Deep brain stimulation of the subthalamic nucleus normalizes Parkinson’s disease related abnormalities of auditory evoked potentials and quantitative EEG


Introduction
Some of the cardinal symptoms of Parkinson’s disease (PD) share a pathological rhythmic dysfunction as common feature.

Voluntary movements:
- Resting tremor
- Isolated gait vs. freezing
- Stiffness
- Progressive ministration of handwriting
- Difficult to follow a given rhythm

Our hypothesis:
PD patients are indicated to switch to an ‘internal’ pathological rhythm which seems to pace their motor actions.

- Following a rhythmic music helps PD patients to overcome their motor impairments.
- Frequencies between 1 and 2 Hz (like music or counting) are particularly helpful for patients to move more fluently.
- Some companies offer pocket-metronome to give patients pulses to synchronize with.
- All this points to a sensorimotor interaction between pathological rhythms and somatomotor rhythms.

Sensorimotor interaction is important for advanced PD patients to overcome motor impairments.

Experimental questions related to sensorimy in the auditory domain:
- Is the auditory processing of rhythmic stimuli in PD patients altered?
- Do rhythms at different frequencies have distinct effects on auditory processing?
- Does STN-DBS modulate the auditory information processing in advanced PD patients?

Methods

2 EEG recordings sessions:
- 1 week after surgery: intervention and
- 5 months after chronic STN-DBS stimulation, with high-frequency DBS ON and OFF.

Which kind of signals did we record and analyzed?
- Event-related potentials (ERPs): are very small electrical potentials originating from the brain recorded from the scalp in response to a stimulus.
- For auditory evoked potentials (AEPs), the “event” is a sound
  (metronome-like clicks):
  - Central auditory ERPs in the Control Group
  - Central auditory ERPs in the PD Group

Participants
- 23 advanced Parkinson’s disease patients in Off/Dopa state
- 12 healthy, control persons matched for age, gender and education
- Age: 62±6
- Disease duration: 14 years ±3
- Hoehn & Yahr: stage III
- Stoffers D, Bosboom JL, Deijen JB, Wolters EC, Berendse HW and Stam CJ.

STN-DBS reduces motor impairment
- UPDRS part II, maximal patients 108
- Pre-Operation in Off-Dopa: 31±13
- Post-Operation in OFF & DBS: 20±9

STN-DBS leads to a decrease of PD patients’ P2 amplitude in the frontal and central areas.

Results I: 1 Hz auditory stimulation

In PD patients the amplitudes of the auditory P50, N1 and P2 components are larger in PD patients compared to control group amplitudes. In PD patients the amplitudes for N1 and P2 are significantly longer than the control group amplitude.

After operations, patients’ P2 amplitudes are no longer significantly different from controls’ P2 amplitudes.

Results II: Different rhythmic conditions

In PD patients the amplitudes of the ERP show a new habituation to decreasing velocity of rhythms (decreasing ISIs) like the control group, but the amplitudes are always significantly larger.

Particularly before the operation, the amplitude of the PD patients’ P2 is strongly modulated by the frequency of the rhythms.

Results III: Effects of treatment on 1minute resting state EEG

In PD patients the amplitude of the ERP shows a new habituation to decreasing velocity of rhythms (decreasing ISIs) like the control group, but the amplitudes are always significantly larger.

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Discussion

Prior surgery, PD patients showed significantly larger ERP amplitudes (P50, N1 and P2) in central and frontal areas compared to controls. Moreover, compared to controls N1 and P2 latencies were significantly increased and AEP habituation reduced in PD patients. In the resting state EEG recordings we observed a significant reduction of delta and theta power in the off-dopa state. Levodopa therapy, which is providing an pr Önce as well as STN-DBS had a normalizing effect on low-frequency EEG activity and AEPs. In particular, high-frequency STN-DBS led to a normalization of P2, but not P50 and N1 amplitudes. We could not find any significant difference between the two post-operative conditions: Stimulation ON vs. Stimulation OFF.

Results

PD patients vs. control group

- N1 : P50
- N1 : N1
- N1 : P2
- P2 : P2

Summary of the results: patients vs. control group

- P50: Delta vs. EIG
- N1: Delta
- P2: Delta

References

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