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Changes in globus pallidus internus local field potentials during freezing-of-gait in Parkinson's disease

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Introduction: Freezing-of-gait (FoG) is a common phenomenon in Parkinson's disease and is characterized by the inability to step. This can occur in a variety of scenarios including gait initiation, tight spaces, or distracting environments. FoG's impact on quality of life can range in severity from annoyance to life-threatening due to the increased risk of falls it carries. Deep brain stimulation (DBS), an effective and widely used treatment for Parkinson's disease, is currently delivered in a continuous, unchanging manner. The field is pushing toward an adaptable approach where stimulation parameters are adjusted based on changes in the local field potentials they stimulate. If a neural signature associated with FoG could be identified, this could allow for tailored stimulation or external perturbation to shorten the freezing episode or eliminate it all together. Previous studies, limited to the subthalamic nucleus, showed that FoG was associated with beta bursts, more prolonged beta just prior to freezing, and excessive synchronization in the 18Hz beta band.

Materials, Methods and Results: This study evaluates the LFPs of the output nucleus of the globus pallidus internus (Gpi) in a real world setting with a sensing-enabled DBS device (Medtronic's Percept), and simultaneous ankle accelerometer data. Five individuals with Parkinson's-related FoG and a Percept DBS system were evaluated on medication and off stimulation. The participants walked an obstacle course of five FoG-triggering scenarios while simultaneous LFPs and ankle accelerometer data were collected. LFPs were analyzed during periods of freezing, standing, and walking. The modulation index, derived from the Kullback-Leibler divergence between the theta phase and various amplitude bands was computed as a measure of phase-amplitude coupling. Preliminary results show that phase-amplitude coupling during freezing followed the trend standing < freezing < walking for the alpha, beta, and gamma amplitude bands. The effect was the most pronounced for theta-gamma coupling.

Conclusion: These results suggest that changes in phase-amplitude coupling could be used to identify periods of freezing-of-gait directly from Gpi LFPs.

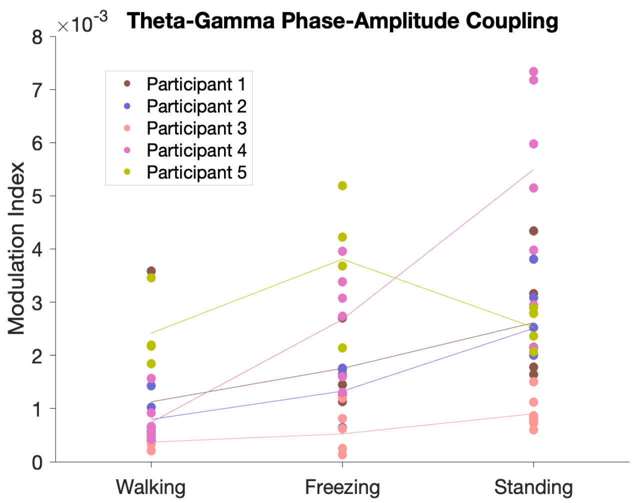

Figure 1: coupling between the theta phase and gamma amplitude during freezing tends to lay between that seen during walking and standing.

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