An Exploration of the Effects of Audio-Visual Entrainment on Parkinson’s Disease Tremor

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Tremor in Parkinson’s Disease

- Tremor affects approximately 70% of PD patients
- Most typically it is a resting tremor
- Frequency of 4–6 Hz
- Initially involves one hand but it progresses to the whole body
Treatment

- Several drugs work in some cases, but many PD patients have drug-resistant tremor
- Deep-brain stimulation can reduce tremor dramatically, but is invasive
- Recently also extradural high-frequency motor cortex stimulation has worked (less invasive)
Origin

- PD tremor is caused by the death of cells in the midbrain that produce neurotransmitters. It is generated by a cortical oscillatory network originating from the thalamus.
- Cortical activity has some role in resting PD tremor.
- There is correlation between cortical activity and the peripheral muscle contractions in the frequency range of the tremor.
Ideas behind our study

- Surgical treatments inject oscillations in neural activity
- Our hypothesis: If we could affect cortical oscillations via external sensory stimuli we might indirectly be able to affect PD tremor.
- We decided to use a form of audio-visual periodic stimulation called *entrainment* to try to achieve this.
"Therapeutic" Intervention

- PD patients underwent daily sessions of audio-visual entrainment at a frequency of approximately 10 Hz
- The intensity of their tremor was monitored via android phone
- Their brainwaves were monitored at the end of the study
- Takes about one month for a patient to do the study, much more due to holidays, patient moving house, etc.
Protocols

- Two types: sessions of audio-visual entrainment (AVE) and control sessions (CTRL).
- Both are with eyes closed and phone strapped or held in hand
- Sessions started with 1 minute of baseline recording, then 10 minutes of AVE or CTRL.
Tremor reduction

PD Participant 1

PD Participant 2

PD Participant 3
Nature of the Tremor

### PD Participant 1

![Power spectrum for PD Participant 1](image)

### PD Participant 2

![Power spectrum for PD Participant 2](image)

### PD Participant 3

![Power spectrum for PD Participant 3](image)
Effect on Brain-waves

EEG spectrum (avg of all channels)

Scalp map (AVE/CTRL at 8–12 Hz)  Scalp map (AVE/CTRL at 4–6 Hz)
The AVE protocol leads to a substantial reduction in the tremor in PD patients. Tremor does not disappear, but settles into a more periodic pattern, in which much less mechanical power is expended. PD subjectively felt that their tremor was substantially reduced during entrainment. CTRL produces similar (but not identical) objective results, but subjectively patients felt that AVE was better. In both effects lasted for some minutes, but subjective positive effects seem to have lasted longer.
Questions for Future Work

- Is tremor reduction due to the state of relaxation induced by both protocols, a sort of placebo effect or is there actual direct interference of the entrainment frequencies with the tremor frequencies, or all three?
- If relaxation/placebo is the reason, could patients learn to control their tremor to some extent if they learnt to relax in the right way?
- If real interference is the reason, can we create less intrusive systems (e.g., audio only, flashing goggles, ...) for people to routinely use?