Human Electrical Brain Dynamics During Locomotor Obstacle Avoidance in Virtual Reality

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ABSTRACT

Visually identifying and avoiding obstacles encountered during walking is crucial for navigating real world environments. Motor deficits that affect gait and balance, and changes due to aging, can increase fall risk. There is a needed to better understand the complex relationships between gaze behaviors of the eye and electrical brain dynamics during locomotor obstacle avoidance. Virtual reality provides nearly limitless opportunities to create experimentally controlled, complex, realistic environments to study human behaviors, such as locomotion. **PURPOSE**: Our aim was to identify human electrocortical dynamics during walking and obstacle avoidance in virtual reality, to better understand visually guided human locomotor control. **METHODS**: We recorded 64-channel mobile high-density electroencephalography (EEG), lower-limb motion capture, ground reaction forces, and eye gaze behavior from participants navigating virtual environments on a treadmill with obstacles to step over. Eighteen (8F and 10M) participants completed nine obstacle avoidance conditions lasting 3-4 minutes each, including 3 gait speeds (1.0 m/s, 1.25 m/s, 1.5 m/s) and 3 obstacle-approach speeds (0.75x, 1x, 1.25x gait speed). Baseline walking conditions without virtual obstacles present were also recorded at each gait speed. **RESULTS**: Based on preliminary analysis, we identified increased gamma band power (>30 Hz) from the visual cortex, posterior parietal cortex, and frontal cortex when compared to walking without virtual obstacles present. At faster walking speeds, beta (13-30 Hz) and low gamma band power (30-60 Hz) decreased from the prefrontal cortex. **CONCLUSION**: Changes in human electrical spectral power dynamics among cortical regions during walking in virtual reality, at different speeds, and with or without obstacles to avoid, provides possible biomarkers for assessing cortical processing during real world locomotor navigation. These findings may be used to better understand cortical networks affected by aging, neurological disease, or disorder, providing objective measure for tracking gait rehabilitation, or developing assistive brain computer interfaces.