

Basal ganglia beta and gamma electrophysiologic dynamics in Parkinson's Disease



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BACKGROUND

Electrophysiologic recordings from the basal ganglia in patients with Parkinson's Disease (PD) may be used to further understand and improve treatments for patients, including levodopa medication and deep brain stimulation (DBS). Many patients with PD receive DBS at one target in the basal ganglia (**Fig 1**): the subthalamic nucleus (STN) or globus pallidus (GP). However, a small number of patients receive “dual-target” DBS at both STN and GP. The unique opportunity to record local field potentials (LFPs) from both targets simultaneously may permit a deeper understanding of PD electrophysiology and treatment effects.

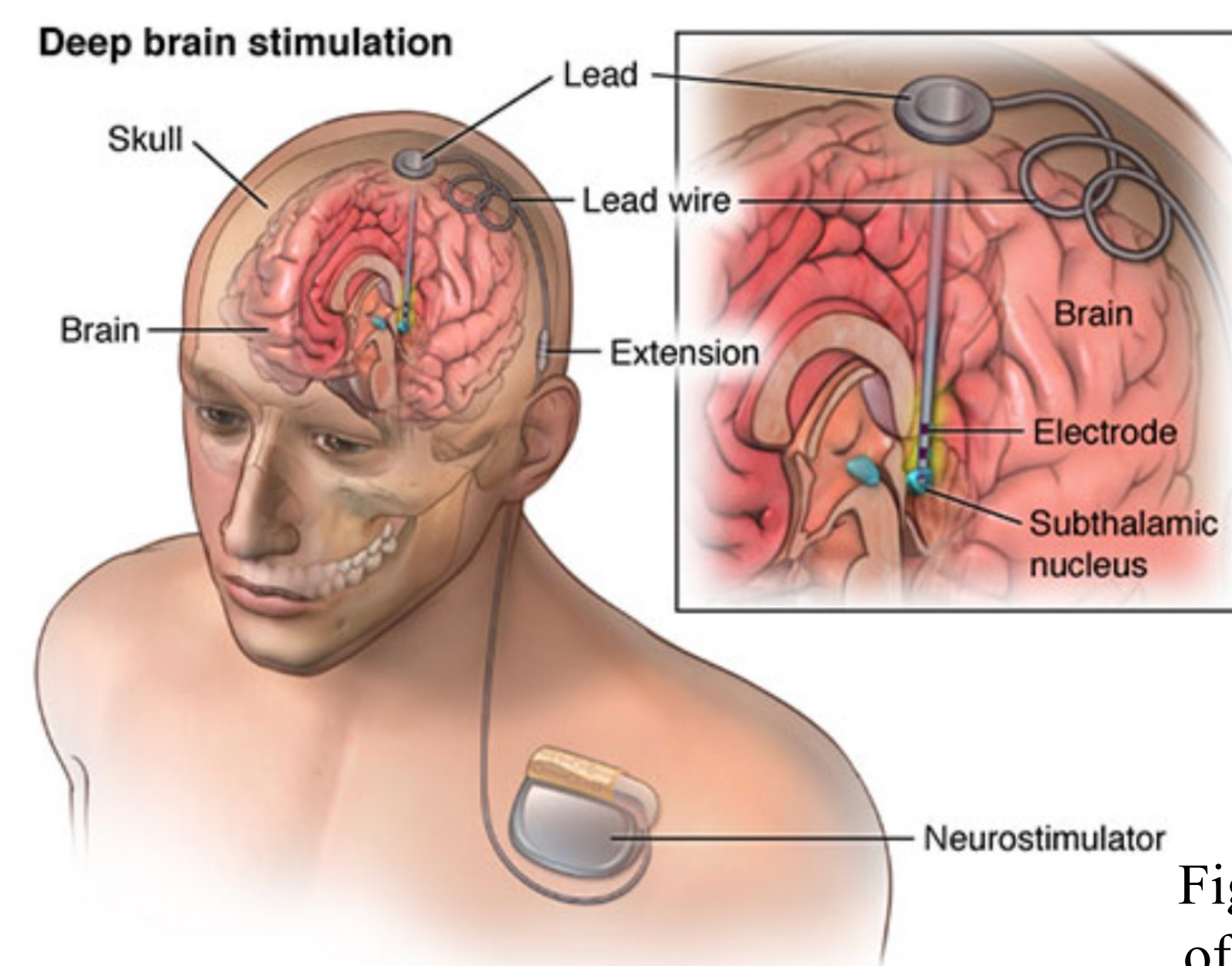


Figure 1: Schematic of DBS at the STN

METHODS

A 43-year-old patient with PD was implanted with bilateral dual-target DBS at the STN (2005) and GP (2021) using sensing-enabled DBS devices designed for long-term recording of neural time series data. LFPs were recorded ON and OFF levodopa medication and ON and OFF DBS from the patient's home one year after implantation. Functional connectivity between STN and GP was determined by magnitude-squared coherence.

RESULTS

In Parkinson's Disease (PD), synchronized beta oscillatory LFPs in the basal ganglia may depend on levodopa medication state.

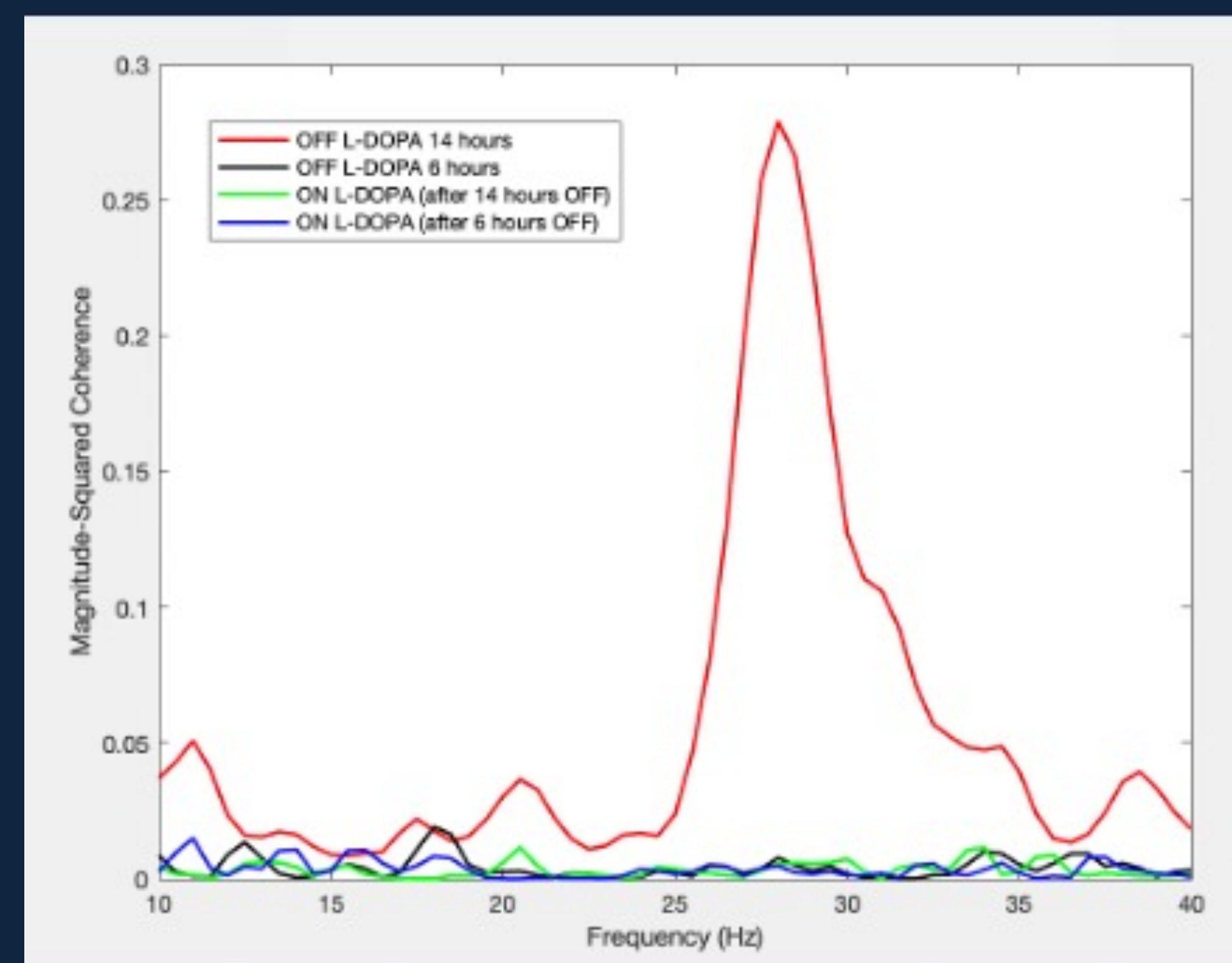


Figure 2: GP coherence in different levodopa states are shown. Strong beta coherence between STN and GP was seen when OFF levodopa for 14 hours (>8 half-lives; red), but not after 6 hours (4 half-lives, black) or when ON levodopa (green and blue). Coherence was calculated using the cross-spectral density normalized by the power spectra at STN and GP.

Finely-tuned gamma activity may arise from pro-kinetic, treated states.

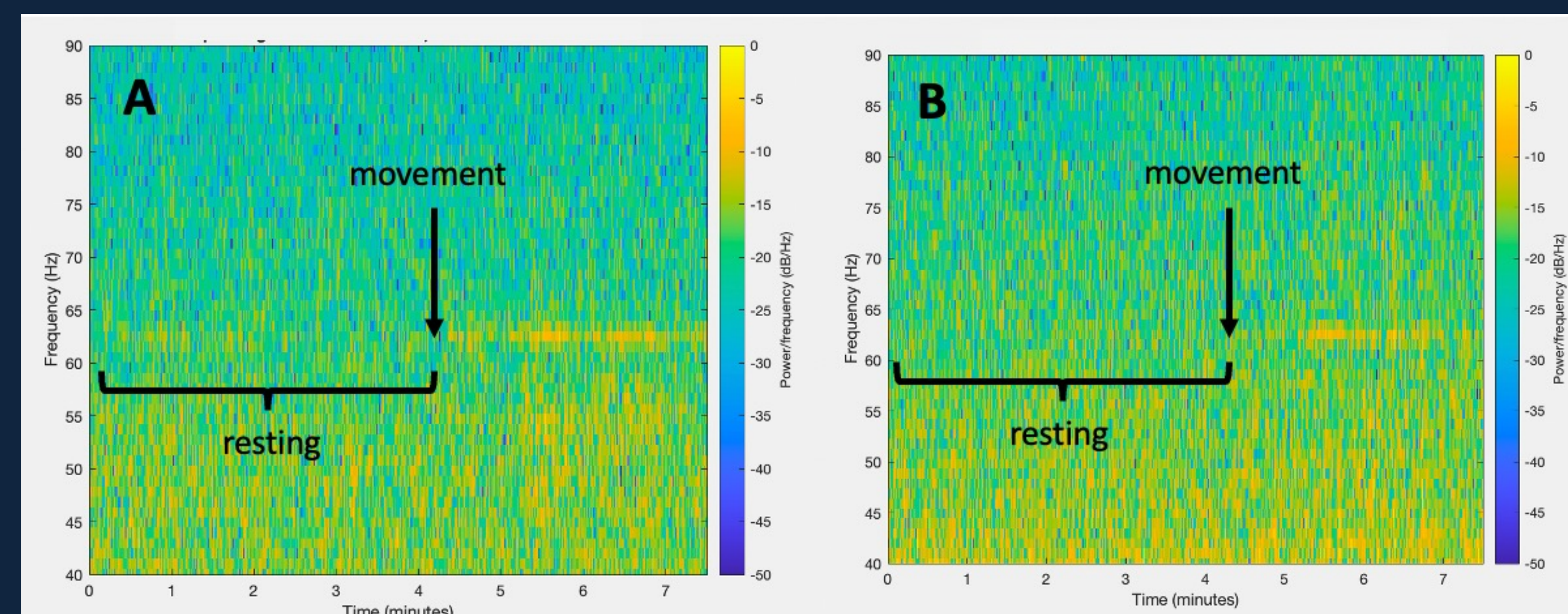


Figure 3. Heat map showing finely-tuned gamma activity at half the stimulation frequency (62.5Hz) was most apparent when on GP-DBS, ON-levodopa, and with movement. A) STN oscillatory activity. B) GP oscillatory activity. Periods of rest vs movement were identified using a Delsys Trigno EMG system.

DISCUSSION

- This study provides evidence for the persistence of STN-GP beta coherence decades after initial DBS implantation, which had previously only been observed days after implantation.
- Finely-tuned gamma oscillations appear to arise in pro-kinetic, therapeutic states.
- Further LFP recordings in patients with dual-target DBS at STN and GP may help generalize these findings of intra-basal ganglia beta and gamma dynamics in PD
- These findings may support ongoing efforts to use recorded LFPs to alter DBS in real-time to improve therapeutic effects and minimize side effect (adaptive DBS)

ACKNOWLEDGEMENTS

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