Measuring oddball responses to vibrotactile textures

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EUROHAPTICS 2022

Introduction

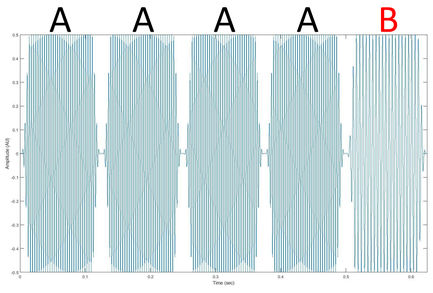
Cortical processing of natural textures has been shown to originate at least in part from the primary somatosensory cortex (S1)[1]. However, whether processing of contrasts in fine-grained tactile textures is already achieved in S1, or whether it requires higher level somatosensory areas of the brain remains debated.

To explore this question, we tested a novel method combining a fast periodic oddball paradigm together with EEG frequency-tagging[2]. 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.

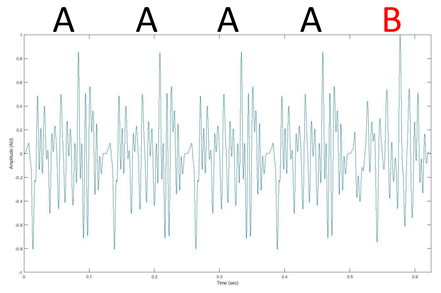
Materials and Methods

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).

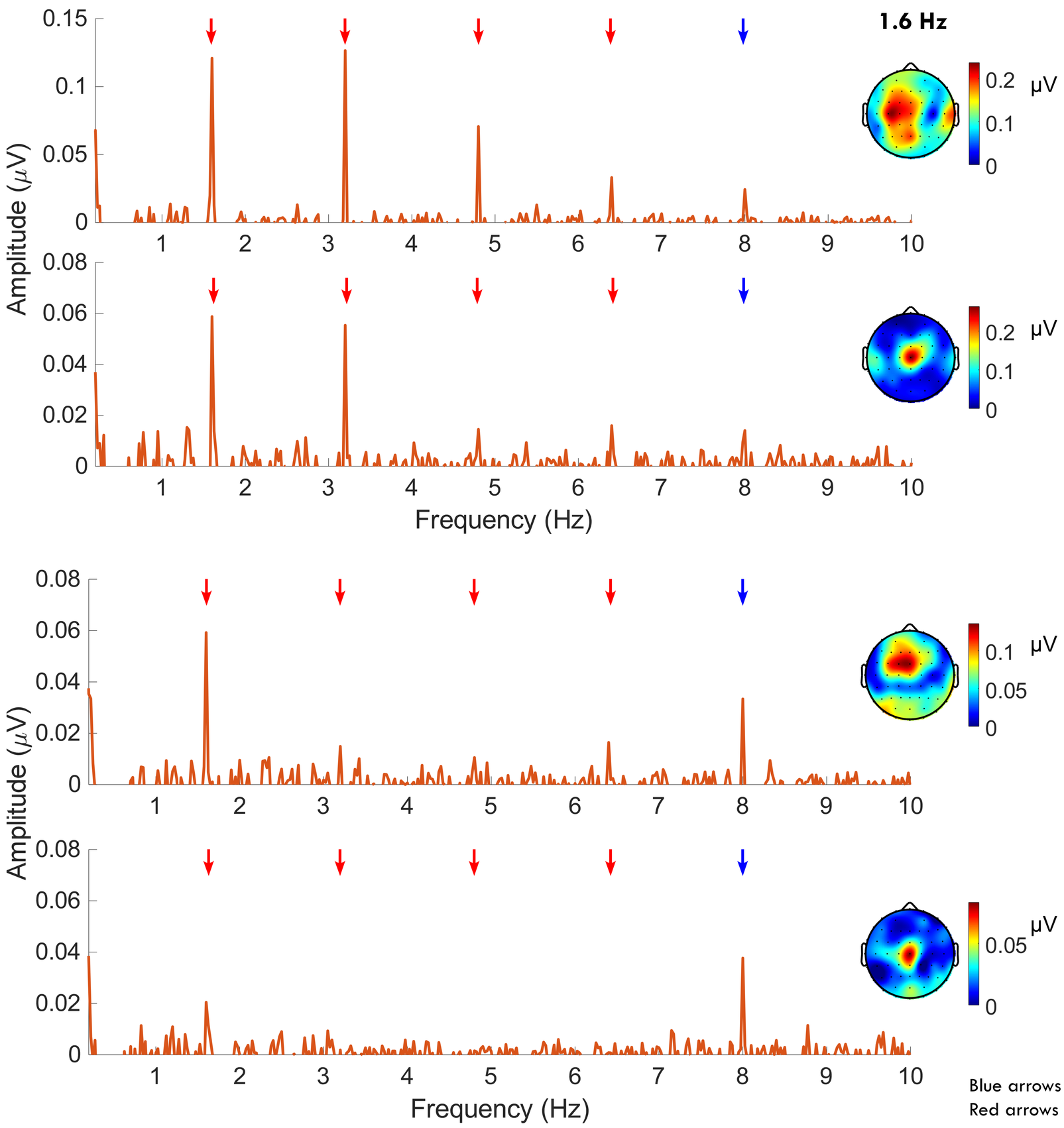


Condition 1 : frequency/intensity contrast



Condition 2 : spectrotemporal contrast

Results (N = 3)



Baseline-subtracted spectrum of EEG responses to:

Frequency-intensity contrasts
Hand stimulation

Frequency-intensity contrasts
Foot stimulation

Spectrotemporal contrasts
Hand stimulation

Spectrotemporal contrasts
Foot stimulation

Conclusions

- Our preliminary results show that EEG frequency-tagging can be used to measure EEG responses specifically associated with changes in vibrotactile textures.
- The topographical distribution of responses (contralateral for hand stimulation and central for foot stimulation) suggests that this activity originates, at least in part, from S1.
- These results have potential implications for the optimization and design of virtual textures to be implemented in haptic displays.

References

1) Moungou 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.

Acknowledgement

This project has received funding from the European Union’s Horizon 2020 Research and Innovation Program Under Grant Agreement No 860114.