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# Modulation of event-related potentials associated with orofacial skin stretch during speech production.

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## Introduction

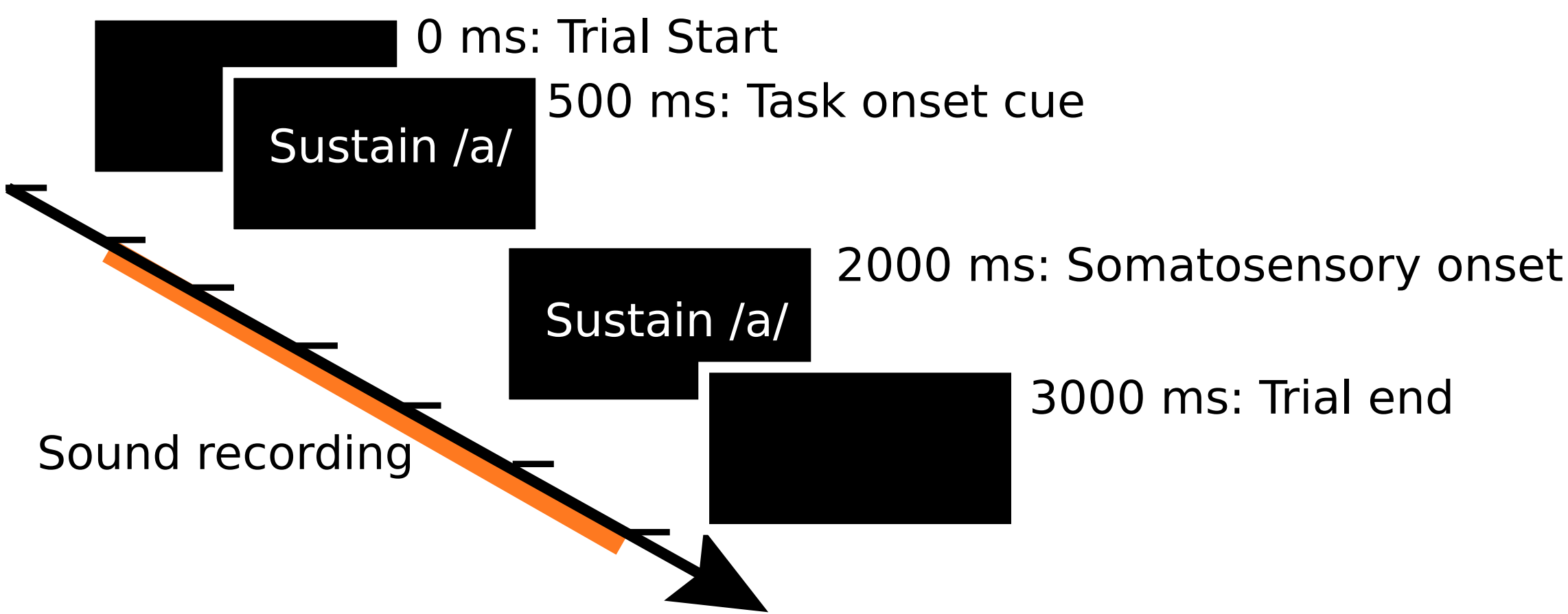
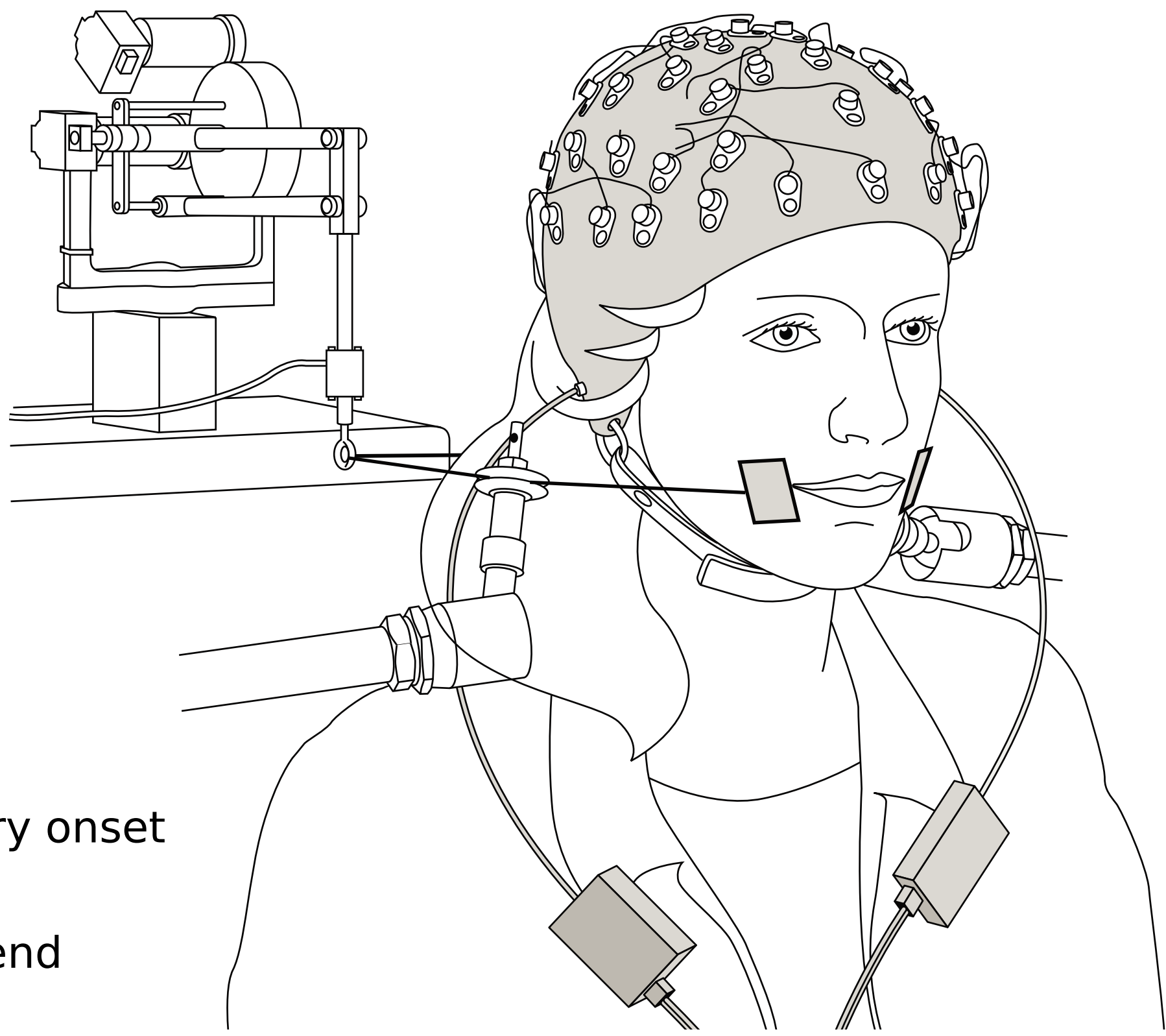
Modulation of sensory event-related potentials occurs before or during voluntary movement. For speech, the amplitude of auditory cortical potentials is reduced during speech production, the so-called speech induced suppression. However, it is unknown whether somatosensory processing is also suppressed during speech production. The current study addressed this question by examining whether somatosensory event-related potentials (ERPs) associated with facial skin deformation are changed during speech production tasks. We investigated changes in the magnitude of somatosensory ERPs during speech posture with and without voicing, and also with changes associated with different speech utterances.

## Method

**Participants:** 10 native speakers of American English (right-handed).

**Task:** (1) Speech utterances: /a/, /i/, /u/, (2) Speaking manner: **Voicing** (sustain the speech utterancens for 2 s) and **Posturing** (hold a posture similar to the speech utterances).

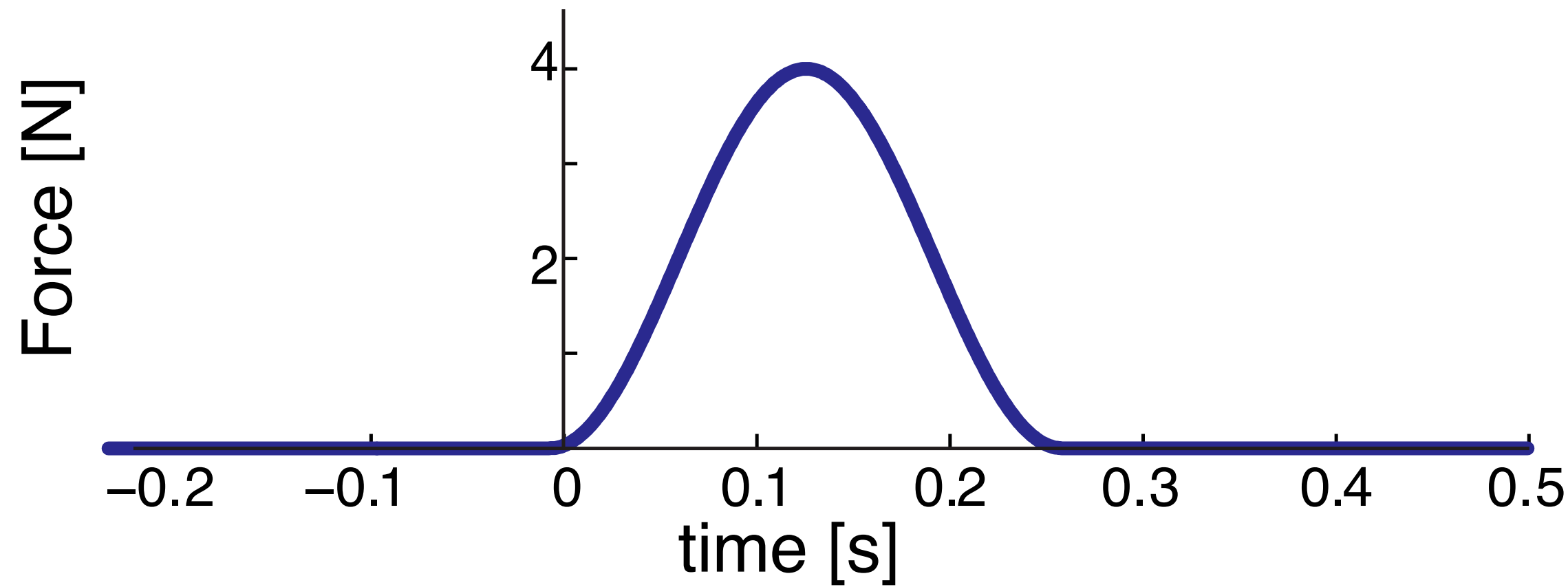
**ERP recording:** 64 scalp sites and 80 ERP responses per a condition. All task conditions including resting condition were carried out in random order.



Sequence for one single trial

Experimental setup

**Stimulation:** The skin lateral to the oral angle was pulled in backward direction and in all trials



Temporal pattern of somatosensory stimulations

**Pre-processing:** (1) 1-30 Hz band-pass filter, (2) Re-referenced to the average acorss all electrodes, (3) Bias levels adjustment based on the average amplitude in the pre-stimulus interval (-100 to 0 ms), (4) Artifacts rejection using independent component analysis, (5) Data alignment at the somatosensory onset.

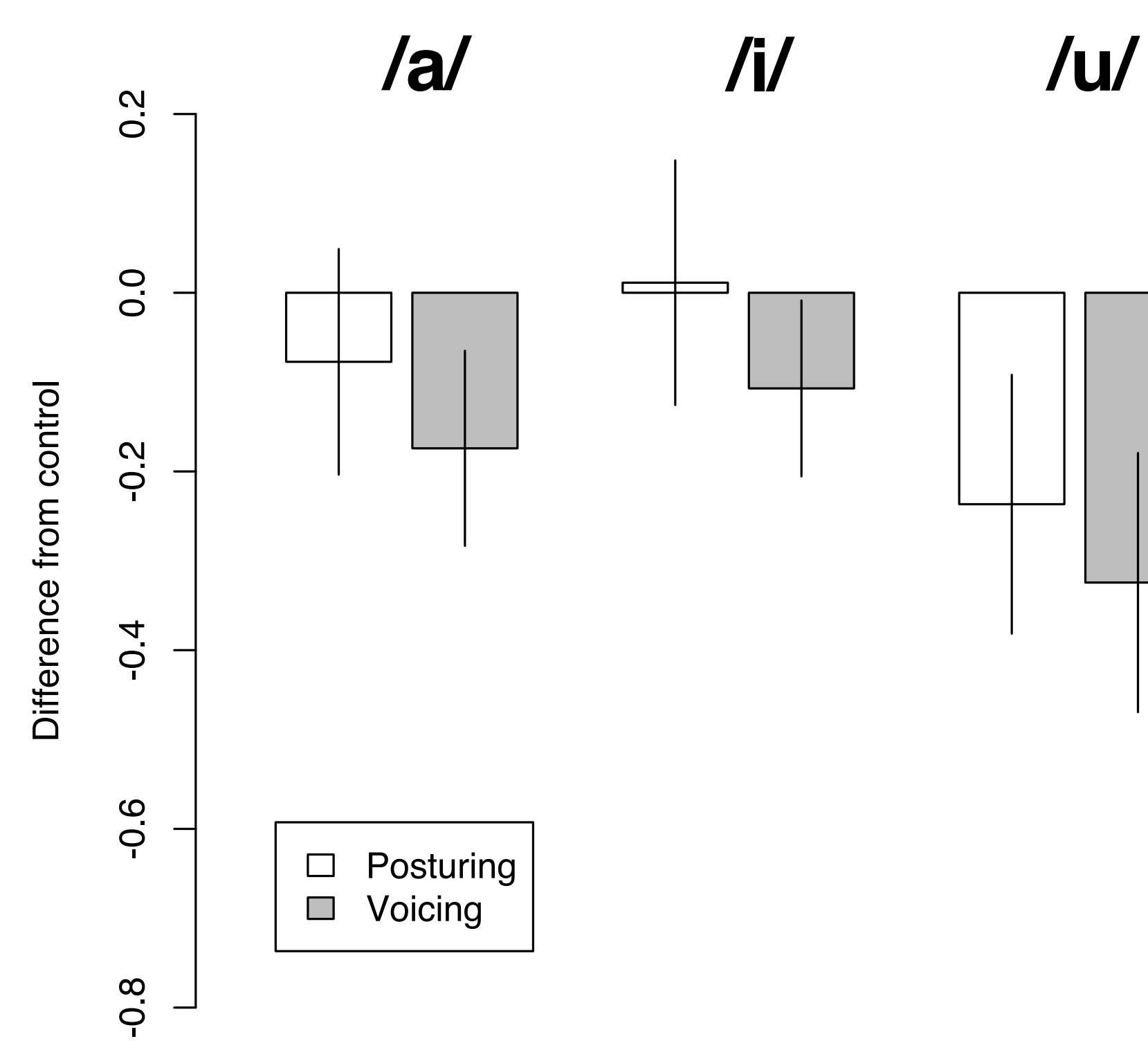
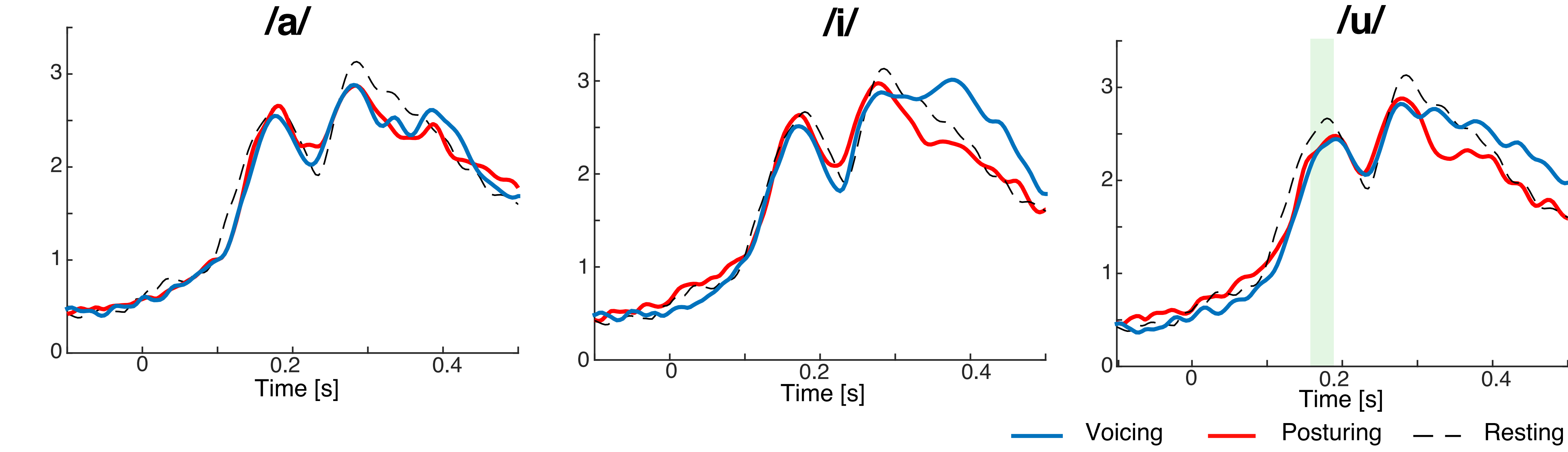
**Global Field Power (GFP):** Equivalent to the spatial standard deviation of the scalp electric fields. A larger value indicates a stronger field.

$$\sqrt{\frac{1}{n} \sum_{i=1}^n ERP_i^2}$$

n : the number of electrodes

## Results

### Global Field Power

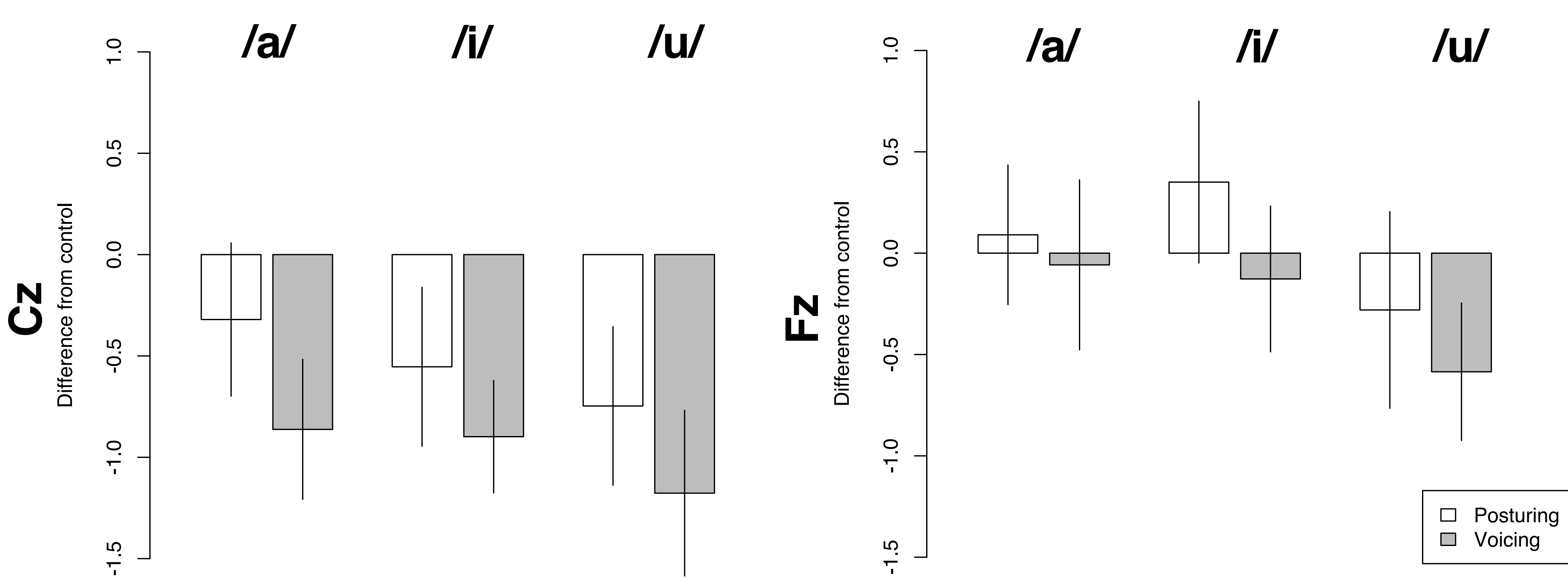
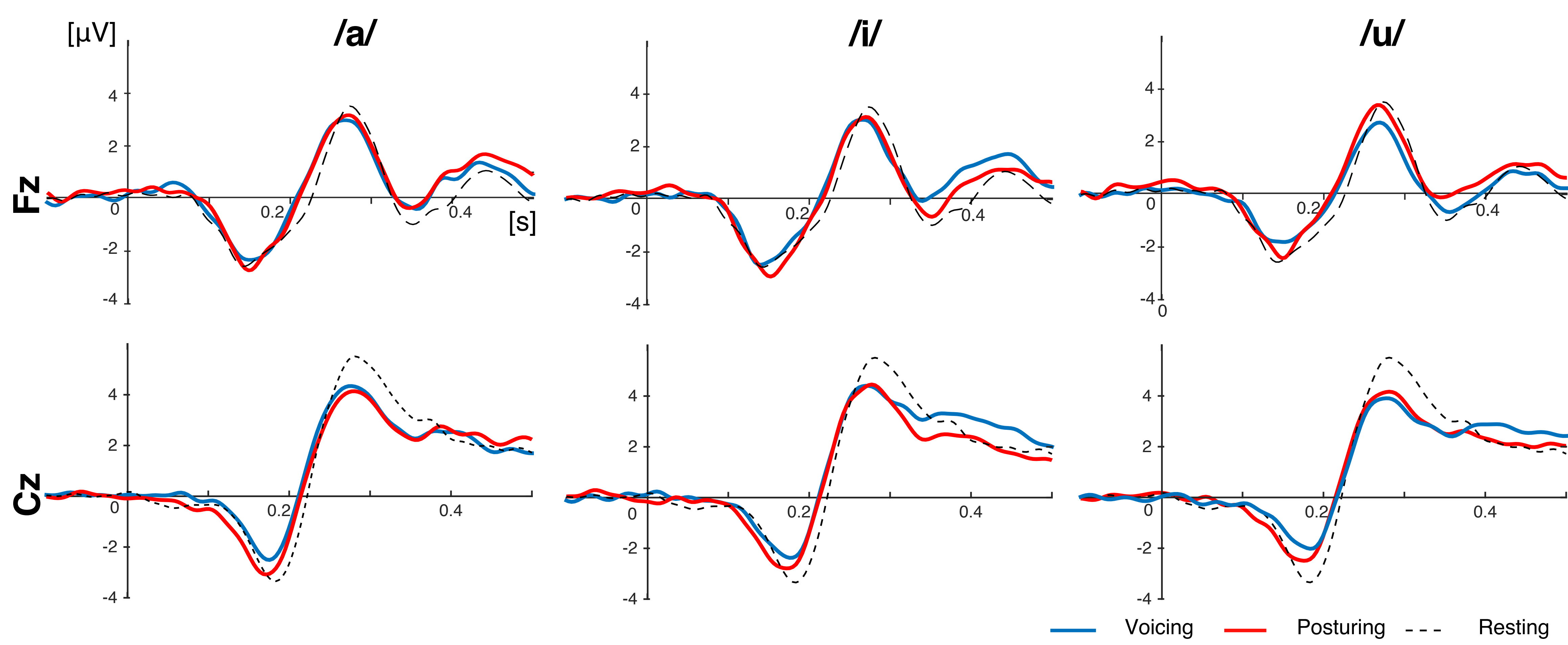


(1) The first peak of GFP was suppressed during both voicing and posturing tasks for /u/ [ $F_{(2,45)} = 3.763$ ,  $p < .05$ ]. This change was observed in ERP at Fz [ $F_{(2,25)} = 4.731$ ,  $p < .05$ ], but not at Cz [ $F_{(2,45)} = 0.285$ ,  $p > .20$ ].

(2) The ERP amplitudes in voicing were more suppressed than the ones in posturing in comparison with control condition [ $F_{(1,45)} = 4.043$ ,  $p = .05$  at Fz;  $F_{(1,45)} = 5.303$ ,  $p < .05$  at Cz].

(3) There was no reliable interaction between speech utterances and speaking manner [ $F_{(2,45)} = 0.017$ ,  $p > .90$  in GFP].

### Event-Related Potentials



## Discussion

It is hypothesized that an attenuation ("gating") of the transmission of somatosensory afferent inputs in the nervous system during movement can be controlled based on the movement pattern. This is consistent with the current results that the "gating" associated with the backward facial skin deformation was induced only in a vowel task "u", which is expected to retract the lip in the following movement, but not in "i".

Somatosensory attenuation has been examined mostly using electrical stimulation. Those demonstration have shown that the attenuation is induced less than 100 ms after stimulation. Although the current stimulation associated with facial skin deformation is not able to elicit such short-latency evoked potentials, it can induce consisently ERP with negative peak around 100 ms and positive peak around 200 ms on the mid-sagittal frontal area, like auditory evoked response. The observed attenuation may reflect not a peripheral level of processing, but cortical level of somatosensory processing.

### Control test

**Purpose:** To examine whether displacements due to facial skin deformation were different according to the facial configuration for the imposed task.

**Procedure:** Displacements of facial skin deformation were measured using electromagnetic articulography (Northern Digital Inc., Wave).

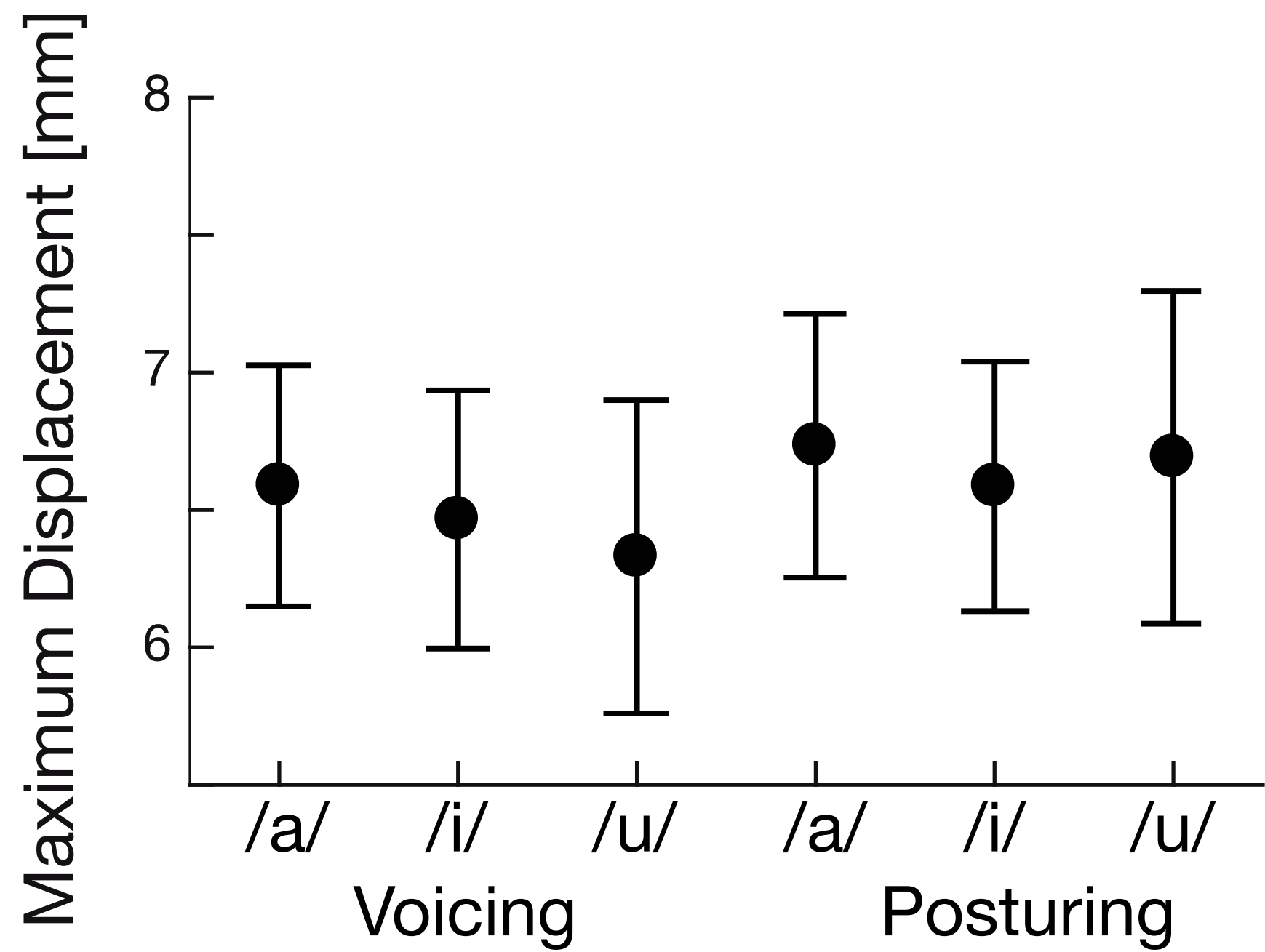
**Participants:** 5 native speakers of American English.

**Task:** The same tasks in main test (three utterances x two speaking manner). Each task condition was carried out 10 times in random order.

**Stimulation:** The same somatosensory stimulation as in the main test was applied in all trials

**Results:** There was no reliable difference in displacement of facial skin across all tasks including speaking manner and utteranes [ $F_{(5,20)} = 1.116$ ,  $p = .384$ ].

**The current somatosensory stimulation was applied in consistent manner across imposed tasks in terms of the amplitude of facial skin deformation.**



## Summary

- (1) We found evidence for relatively short latency (around 150 ms) gating of somatosensory input during speech.
- (2) The global sensitivity of somatosensory ERP associated with facial skin deformation changes according to the task utterances, suggesting that somatosensory system may be modulated differently relative to phonetic identity.
- (3) Voicing induced a greater suppression than posturing in individual electrodes (Cz and Fz), suggesting that sensory suppression may be more influential when sensorimotor system is active.
- (4) Somatosensory suppression mechanism is reflected in both somatosensory and auditory modalities associated with speech production.

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