Effect of finger tapping frequency on abnormal subthalamic nucleus oscillations in Parkinson's disease

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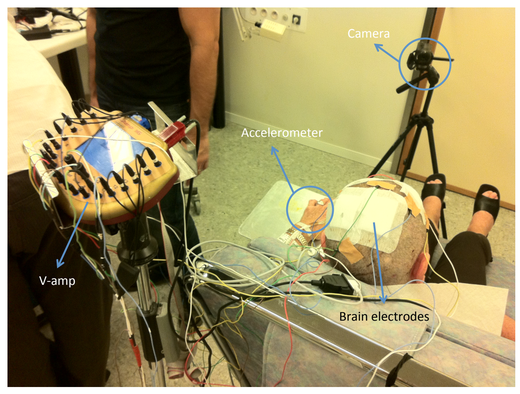
1. Context

- **The clinical hallmarks of Parkinson's disease (PD) are movement poverty and slowness (i.e. bradykinesia), muscle rigidity and limb tremor[1].**
- **Abnormal synchrony in the basal ganglia (BG) cortical loops may contribute to the PD motor symptoms such as bradykinesia[2].**
- **The most popular test to evaluate bradykinesia is the Unified Parkinson's Disease Rating Scale (UPDRS) finger tapping test[3].**
- **In practice, patients tend to adopt compensatory strategies, i.e. slow but wide movements or rapid but narrow movements.**
- **In healthy patients, slow movements (<2Hz) are controlled separately while for fast movements (>2Hz), the movement is continuous and only the rhythm is controlled[4].**

2. Material

- **The Clinical Cerebral Movement Assessment Tool (CCMAT), based on accelerometers.**
- **Eight subthalamic nucleus (STN) local field potentials (LFP) from two deep brain stimulation (DBS) electrodes, eight-channel surface EEG and surface EMG of the extensor digitorum.**
- **All data time-locked and synchronized on a V-amp amplifier.**

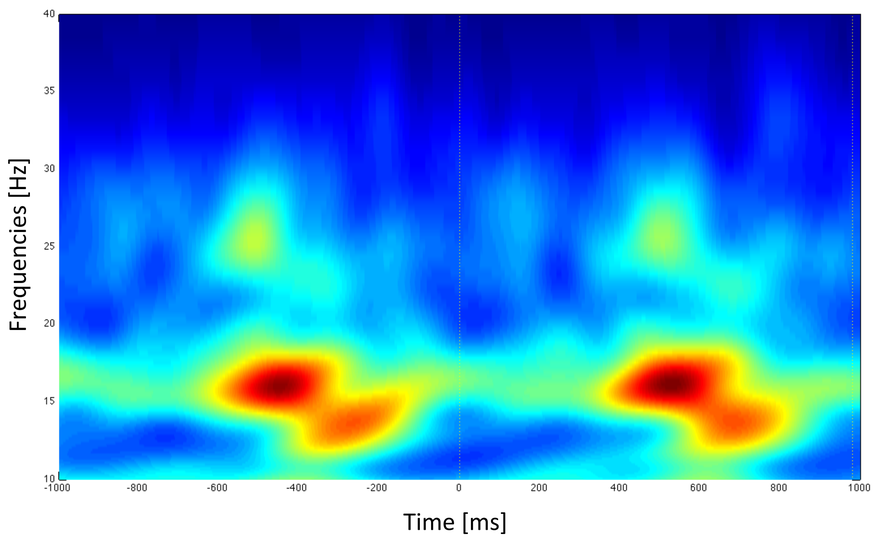
3. Method



- **Four parkinsonian patients included 5 days after DBS surgery.**
- **Patients performed nine 30 seconds-long auditory-paced finger tapping trials at various frequencies ranging from 1 to 3 Hz broken down into 0.25 Hz steps.**
- **Accelerometer recordings were used to define each finger tapping movement and extract several movement features such as movement frequency, amplitude or phase-shift from tone.**
- **Accelerometer recordings were also used in the movement-related potential (MRP) analysis of STN LFP.**
- **For each epoch of the LFP signal, the complex Morlet wavelet transform was computed and the coefficients were averaged over all the epochs to present the power of the averaged MRPs.**

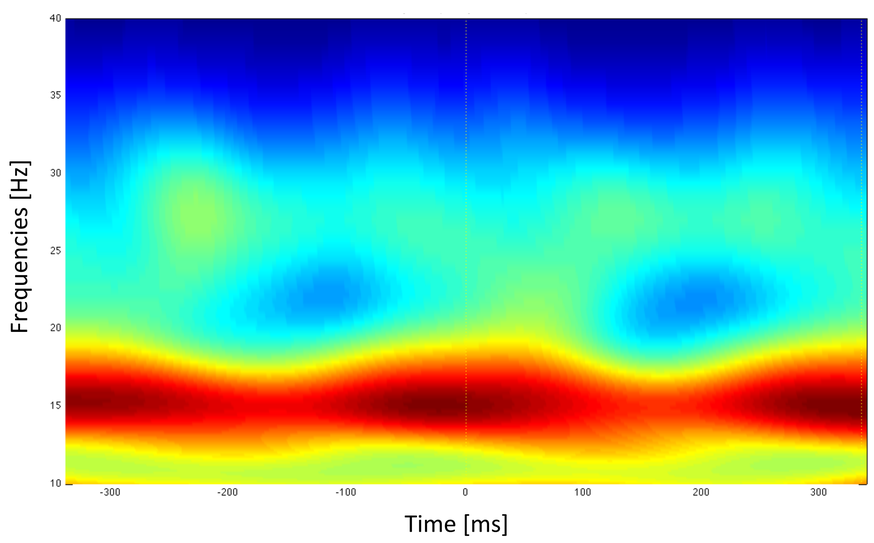
4. Results

- **Parkinsonian patient performing FT at 1Hz**



- **The patients were able to perform the FT at the imposed frequency and did not show any decrease in performance as the movement frequency increased.**
- **For slow movements, the time-frequency analysis of the MRPs revealed a decrease in beta band power during each FT movement, followed by a beta band post-movement rebound.**

- **Parkinsonian patient performing FT at 3Hz**



- **The time needed to perform the FT movement, from finger lift to tap, decreased significantly in parallel to increased auditory-paced frequency (r=-0.79).**
- **For faster movements, no pattern of synchronization-desynchronization were observed, but rather a STN activity modulation dephased compared to movements.**

5. Conclusion & future work

- **Preliminary analysis suggests that abnormal oscillations in the STN are modulated by movement frequency during a FT task.**
- **However, those results are not reproducible for all patients.**
- **Less and slower FT frequencies should be evaluated, with more trials in order to improve the resolution of the MRPs.**
- **Frequency-specific relationship between STN, EEG and EMG.**

6. References

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