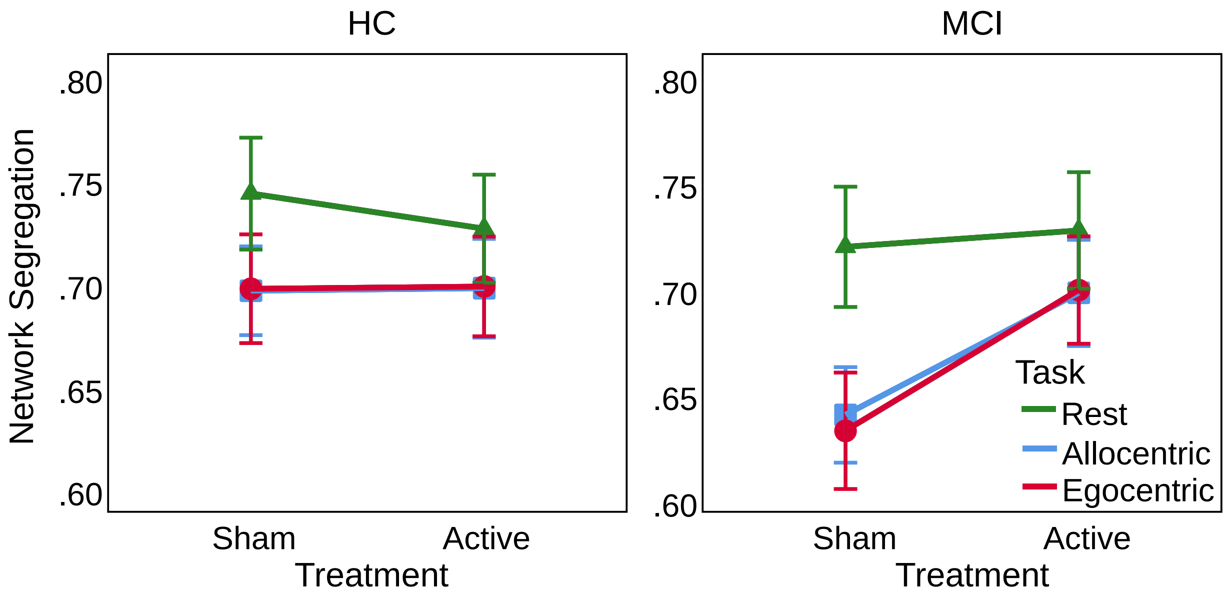
Supplementary Results

No significant effect of the number of days between sessions on navigation performance. We performed exploratory analyses to evaluate whether the number of days between the first and the second session [*M* (*SD*) 7.79 (6.93) days] had any effect on performance in the navigation tasks. When entered as a covariate in the Group×Order×Treatment mixed-model ANOVA, the number of days between sessions yielded no significant effects on allocentric (main effect: $F_{1,33}$=0.58, p=0.453, η_p^2=0.02; covariate×Treatment interaction: $F_{1,33}$=1.68, p=0.204, η_p^2=0.05) or egocentric (main effect: $F_{1,34}$=0.98, p=0.33, η_p^2=0.03; covariate×Treatment interaction: $F_{1,33}$=1.36, p=0.252, η_p^2=0.04) navigation performance.

No significant effect of HD-tDCS on resting-state data. To check whether the effects of HD-tDCS would also be observed during resting-state, we performed a Group×Order×Treatment mixed-model ANOVA on resting-state brain-wide segregation. This analysis showed no significant effects (*p*s>0.2, η_p^2<0.03). As expected, however, brain-wide network segregation was higher during rest compared to task during both allocentric ($F_{1,38}$=17.39, p<0.001, η_p^2=0.31) and egocentric navigation ($F_{1,38}$=15.54, p<0.001, η_p^2=0.29) task performance (see Supplementary Figure S1).

The thresholds used here to identify outlier scans (i.e., differential motion/FD d>2mm and global intensity z>5) are justified given that we are dealing with a special population and we are comparing task and rest results. Accumulating evidence suggests that, for older adults and especially for those with cognitive impairments, too stringent motion criteria may inadvertently introduce sampling bias (e.g., Geerligs, Tsvetanov, & Henson, 2017; Haller et al., 2014; Zeng et al., 2014). Furthermore, the present thresholds allowed us to directly compare the effects of HD-tDCS on task and resting-state segregation using the same metrics. Nevertheless, we repeated the

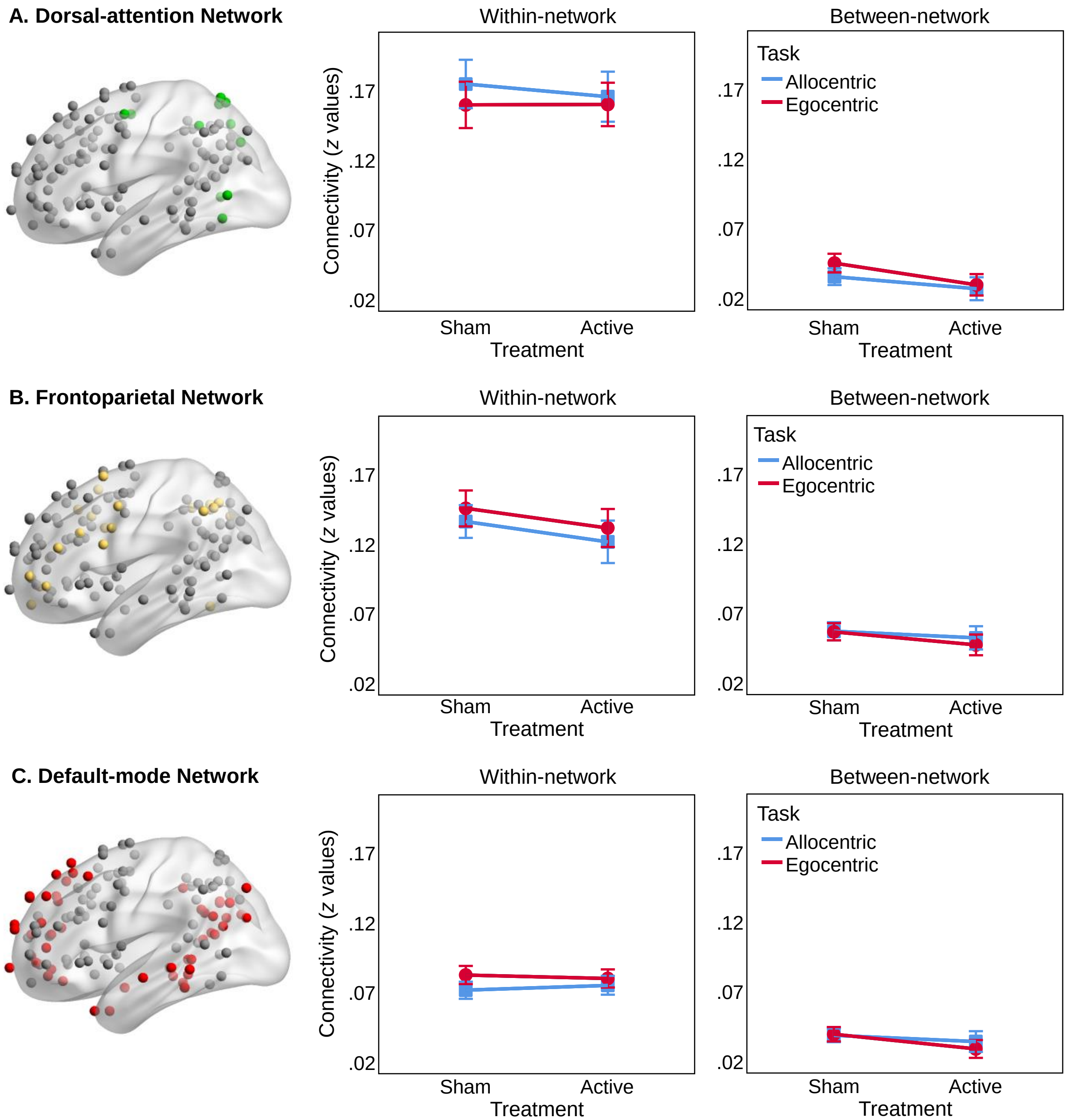


Supplementary Figure S1. Whole-brain network segregation during resting-state and spatial navigation. Only task-related network segregation was modulated by HD-tDCS. Error bars display standard error of the mean. Abbreviations: HC, healthy controls; MCI, patients with mild cognitive impairment.

resting-state analysis using a more stringent, commonly used motion threshold of d<0.5mm and the results did not change, i.e. a Group×Order×Treatment mixed-model ANOVA on resting-state segregation showed no significant effects (ps>0.2, η_p^2<0.04).

We did not employ global signal regression in our analyses for the following reasons: (1) it has been shown that regressing-out signal from white matter and CSF using the anatomical CompCor approach (Behzadi, Restom, Liau, & Liu, 2007), as done here, achieves results similar to global signal regression while limiting artifactual anticorrelations in the data (Muschelli et al., 2014); (2) applying global signal regression only to rest data would make the comparison with the task data inappropriate, and global signal regression for task data is typically not performed (e.g., Cole et al., 2013); (3) global signal regression remains a contentious issue even for resting-state data (Aquino, Fulcher, Parkes, Sabaroedin, & Fornito, 2020).

Effects of HD-tDCS on within- and between-network connectivity. To check whether the observed segregation effects for MCI participants were driven primarily by within- or between-network connectivity, we performed exploratory Order×Treatment×Task mixed-model ANOVAs separately for within- and between-network connectivity (Supplementary Figure 2). First, for the dorsal-attention network, results showed greater within-network connectivity for Allocentric than Egocentric navigation (Task: $F_{1,18}$=5.11, p=0.036, η_p^2=0.22) and lower between-network connectivity following Active than Sham stimulation, with a large effect size (Treatment: $F_{1,18}$=7.38, p=0.014, η_p^2=0.29), as well as lower between-network connectivity for Allocentric than Egocentric navigation (Task: $F_{1,18}$=19.94, p<0.001, η_p^2=0.53). Second, for the frontoparietal network, results showed lower within-network connectivity following Active than Sham stimulation (Treatment: $F_{1,18}$=5.45, p=0.031, η_p^2=0.23) and greater within-network connectivity for Egocentric than Allocentric navigation (Task: $F_{1,18}$=8.31, p=0.01, η_p^2=0.32), as well as a trend for lower between-network connectivity following Active than Sham stimulation, with a large effect size (Treatment: $F_{1,18}$=3.22, p=0.09, η_p^2=0.15). Finally, for the default-mode network, results showed greater within-network connectivity for Egocentric than Allocentric navigation (Task: $F_{1,18}$=4.93, p=0.039, η_p^2=0.22) and a trend for lower between-network connectivity following Active than Sham stimulation, with a large effect size (Treatment: $F_{1,18}$=3.27, p=0.087, η_p^2=0.15). Overall, these results suggest that increased network segregation following HD-tDCS in MCI patients may be due to reductions in between-network connectivity between the association networks. This interpretation is also supported by a general trend across all association networks toward lower between-network connectivity following Active than Sham stimulation, with a large effect size (Treatment: $F_{1,18}$=3.27, p=0.087, η_p^2=0.15).



Supplementary Figure S2. Within- and between-network connectivity of the dorsal-attention, frontoparietal, and default-mode networks, for patients with mild cognitive impairment. Error bars display standard error of the mean.

Effects of HD-tDCS on other association networks. Exploratory Group×Order×Treatment×Task ANOVAs on individual network segregation also identified a trending Group×Treatment interaction for salience ($F_{1,38}$=3.51, p=0.069, η_p^2=0.09), but not for any other association (or sensory-motor) networks (*p*s>0.1, η_p^2<0.05). In addition, exploratory analyses in MCI patients suggest a more general trend toward increased segregation following active HD-tDCS within the association system, with effects of treatment also for the cingulo-opercular ($F_{1,18}$=5.17, p=0.035, η_p^2=0.22) and salience networks ($F_{1,18}$=6.28, p=0.022, η_p^2=0.26), though these were not backed by superordinate Group×Treatment interactions. In contrast, there were no effects of Treatment for any of the sensory-motor networks in the MCI group (*p*s>0.33, η_p^2<0.06) and no Treatment effects for any network in HC (*p*s>0.1, η_p^2<0.11).