

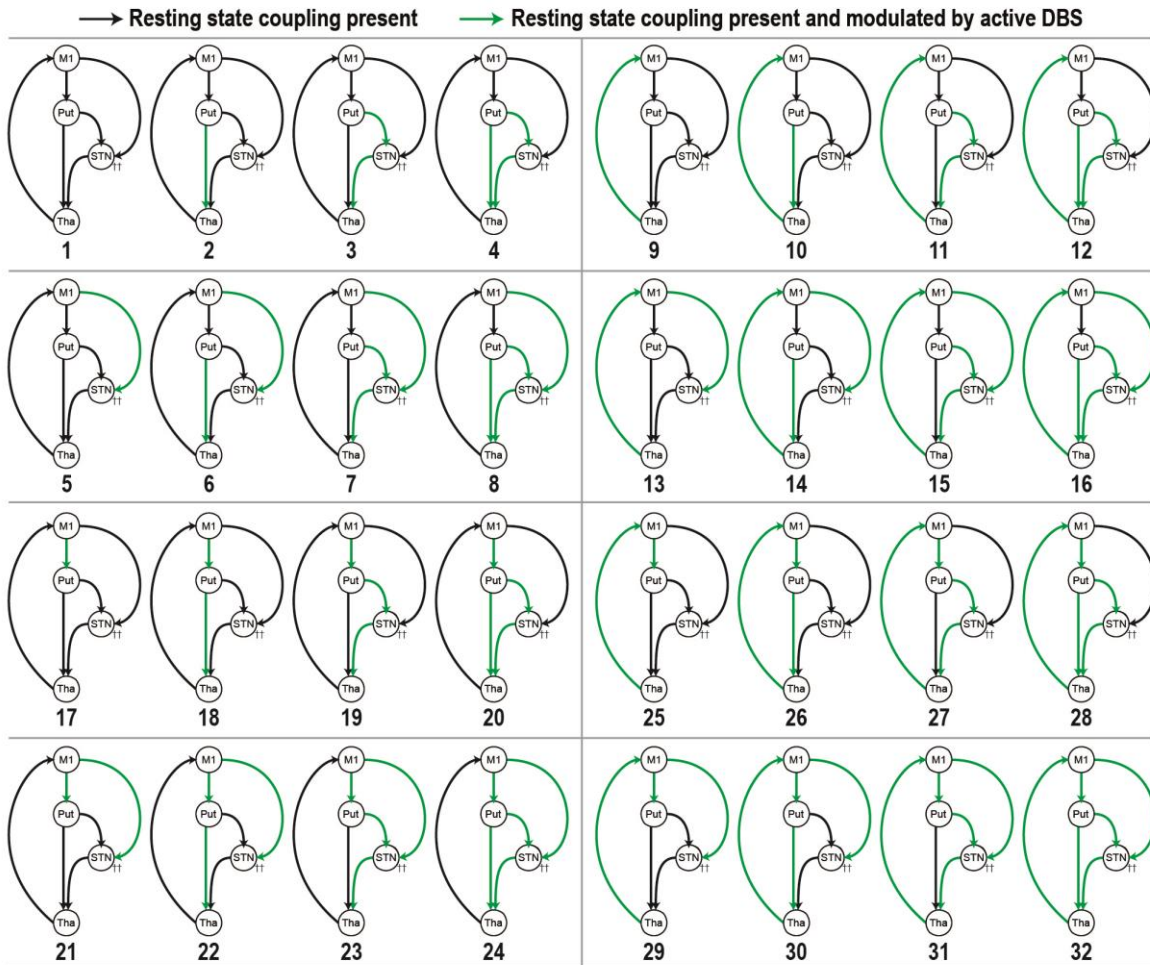
Supplementary Material

MRI Data acquisition: Sequence parameters

1. Anatomical T1 MPRAGE (TR=1900ms; TE=3.14ms; TI=900ms; Flip angle=9°; FOV=256x256mm²; 176 sagittal slices 1mm thick; Spatial resolution= 1x1x1mm³; Duration=7min 24sec)
2. Resting state fMRI (TR=2420ms; TE=40ms; Flip angle=90°; FOV=192x192mm²; 32 axial slices 3.7mm thick, gap between slices of 0.52mm; Spatial resolution= 3x3x3.7mm³; Duration=6min 21sec; 155 scans)
3. Movement task fMRI (TR=3650ms; TE=40ms; Flip angle=90°; FOV=192x192mm²; 49 axial slices 2.5mm thick, gap between slices of 0.5mm; Spatial resolution= 3x3x3mm³; Duration=8min 53sec; 145 scans)

Analysis of task performance

Joystick position was recorded at a rate of 20 Hz. Data were first squared and summed over dimensions to ensure movements *away from the centre* in all directions produced a positive displacement. A window of 3 seconds after each beep was extracted and the first derivative was calculated, yielding velocity plots for each voluntary movement. The peak velocity (V_{\max}) of the movement away from the centre was used as a summary for movement speed, and the latency from stimulus onset to reaching half their V_{\max} defined the reaction time (RT). V_{\max} and RT were averaged across trials in each DBS condition in each subject. These summaries were then taken to the group level, where two-tailed paired T tests were used to compare the mean V_{\max} and RT in the different stimulation conditions. Significance was set at $p < 0.05$. Additionally, the direction of each movement was calculated, and each movement was placed into one of eight direction “bins” (0-45°, 45-90°, 90-135°, 135-180°, 180-225°, 225-270°, 270-315°, 315-360°). The randomness of movement direction was compared using the Evans RNG index, which considers the sequence of movements between direction bins. The greater the RNG index, the less random the sequence of movements (Evans, 1978).



Supplementary Figure 1: Experiment 1 Model Space

The original 32 competing models in which a different subset of connections is modulated by active STN DBS. Circles represent the 4 nodes studied. † The STN was included in the model but was treated as a “hidden node”; i.e., a node that BOLD data could not be recorded from, but has known involvement in network dynamics. Black arrows represent the presence of directed effective connectivity during rest. Green arrows represent modulation of effective connectivity by active DBS during rest.

VOI	Mean MNI coordinates (x,y,z mm)
M1	34, -22, 60
Putamen	27, -7, 5
Thalamus	20, -20, 9
Cerebellum	5, -60, -19

Supplemental Table 1

The mean coordinates of the centre of the VOIs used in DCM analysis.