6 Adjunctive Transcranial Direct Current Stimulation and Cognitive Training Alters Default Mode and Frontoparietal Control Network Connectivity in Older Adults

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Objective: Aging is associated with disruptions in functional connectivity within the default mode (DMN), frontoparietal control (FPCN), and cingulo-opercular (CON) resting-state networks. Greater within-network connectivity predicts better cognitive performance in older adults. Therefore, strengthening network connectivity, through targeted intervention strategies, may help prevent age-related cognitive decline or progression to dementia. Small studies have demonstrated synergistic effects of combining transcranial direct current stimulation (tDCS) and cognitive training (CT) on strengthening network connectivity; however, this association has yet to be rigorously tested on a large scale. The current study leverages longitudinal data from the first-ever Phase III clinical trial for tDCS to examine the efficacy of an adjunctive tDCS and CT intervention on modulating network connectivity in older adults.
Participants and Methods: This sample included 209 older adults (mean age = 71.6) from the Augmenting Cognitive Training in Older Adults multisite trial. Participants completed 40 hours of CT over 12 weeks, which included 8 attention, processing speed, and working memory tasks. Participants were randomized into active or sham stimulation groups, and tDCS was administered during CT daily for two weeks then weekly for 10 weeks. For both stimulation groups, two electrodes in saline-soaked 5x7 cm2 sponges were placed at F3 (cathode) and F4 (anode) using the 10-20 measurement system. The active group received 2mA of current for 20 minutes. The sham group received 2mA for 30 seconds, then no current for the remaining 20 minutes. Participants underwent resting-state fMRI at baseline and post-intervention. CONN toolbox was used to preprocess imaging data and conduct region of interest (ROI-ROI) connectivity analyses. The Artifact Detection Toolbox, using intermediate settings, identified outlier volumes. Two participants were excluded for having greater than 50% of volumes flagged as outliers. ROI-ROI analyses modeled the interaction between tDCS group (active versus sham) and occasion (baseline connectivity versus post-intervention connectivity) for the DMN, FPCN, and CON controlling for age, sex, education, site, and adherence.
Results: Compared to sham, the active group demonstrated ROI-ROI increases in functional connectivity within the DMN following intervention (left temporal to right temporal [T(202) = 2.78, pFDR < 0.05] and left temporal to right dorsal medial prefrontal cortex [T(202) = 2.74, pFDR < 0.05]. In contrast, compared to sham, the active group demonstrated ROI-ROI decreases in functional connectivity within the FPCN following intervention (left dorsal prefrontal cortex to left temporal [T(202) = -2.96, pFDR < 0.05] and left dorsal prefrontal cortex to left lateral prefrontal cortex [T(202) = -2.77, pFDR < 0.05]). There were no significant interactions detected for CON regions.
Conclusions: These findings (a) demonstrate the feasibility of modulating network connectivity using tDCS and CT and (b) provide important information regarding the pattern of connectivity changes occurring at these intervention parameters in older adults. Importantly, the active stimulation group showed increases in connectivity within the DMN (a network particularly vulnerable to aging and implicated in Alzheimer's disease) but decreases in connectivity between left frontal and temporal FPCN regions. Future analyses from this trial will evaluate the association between these changes in connectivity and cognitive performance post-intervention and at a one-year timepoint.

Categories: Neurostimulation/Neuromodulation
Keyword 1: aging (normal)
Keyword 2: neurostimulation
Keyword 3: neuroimaging: functional connectivity
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1 Associations of Locus of Control and Memory Self-Awareness in Older Adults with and without MCI

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Objective: While loss of insight into one's cognitive impairment (anosognosia) is a feature in Alzheimer's disease dementia, less is known about memory self-awareness in cognitively unimpaired (CU) older adults or mild cognitive impairment (MCI) or factors that may impact self-awareness. Locus of control, specifically external locus of control, has been linked to worse cognitive/health outcomes, though little work has examined locus of control as it relates to self-awareness of memory functioning or across cognitive impairment status. Therefore, we examined associations between locus of control and memory self-awareness and whether MCI status impacted these associations.
Participants and Methods: Participants from the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study (mean age=73.51; 76% women; 26% Black/African American) were classified as CU (n=2177) or MCI (amnestic n=313; non-amnestic n=170) using Neuropsychological Criteria. A memory composite score measured objective memory performance and the Memory Functioning Questionnaire measured subjective memory. Memory self-awareness was defined as objective memory minus subjective memory, with positive values indicating overreporting of memory difficulties relative to actual performance (hypernosognosia) and negative values indicating underreporting (hyponosognosia). Internal (i.e., personal skills/attributes dictate life events) and external (i.e., environment/others dictate life events) locus of control scores came from the Personality in Intellectual Aging Contexts Inventory. General linear models, adjusting for age, education, sex/gender, depressive symptoms, general health, and vocabulary examined the effects of internal and external locus of control on memory self-awareness and whether MCI status moderated these associations.
Results: Amnestic and non-amnestic MCI participants reported lower internal and higher external locus of control than CU participants. There was a main effect of MCI status on memory self-awareness such that amnestic MCI participants showed the greatest degree of hyponosognosia/underreporting, followed by non-amnestic MCI, and CU participants slightly overreported their memory difficulties. While, on average, participants were fairly accurate at reporting their degree of memory difficulty, internal locus of control was negatively associated with self-awareness such that higher internal locus of control was associated with greater underreporting (β=-.127, 95% CI [-.164, -.089], p<.001). MCI status did not moderate this association. External locus of control was positively associated with self-awareness such that higher external locus of control was associated with greater hypernosonosia/overreporting (β=.259, 95% CI [.218, .300], p<.001). Relative to CU, amnestic, but not non-amnestic, MCI showed a stronger association between external locus of control and memory self-awareness. Specifically, higher external locus of control was associated with less underreporting of cognitive difficulties in amnestic MCI (β=.107, 95% CI [.006, .208], p=.038).
Conclusions: In CU participants, higher external locus of control was associated with

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