Summary Report

Cortical Activation in Freezers vs. Non-Freezers (fNIRS – Preliminary Analysis)

Purpose

This preliminary analysis examines whether individuals with Parkinson's disease who experience Freezing of Gait (FoG) show differences in task-related cortical activation compared to those who do not. The focus is on changes in oxygenated hemoglobin (HbO_2) levels during a motor task using functional near-infrared spectroscopy (fNIRS).

Method

- **Groups Compared:** Freezers (n ≈ 5–7) vs. Non-Freezers (n ≈ 12–14)
- **Signal:** HbO_2 theta coefficients derived from a GLM (General Linear Model)
- **Regions of Interest (ROIs):**
  - Prefrontal Cortex (PFC)
  - Premotor Cortex (PMC)
  - Supplementary Motor Area (SMA)
  - Primary Motor Cortex (M1)
  - Somatosensory Association Cortex (SA)
- **Statistical Approach:**
  - Independent t-tests for group comparisons
  - Covariates (age, sex, UPDRS) recorded but not yet applied
  - No corrections for multiple comparisons applied at this stage

Statistical Results

Region	Trend in Freezers	p-value
PFC	Lower HbO_2	0.55
PMC	Lower HbO_2	0.50
SMA	Lower HbO_2	0.44
M1	Lower HbO_2	0.69
SA	Lower HbO_2	0.75

Across all ROIs, Freezers showed numerically lower HbO_2 activation compared to non-freezers. None of these differences reached statistical significance (all $p > 0.4$), likely due to small sample size and between-subject variability.

Interpretation

Statistical Viewpoint

While group differences were not statistically significant, the directional consistency (i.e., lower activation in Freezers across all five ROIs) is notable. The lack of significance is expected in a sample of this size and does not negate potential clinical relevance.

Clinical Interpretation

The observed pattern indicates that individuals with Freezing of Gait (FoG) may exhibit reduced activation in key cortical regions during motor task engagement. This reduction is particularly notable in areas responsible for motor planning and initiation—such as the supplementary motor area (SMA) and premotor cortex (PMC)—as well as regions involved in executive function, including the prefrontal cortex (PFC). These findings are consistent with existing neurophysiological models of FoG, which suggest that impaired top-down control and disrupted motor-cognitive integration contribute to freezing episodes.

While the current analyysis exploratory in nature, the directionally consistent hypoactivation seen in Freezers raises the possibility that reduced cortical engagement could serve as an early neural correlate or biomarker of gait freezing in Parkinson's disease

Conclusion

This preliminary analysis shows a consistent pattern of reduced cortical activation in Freezers, most evident in regions associated with planning and executive function. While statistical evidence is limited, the trend is directionally meaningful and supports further study. Largr sample sizes and models incorporating covariates will be necessary to confirm these findings and assess their clinical utility.