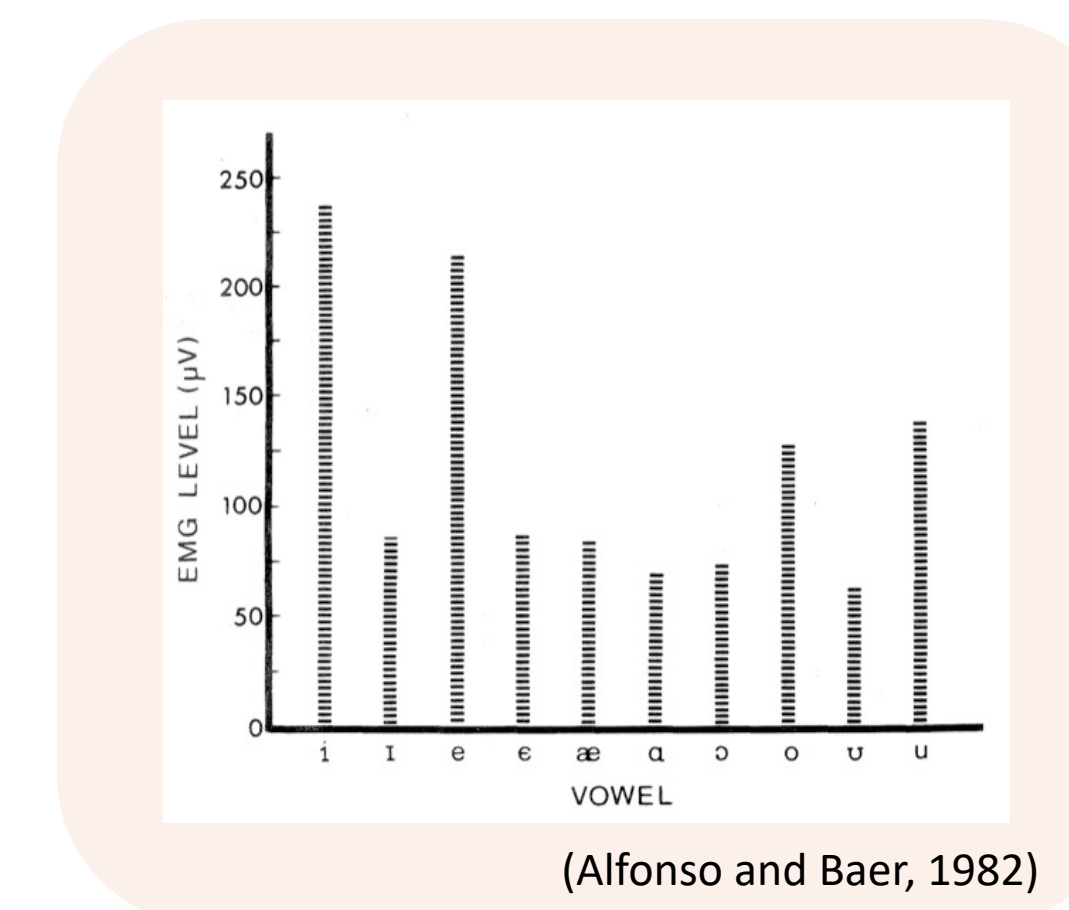
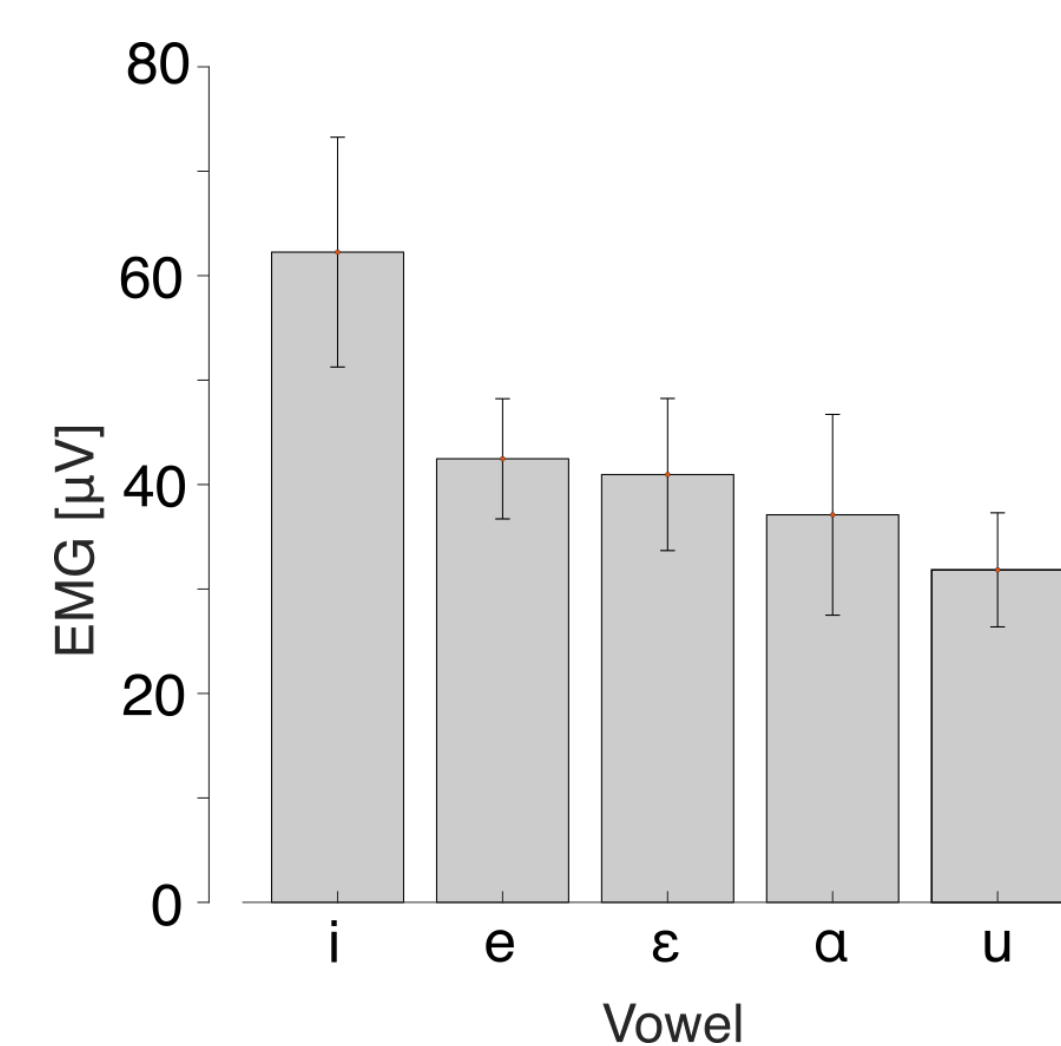
Reflex response in response to the tongue perturbation



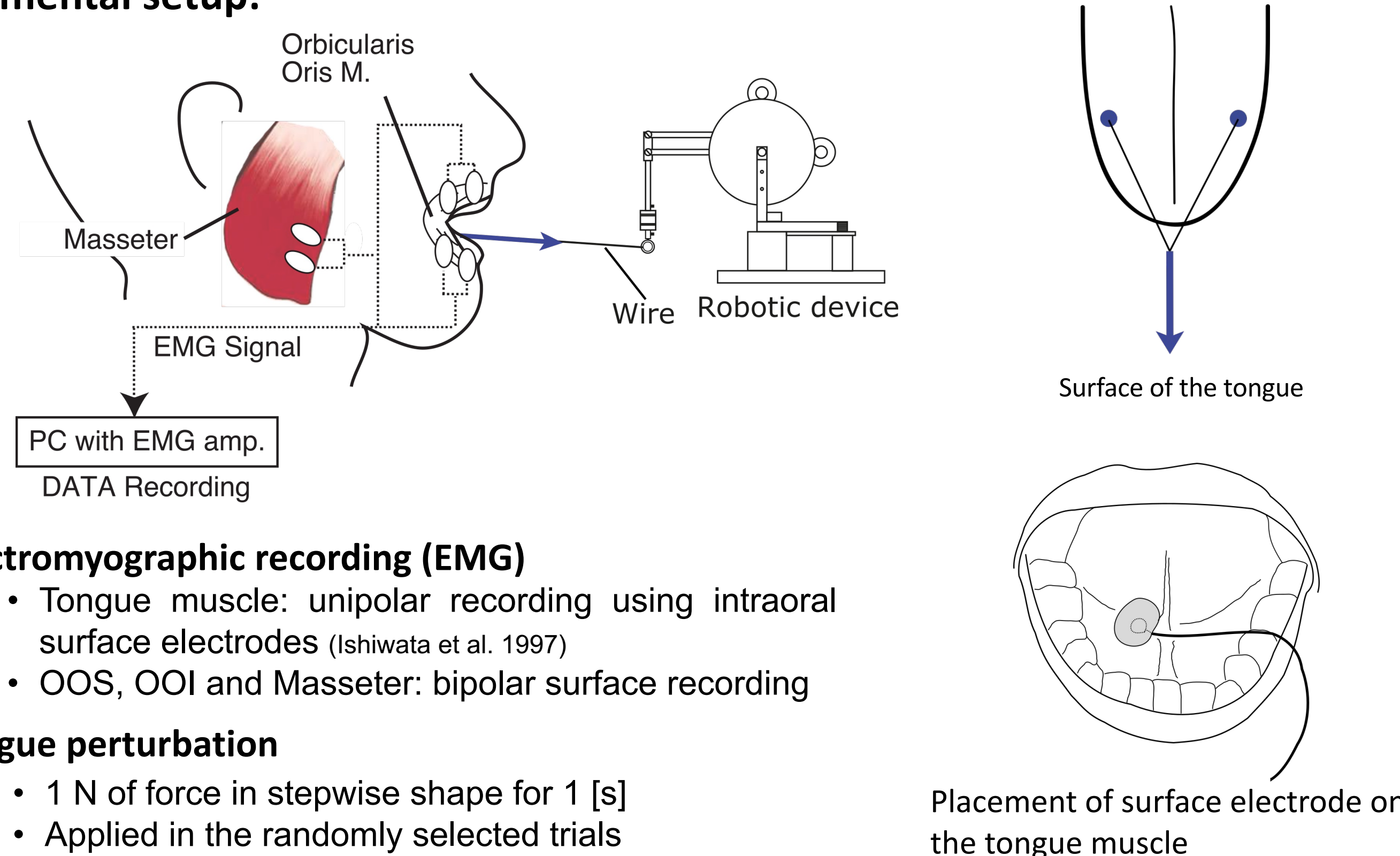
Mathematical simulation



Vowel production task



Experimental setup:



Electromyographic recording (EMG)

- Tongue muscle: unipolar recording using intraoral surface electrodes (Ishiwata et al. 1997)
- OOS, OOI and Masseter: bipolar surface recording

Tongue perturbation

- 1 N of force in stepwise shape for 1 [s]
- Applied in the randomly selected trials

Summary

- Reflex response was clearly induced in response to the tongue perturbation.
- The peak response in non-speech condition was smaller than the one in speech condition, suggesting the reflex gain was controlled for speech task.
- The response latency in resting condition was similar the one of the main reflex response, suggesting no evidence of short-latency reflex corresponding to mono-synaptic reflex.
- Using the recorded EMG response, the observed displacement change was successfully reproduced in mathematical simulation.

Reflex mechanism is involved in the compensatory mechanism of the tongue posture stabilization for speech production.

Acknowledgement

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References

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