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ASSESSMENT OF EARLY-STAGE PARKINSON'S DISEASE USING HD-EEG AND POSTURAL CONTROL RESPONSE

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Early-stage Parkinson's disease (PD) is frequently characterized by subtle neurophysiological alterations that precede overt motor symptoms, making early detection and objective assessment particularly challenging. Postural control (PC) impairment is among the earliest functional deficits in PD and reflects disrupted integration of sensory, motor, and cognitive processes. Electroencephalography (EEG), with its high temporal resolution, offers a powerful tool for capturing rapid neural dynamics underlying balance regulation. Oscillatory activity and functional connectivity in the alpha band have been closely linked to postural stability, sensorimotor integration, and attentional control. However, most EEG studies in PD have focused on resting-state conditions or static balance tasks, limiting insight into brain network dynamics during complex, ecologically valid postural challenges. [1-2] This study aimed to investigate alpha-band functional brain connectivity and dynamic brain network states (BNSs) during a visuomotor postural control task in individuals with early-stage PD, using a high-density EEG (HD-EEG) framework combined with the BioVRSea paradigm. BioVRSea provides a dynamic and immersive balance task that integrates visual perturbations and motor demands, enabling the detection of subtle neural adaptations that may not be captured by conventional postural assessments. The findings highlight altered alpha-band brain network dynamics in early-stage PD, supporting the potential of BioVRSea and EEG-based BNS metrics as early neurophysiological markers of postural instability. [3]

Keywords: *postural control, early-stage Parkinson's disease, quantitative neurophysiology, BioVRSea, balance control.*

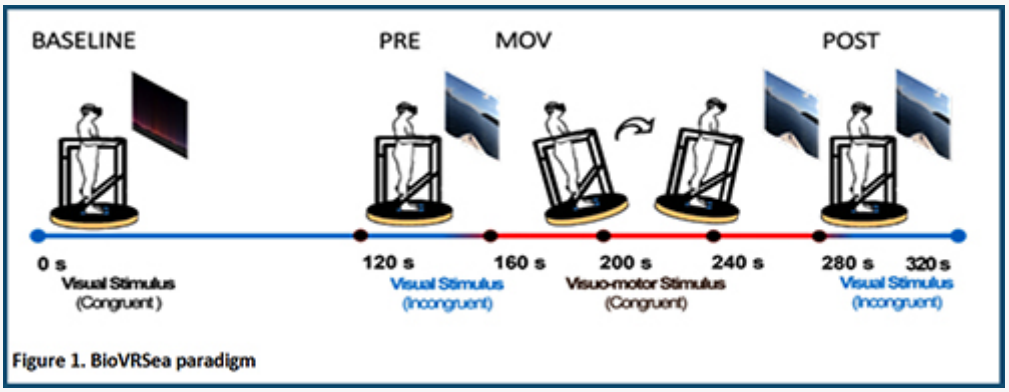

Figure 1. BioVRSea paradigm