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Tongue stretch reflex for speech motor control

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► **To cite this version:**

Takayuki Ito, Mohamed Bouguerra, Morgane Bourhis, Pascal Perrier. Tongue stretch reflex for speech motor control. SMC 2022 - 8th International Conference on Speech Motor Control, Aug 2022, Groningen, Netherlands. hal-03767745

HAL Id: hal-03767745

<https://hal.science/hal-03767745>

Submitted on 2 Sep 2022

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Introduction

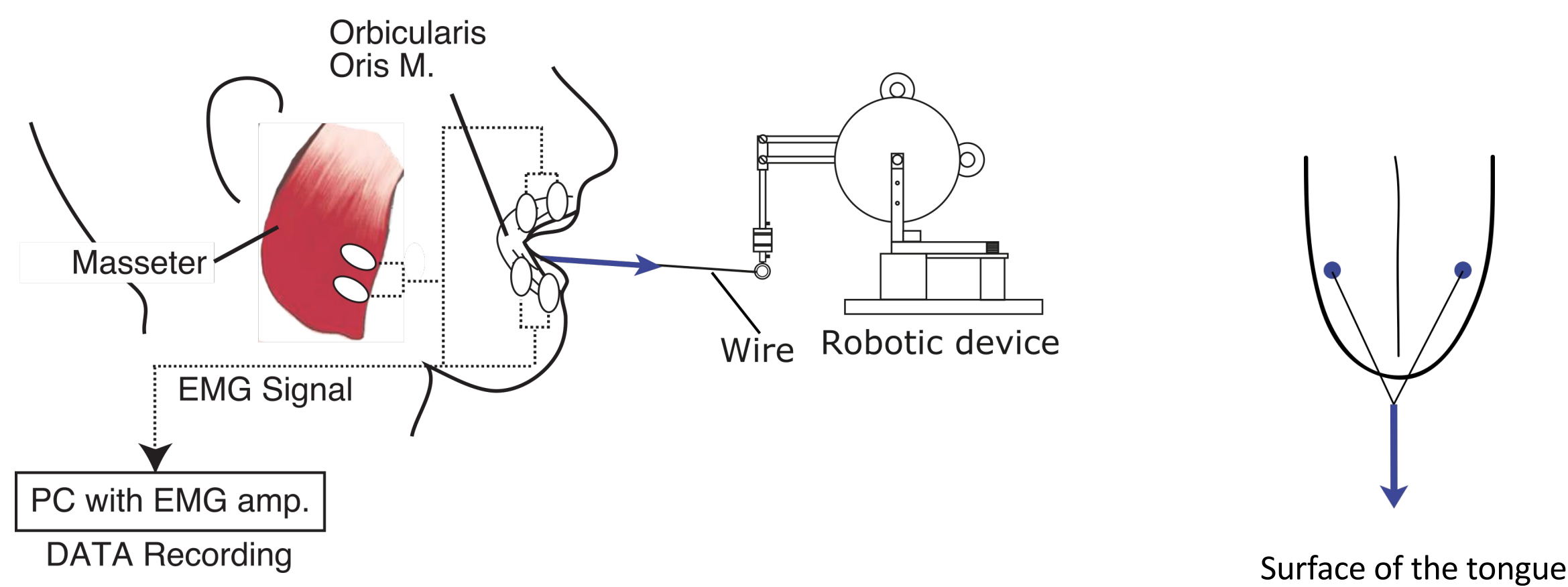
Stretch reflex is known as one mechanism that contributes to the stability of human sensorimotor control. When a muscle is stretched by unknown disturbance, the muscle makes a quick contraction to maintain the posture (and then keep its length constant). Although this quick reflex has been quite extensively 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 (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 at clarifying this issue with the recording of the muscle activity induced by a quick stretch of the tongue during speaking.

Method

Participants:

- Eight native speaker of French. Two of them was removed by technical problem in recording.

Experimental setup:

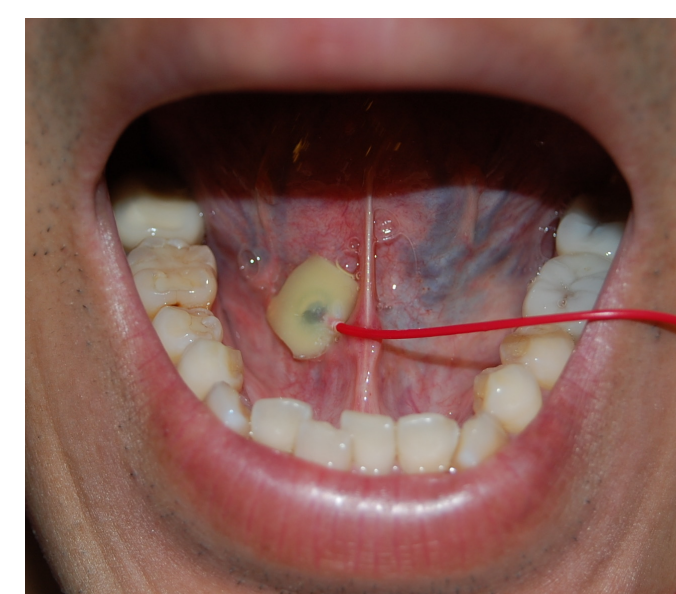


Electromyographic recording (EMG)

- 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

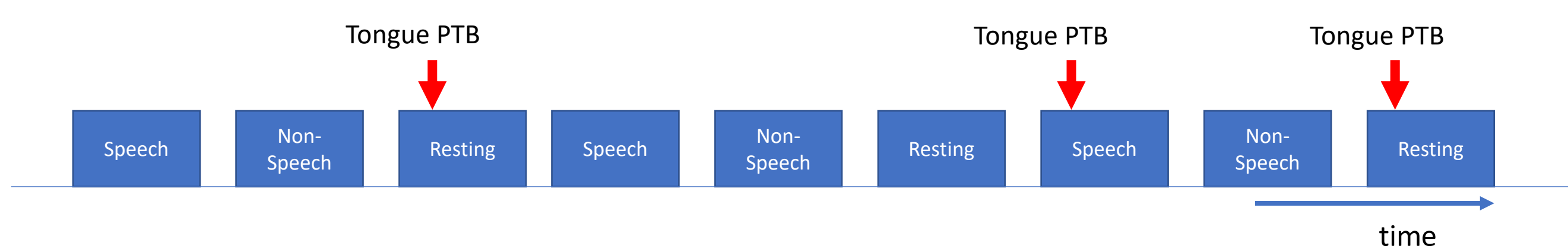


Placement of surface electrode on the tongue muscle

Experimental procedure:

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



Sequence of trials with tongue perturbation

Session 2: Reaction task

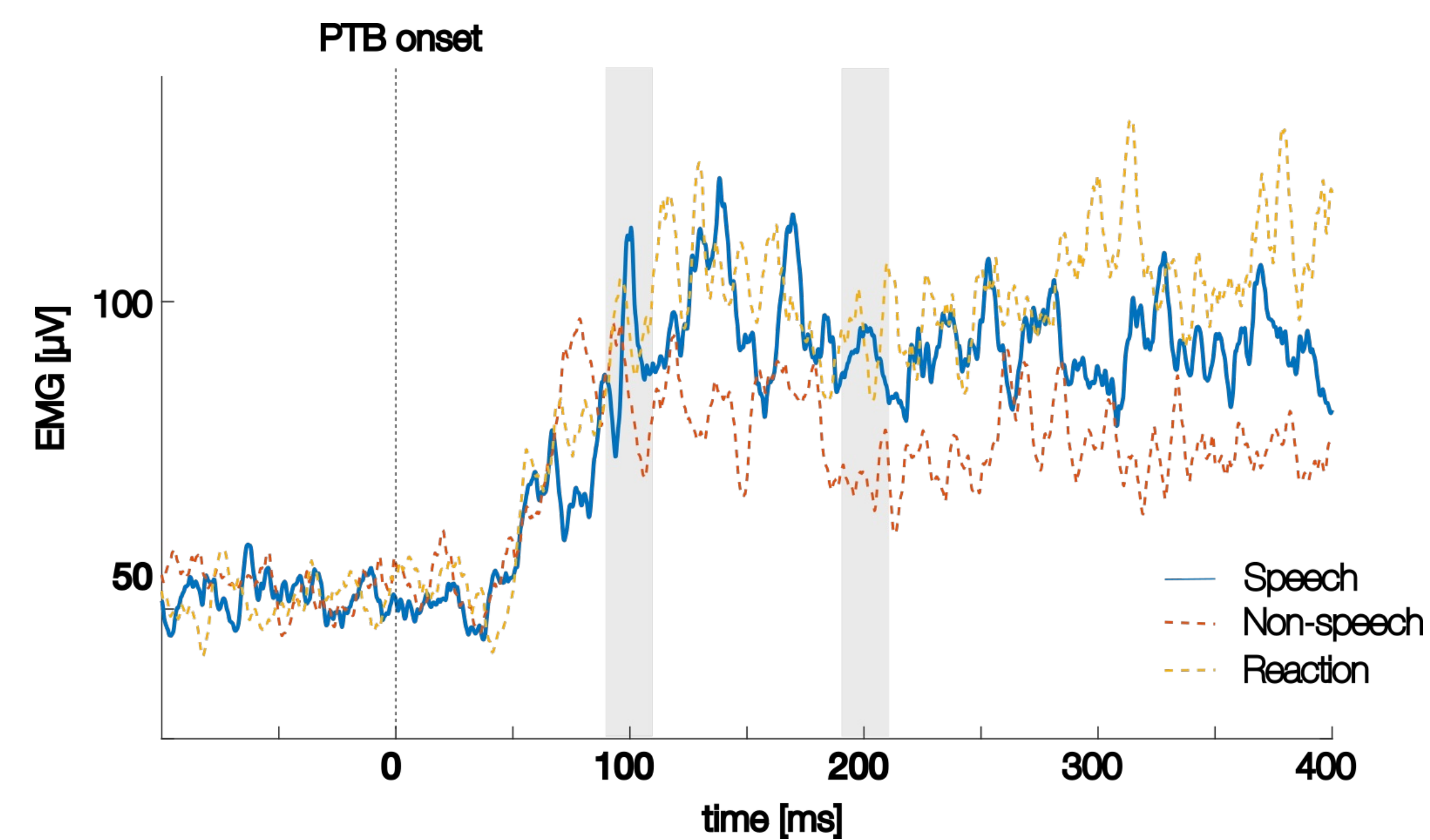
- Produce the vowel /i/.
- Make a maximum contraction when the perturbation was applied.

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

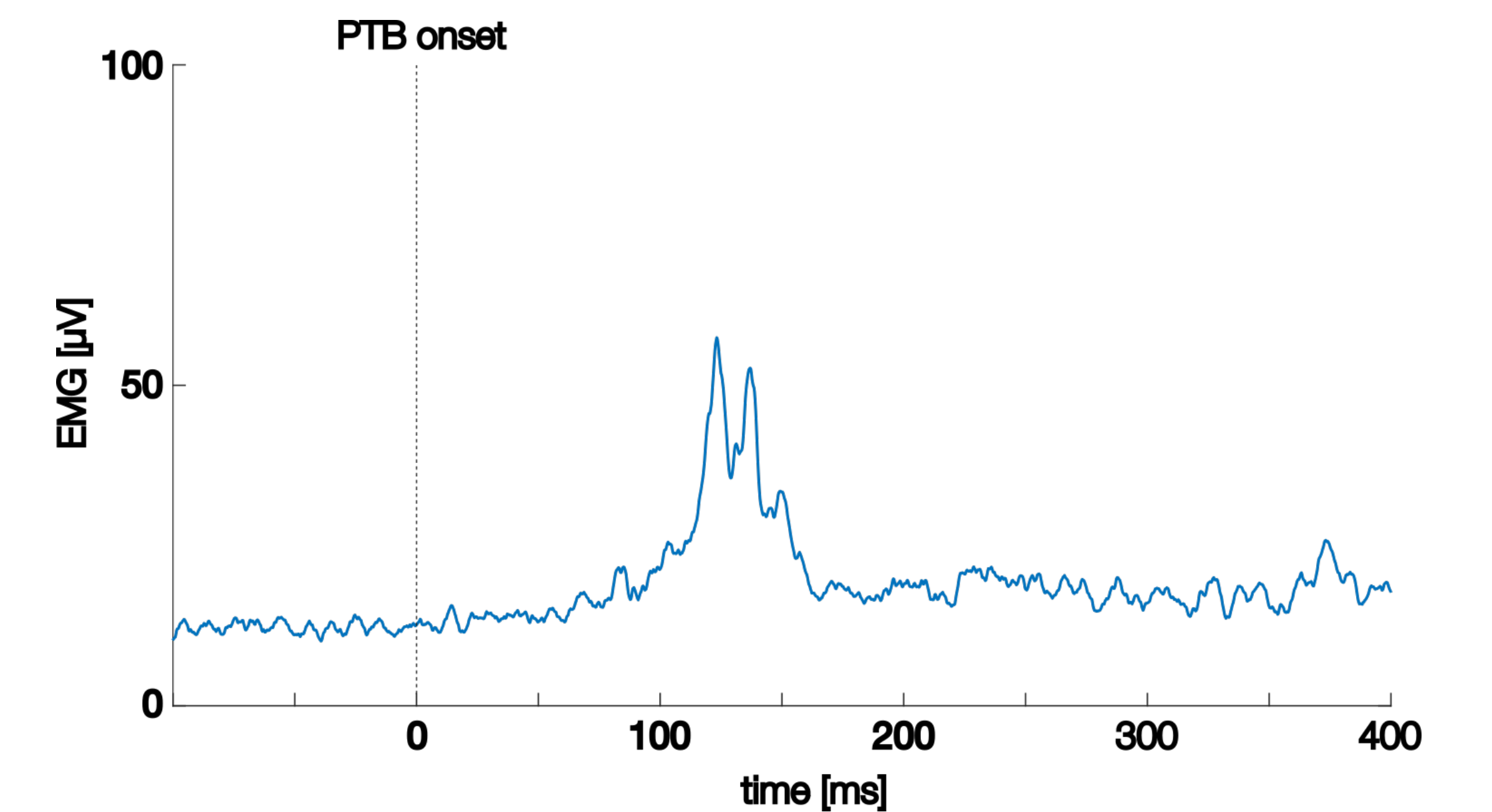
- Sustain the vowels /i/, /e/, /e/, /a/ and /ou/ five times each.

Results

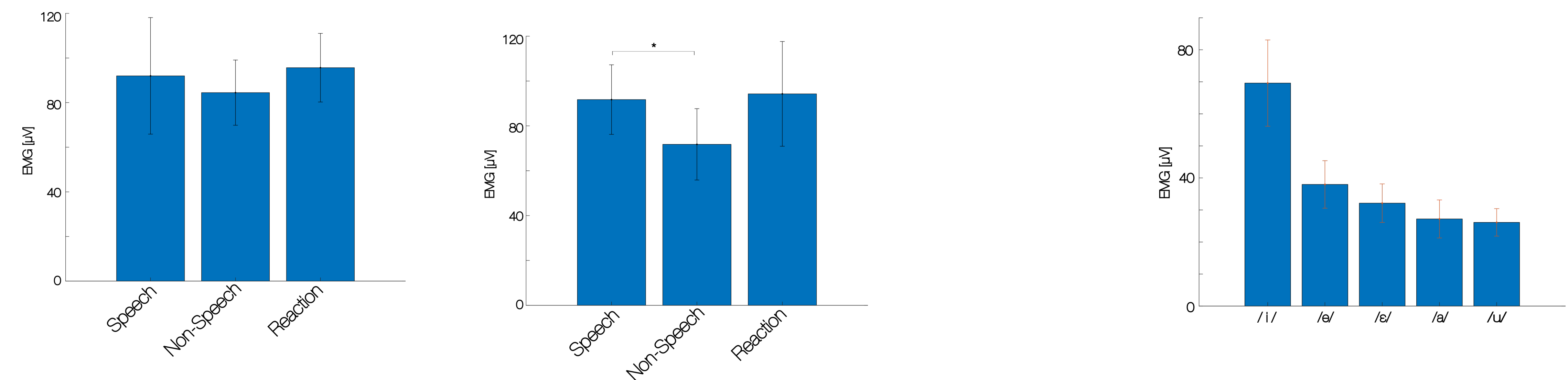
Reflex response in response to the tongue perturbation



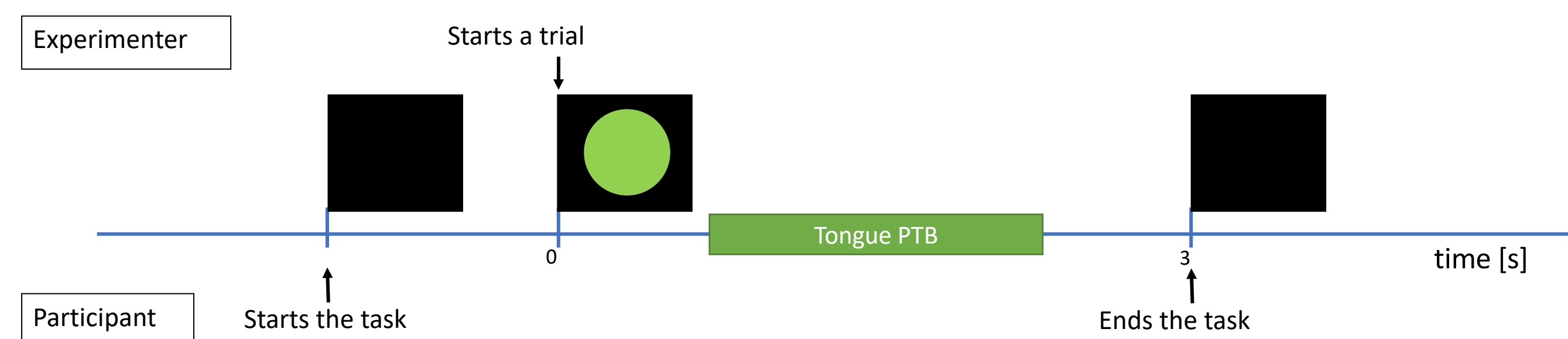
Resting task



Vowel production



Sequence of one trial



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.

Summary

- Reflex response was clearly induced in response to tongue perturbation.
- The response in non-speech condition was similar in the earlier period, but smaller than the one in speech condition.
- The latency of response is compatible with the compensatory response in movement.
- The response was induced in resting condition, but in a later period.

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

Acknowledgement

This work was supported by Agence Nationale de la Recherche (ANR-21-CE28-0022), and the National Institute on Deafness and Other Communication Disorders Grant R01-DC017439.



References

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