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EEG frequency-tagging suggests that fine-grained vibrotactile contrast is (partly) implemented in S1

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Introduction

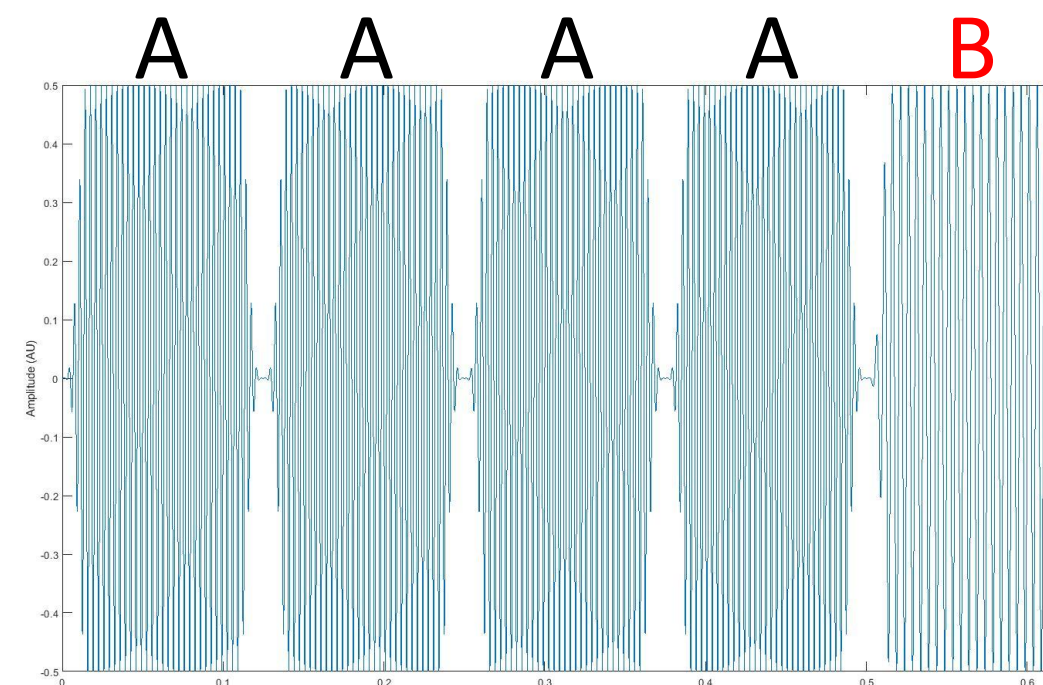
Cortical processing of natural textures has been shown to originate at least in part from primary somatosensory cortex (S1)¹. However, whether processing of contrasts in fine-grained tactile textures is already achieved in S1, or whether it requires higher level somatosensory areas of the brain remains debated. To address this question, we tested a novel method combining a fast periodic oddball paradigm together with EEG frequency-tagging².

We hypothesized that a complex spectrotemporal vibrotactile contrast would elicit significant oddball responses, which, similarly to responses to a simple frequency/intensity contrast, would display somatotopy (with contralateral and central scalp distributions for hand and foot stimulation, respectively), indicating that these responses originate, at least partly, from S1.

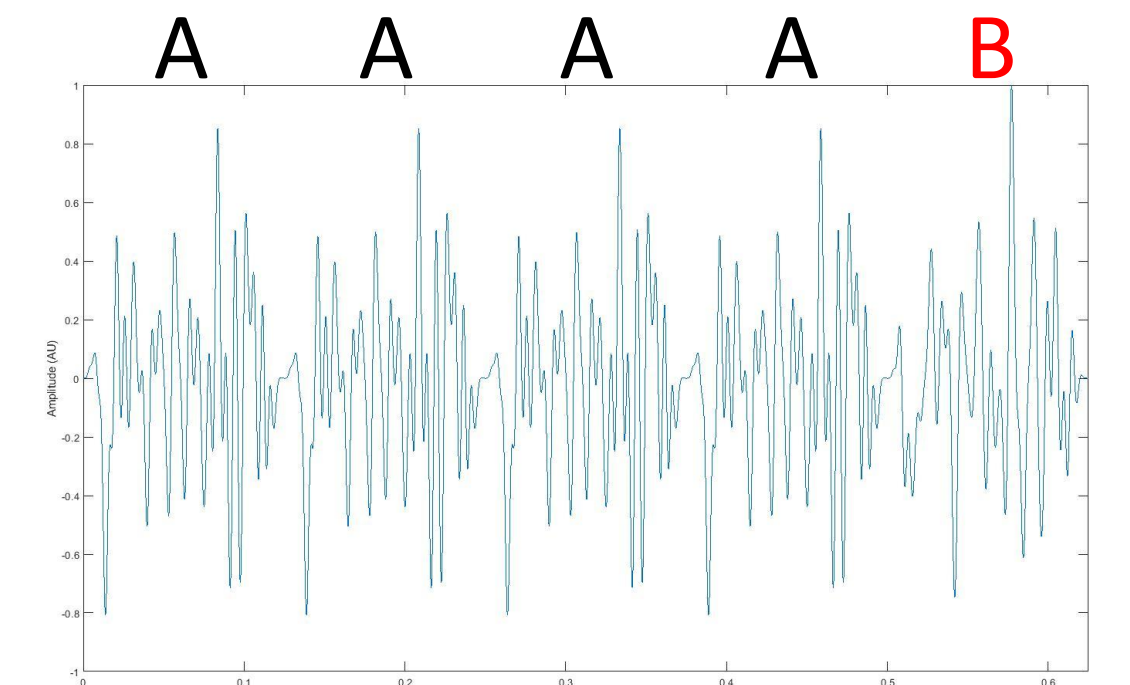
Materials and Methods

40-second oddball (AAAAB) vibrotactile stimulations :

- 125 ms inter-onset interval (8 Hz and harmonics)
- > oddball expected at 1.6 Hz and harmonics
- Condition 1: sine vibrations where A = 300 Hz and B = 200 Hz.
- Condition 2: bandpass filtered (40-200 Hz) white noise vibrations where B is a "scramble" of A.
- delivered to the right index finger or right foot to assess if responses originate from S1 (somatotopy).



Condition 1 : frequency/intensity contrast



Condition 2 : spectrotemporal contrast

Results

For each condition, we summed the activity at prominent oddball harmonics (1.6 Hz, 3.2 Hz, 4.8 Hz, 6.4 Hz). Significant responses were recorded at the oddball frequencies in both conditions and both limbs.

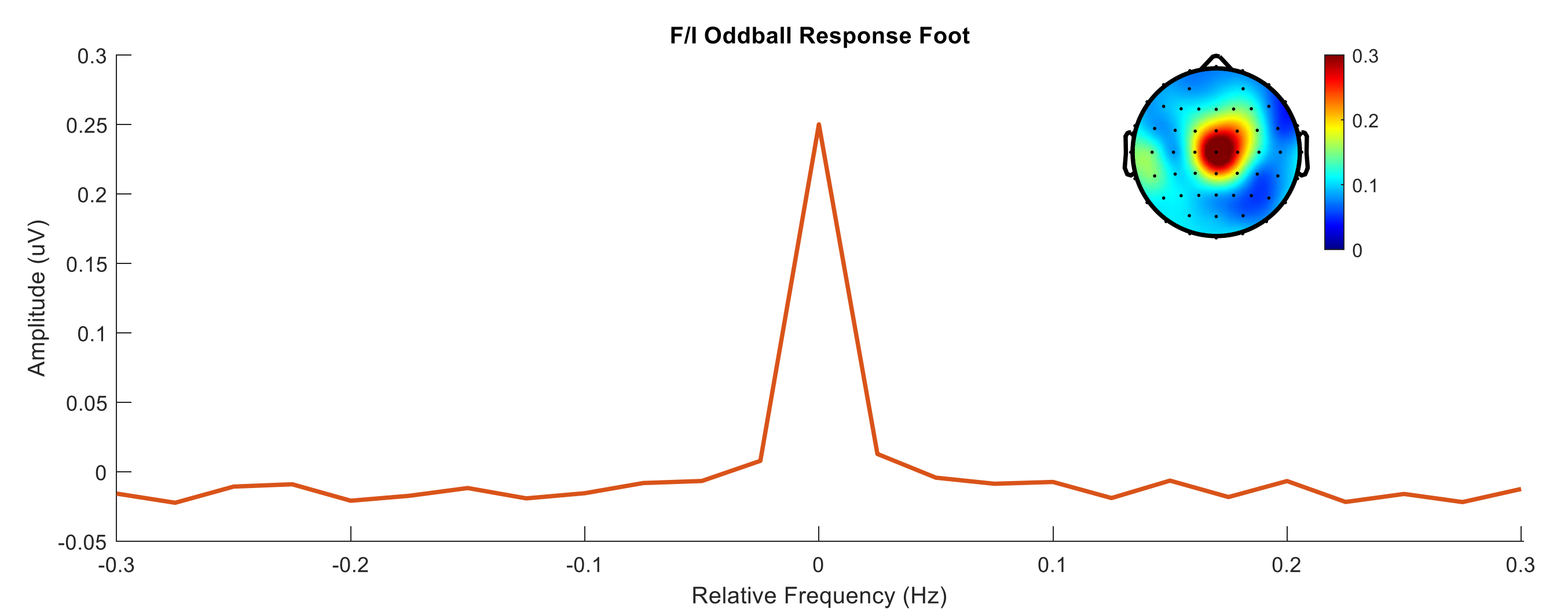
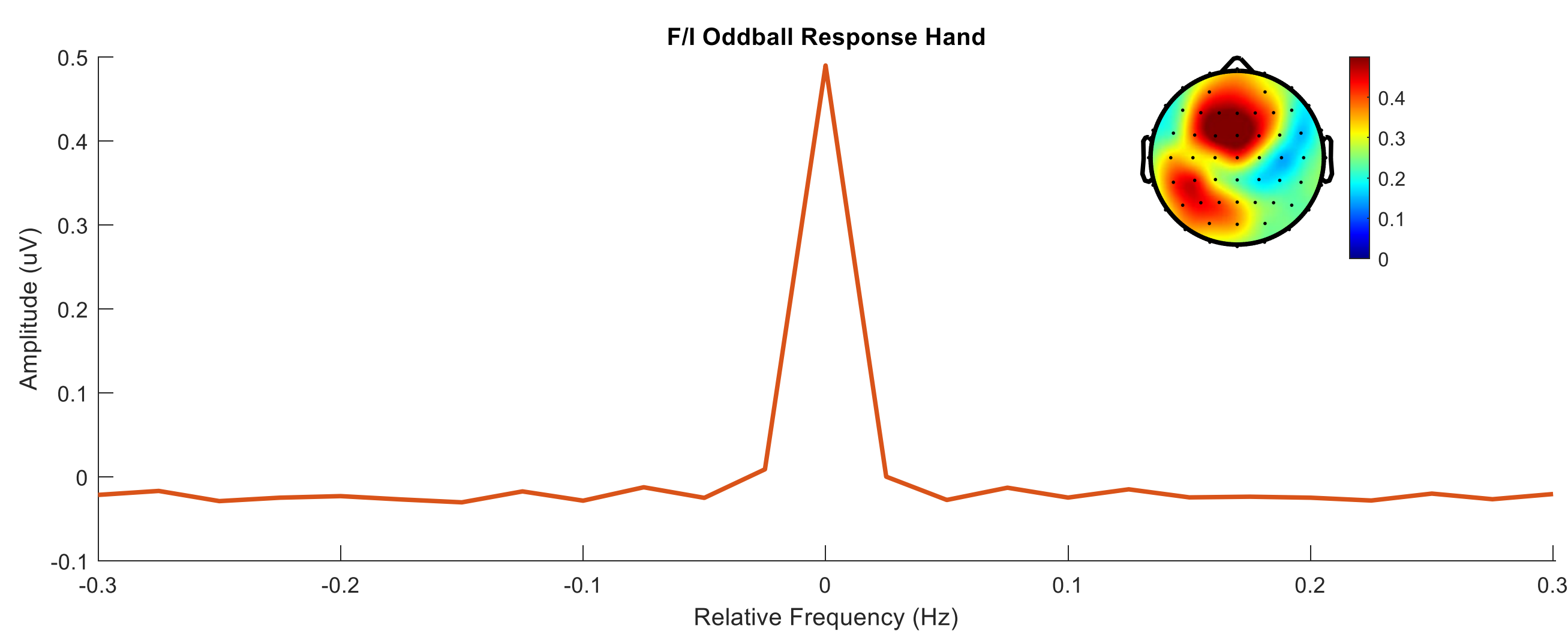


Fig. 1: Localizer data. Oddball responses to the frequency/intensity (localizer) contrast condition for hand stimulation (left) were maximal at contralateral parietal and frontal electrodes, consistent with the hand area of S1. For foot stimulation (right), responses were maximal at central midline electrodes, consistent with the foot area of S1.

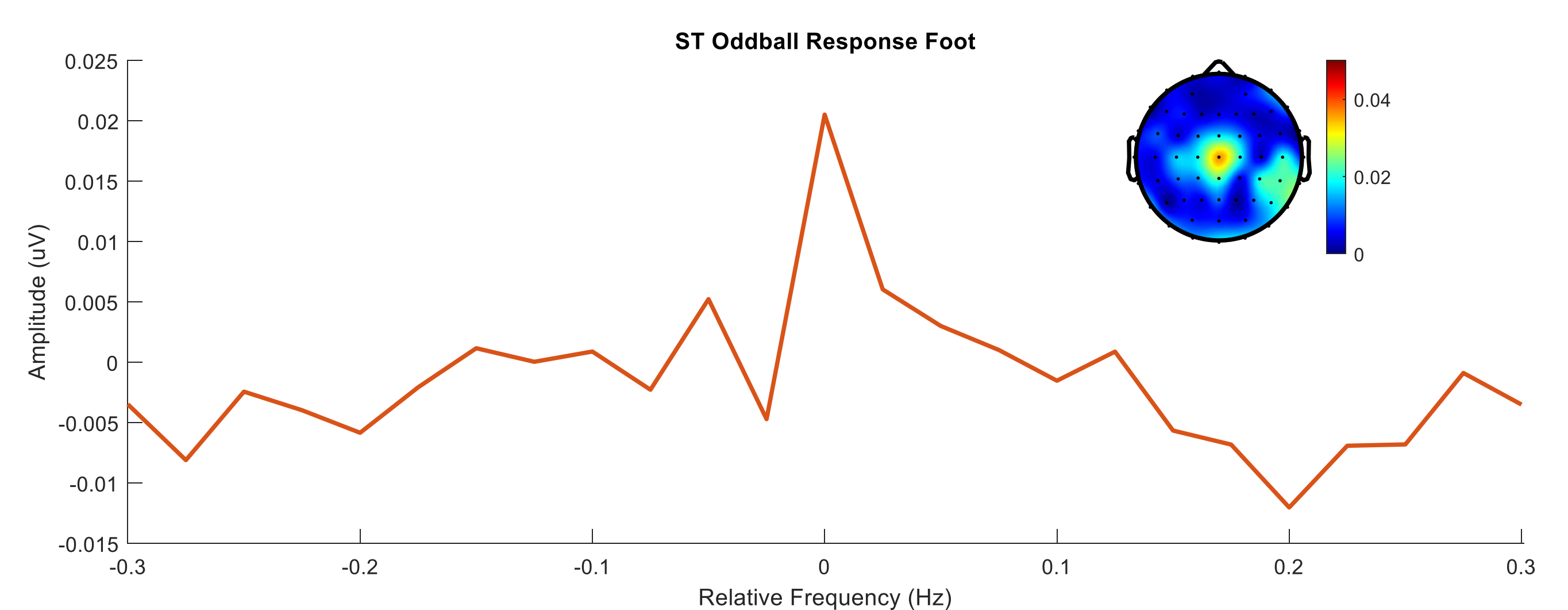
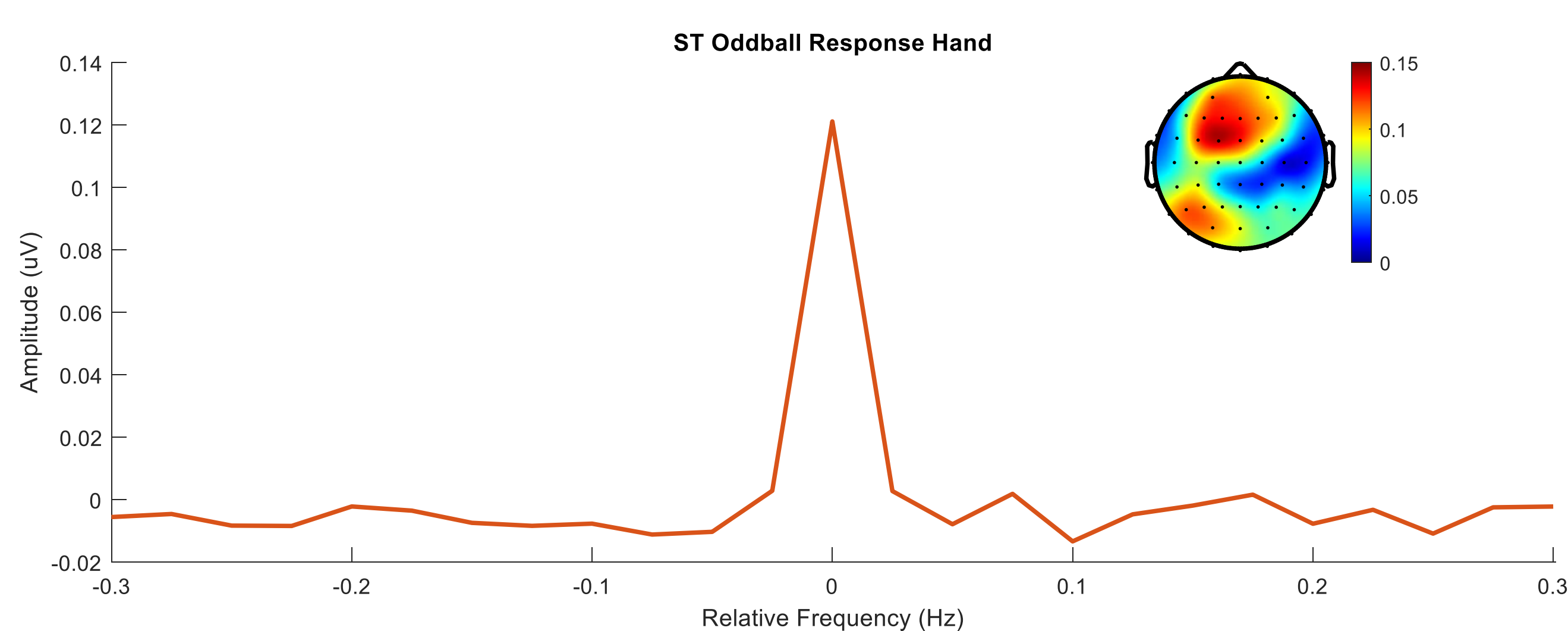


Fig. 2: Experimental data. The topography of responses to spectrotemporal contrasts was highly similar to the localizer condition. For hand stimulation (left) responses were maximal at contralateral parietal and frontal electrodes, consistent with the hand area of S1. For foot stimulation (right), responses were maximal at central midline electrodes, consistent with the foot area of S1.

Conclusions

We show that using EEG frequency-tagging and an oddball paradigm, it is possible to record contrast specific responses to complex spectrotemporal vibrotactile contrasts.

In both conditions, the topography was highly similar, and compatible with activity originating, at least in part, from S1. The somatotopic pattern of responses to the spectrotemporal contrasts suggests that the somatosensory system integrates information about a vibrotactile "texture" already at the level of S1, laying the basis for future investigations concerning the processing of changes in natural textures in dynamic active touch.

References

- 1) Mougou A., Thonnard JL. and Mouraux A. (2016) EEG frequency tagging to explore the cortical activity related to the tactile exploration of natural textures. *Scientific Reports*, 6: 20738.
- 2) Nozaradan S., Mouraux A. and Cousineau M. (2017) Frequency contrast to track the neural processing in fast, continuous sound sequences. *Journal of Neurophysiology*, 118(1): 243-253.

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