

Introduction: Accompanying the natural advancing of age is a decline in cognitive and motor functions, which can significantly impact the daily life activities in the elder demographic (>65 y). Such declines may involve altered neuroplasticity, due to changes in synaptic function and neurotransmission. Successful performance of complex motor tasks may also entail distinct patterns in motor cortical functional connectivity, which may also be subject to age related changes. On the other hand, recent work has shown that transcranial direct current stimulation (tDCS) may be a useful tool to reconstitute these altered mechanisms, and improve performance of motor skills.

Objectives: The present study first addresses the question of identifying physiological markers of age-related differences during acquisition of new bimanual motor control tasks, based on motor cortical functional connectivity using EEG. Second, the study assesses whether performance of complex bimanual motor skills can be improved in the elderly using tDCS.

Methods: *Experiment 1:* 43 healthy subjects (22 young/21 elderly) were recruited. Subjects performed the bimanual tracking task (BTT), which is a complex task requiring multiple cognitive domains, as well as the skilled use of in-phase and anti-phase movements, at various frequencies. Three blocks of the task were performed (180 total trials) while 32-channel EEG was recorded.

Experiment 2: An additional 40 subjects (20 young/20 elderly) were recruited for evaluating whether right M1 anodal tDCS (1.0 mA, 20 min) may improve performance in the task, particularly in the non-dominant left hand. The study was double-blinded, sham-controlled, and employed a randomized crossover design in order to assess tDCS-induced performance and functional connectivity differences between young and elderly groups.

Results: Experiment 1: Task performance in younger subjects was more accurate than in elderly. Younger subjects exhibited significantly stronger functional connectivity in the theta power band, which was also a reliable predictor for accurate performance of the task. Experiment 2: ANOVA revealed a main effect of stimulation, which was significant between sessions in the elderly but not in young. Further exploratory analyses revealed significant improvements in both left and right hand coordination in real stimulation conditions for both groups of subjects.

Conclusion: We show that both functional connectivity and inter-limb kinematics underlying bimanual motor coordination are different between the young and elderly. We further show that a single session of tDCS applied to the motor cortex was able to significantly improve bimanual performance in both young and elderly. Although further studies are needed to optimize tDCS parameters for enhanced and prolonged effects, this non-invasive stimulation technique may be a viable tool in reconstituting and even further optimizing the learning of complex motor functions in the aging population.