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# Changes of somatosensory event-related potentials during speech production

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## Introduction

Gating of sensory information around the onset of movement is a characteristic of a range of voluntary behaviors. 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 (or perception) is also suppressed during speech production. The current study focused on somatosensory event-related potentials (ERPs) associated with facial skin deformation and examined **whether the somatosensory ERPs are changed during speech production tasks**. Specifically, we investigated changes in the magnitude of somatosensory ERPs during speech posture with and without voicing together with changes associated with different speech utterances.

## Method

### Participants:

- 6 native speakers of American English (right-handed)

### ERP recording:

- 64 scalp sites and 80 ERP responses per condition were recorded.

- Task utterances: /a/, /i/, /u/

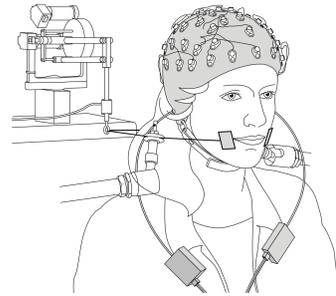
Speaking manner: 1) Voicing: sustain the task utterances for 2 s

2) Posture: hold a posture similar to the task utterances

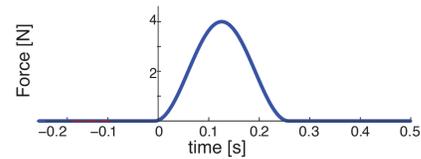
- All conditions including resting condition were carried out in random order.

- Somatosensory stimulation applied during the task in all trials.

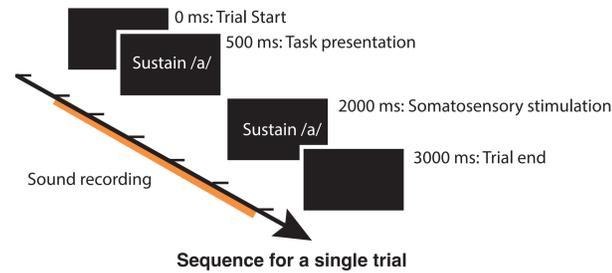
- Speech recorded at 44.1 kHz.



Experimental setup



Temporal pattern of somatosensory stimulations



Sequence for a single trial

## Data analysis:

### Global Field Power (GFP)

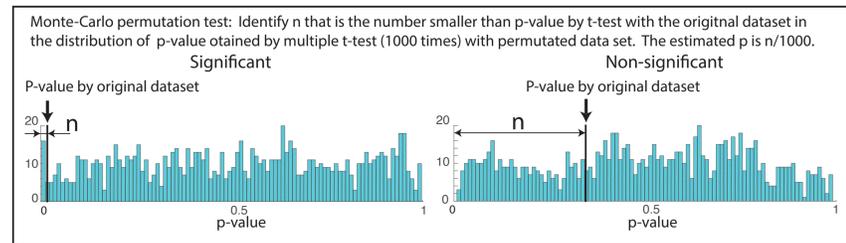
GFP is equivalent to the spatial standard deviation of the scalp electric field, and yields larger values for stronger fields.

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

n : the number of electrodes

### Cluster-based permutation analysis for temporal difference

1. Examine statistical difference between conditions in each individual sample point using Monte-Carlo Permutation test.



2. Extract the longest length of cluster: the sequence of sampling points that show a reliable difference in the permutation analysis.

## Control test

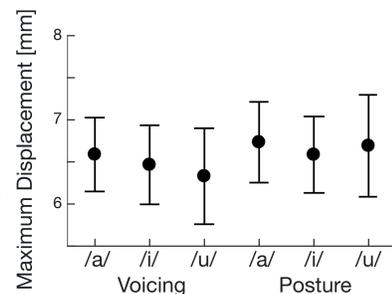
**Purpose:** To examine whether displacements due to facial skin deformation were different according to the task condition (three task utterances x two speaking manner).

**Procedure:** Displacements of facial skin deformation were measured using 3 dimensional position sensing system (Northern Digital Inc, Wave) in each condition.

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

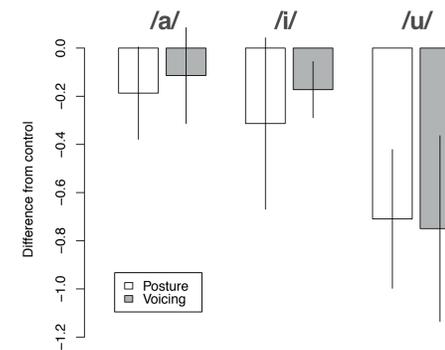
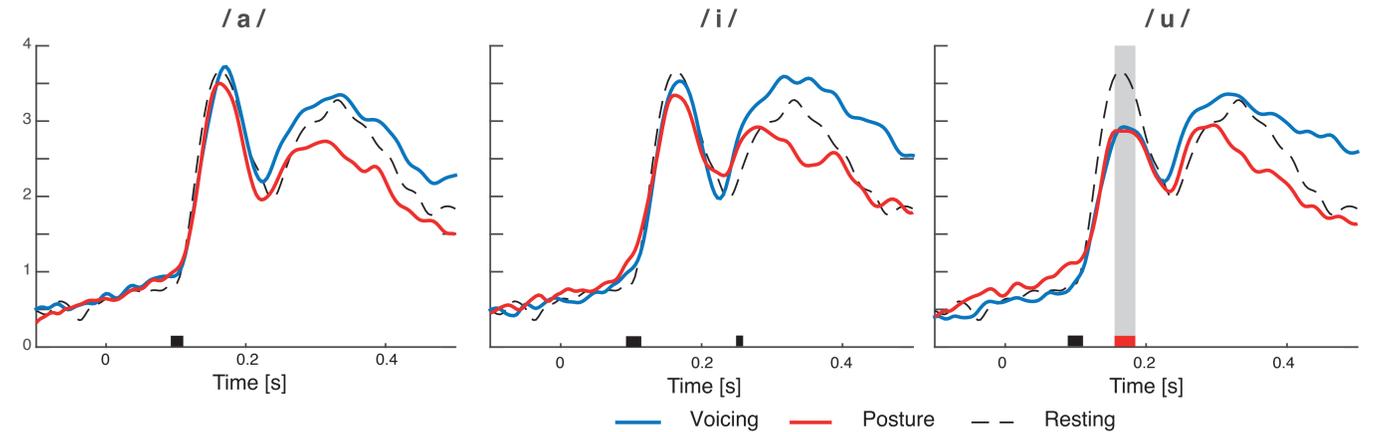
**Task:** The same task in the main test. Each task condition was carried out 10 times in random order. Stimulation: Somatosensory stimulation associated with skin stretch was applied in all trials.

**Results:** There was no reliable difference in displacement of facial skin deformation across all tasks including speaking task and utterances [F(5,20)=1.116, p=.384]. This indicates that **the current somatosensory stimulation was applied in consistent manner across the imposed tasks in terms of the amplitude of facial skin deformation**.



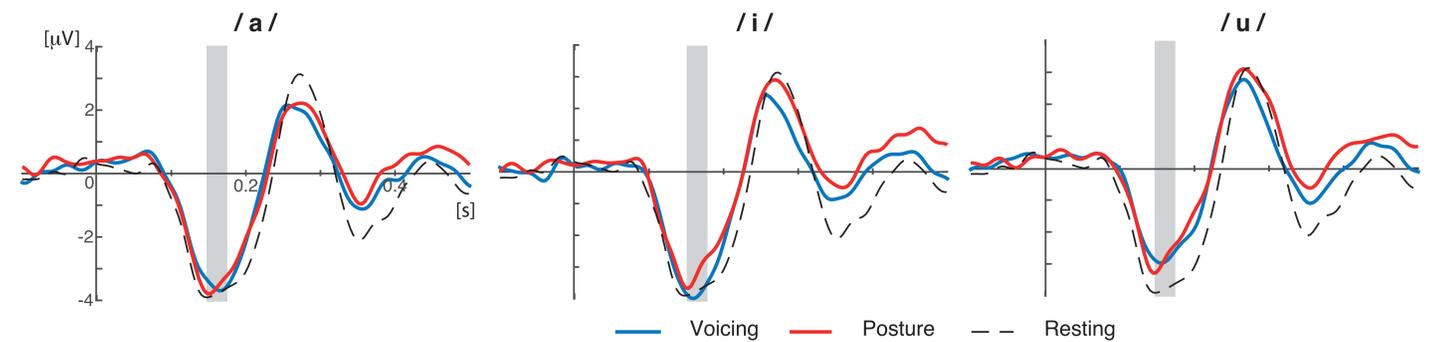
## Results

### Global Field Power



- (1) The first peak of GFP was suppressed during the speech task /u/ in both voicing and posture tasks [F(2,25)= 6.350, p < 0.001].
- (2) Cluster-based analysis demonstrated a reliable change in the periods between 150 and 180 ms after somatosensory onset.
- (3) This change was observed in ERP at Fz [F(2,25)= 4.06, p < 0.03]
- (4) GFP were modestly different between two speaking manners in the period after 250 ms [F(1,25) = 3.575, p = 0.07].

### Event-Related Potentials at Fz



## Discussion

■ It is known that there is an attenuation of the transmission of somatosensory afferent inputs in the nervous system during movement, that is called as "gating." We found the "gating" associated with facial skin deformation was induced only in a specific vowel task, suggesting that "gating" mechanism associated with facial skin deformation for speech production can be controlled by a specific motor command or plan.

■ Somatosensory attenuation has been examined mostly by using electrical stimulation. Those demonstration have showed 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 of evoked potentials, it can induce a consistently at the 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 a relatively higher level of somatosensory processing.

## Summary

- (1) We found an evidence for a relatively short latency (around 150 ms) gating of somatosensory input during speech.
- (2) The 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) Sensory suppression mechanisms are reflected in both somatosensory and auditory modalities associated with speech production.

## Acknowledgement

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