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Supplemental information

Causal evidence for cholinergic

stabilization of attractor landscape dynamics

Natasha L. Taylor, Christopher J. Whyte, Brandon R. Munn, Catie Chang, Joseph T. Lizier, David A. Leopold, Janita N. Turchi, Laszlo Zaborszky, Eli J. Müller, and James M. Shine

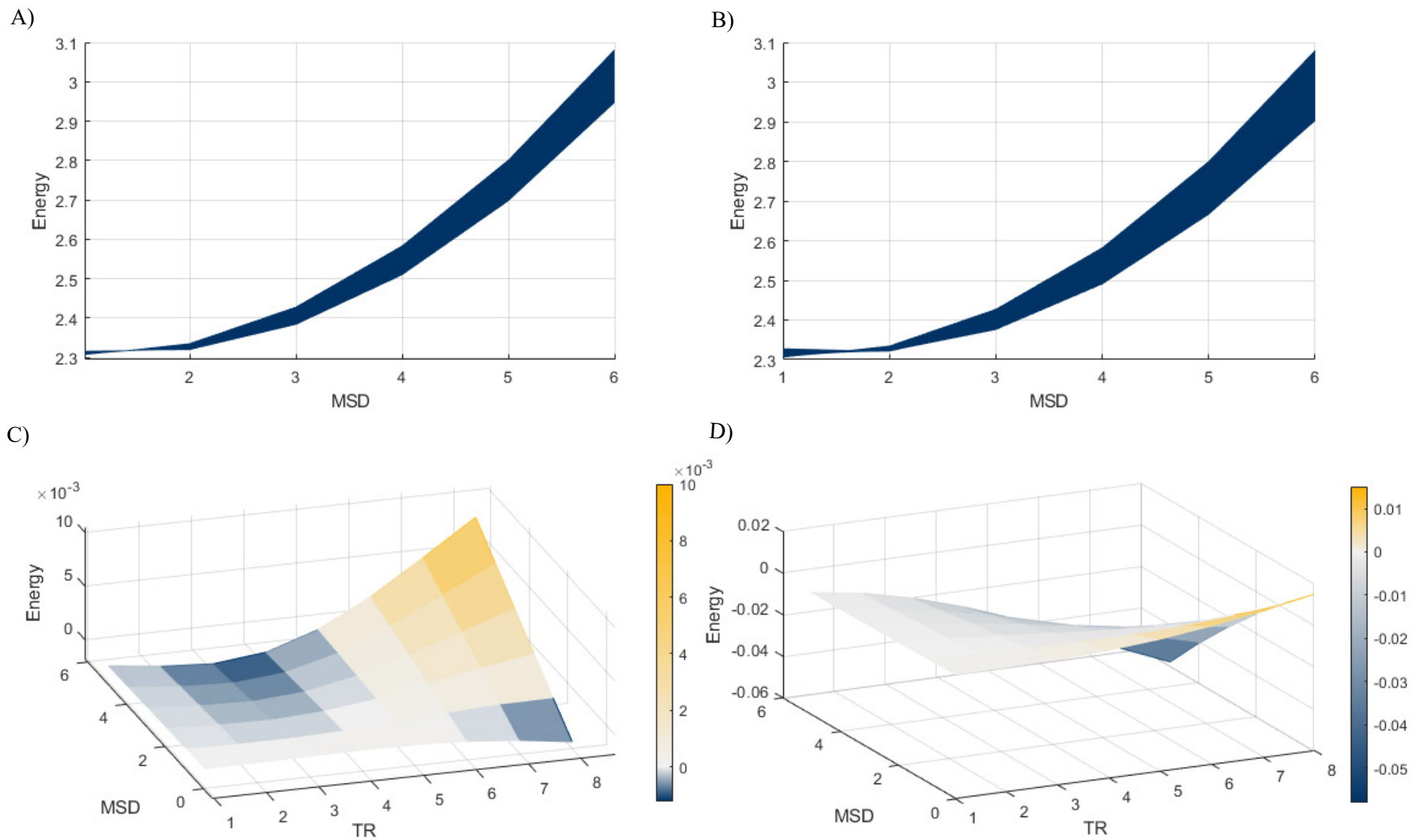


Figure S1 Related to Figure 2– Monkey Differences in Attractor Landscape

A) Plot of the average attractor landscape of MonkeyF (changes in fMRI signal activity being measured by MSD and MSD energy being the likelihood of transitioning) during inhibition of nbM across all ROIs. B) Plot of the average attractor landscape of MonkeyZ (changes in fMRI signal activity being measured by MSD and MSD energy being the likelihood of transitioning) during inhibition of nbM across all ROIs. C) Average difference in attractor landscape of MonkeyF between the nbM inhibition compared to no inhibition, differences in MSD energy are represented on the colour bar. D) Average difference in attractor landscape of MonkeyZ between the nbM inhibition compared to no inhibition, differences in MSD energy are represented on the colour bar. No significant difference between average attractor landscape of MonkeyF and MonkeyZ during nbM inhibition ($p=0.25$, independent sample t-test). No significant difference between average attractor landscape of MonkeyF during no inhibition compared to MonkeyZ during no inhibition ($p=0.515$, independent sample t-test).

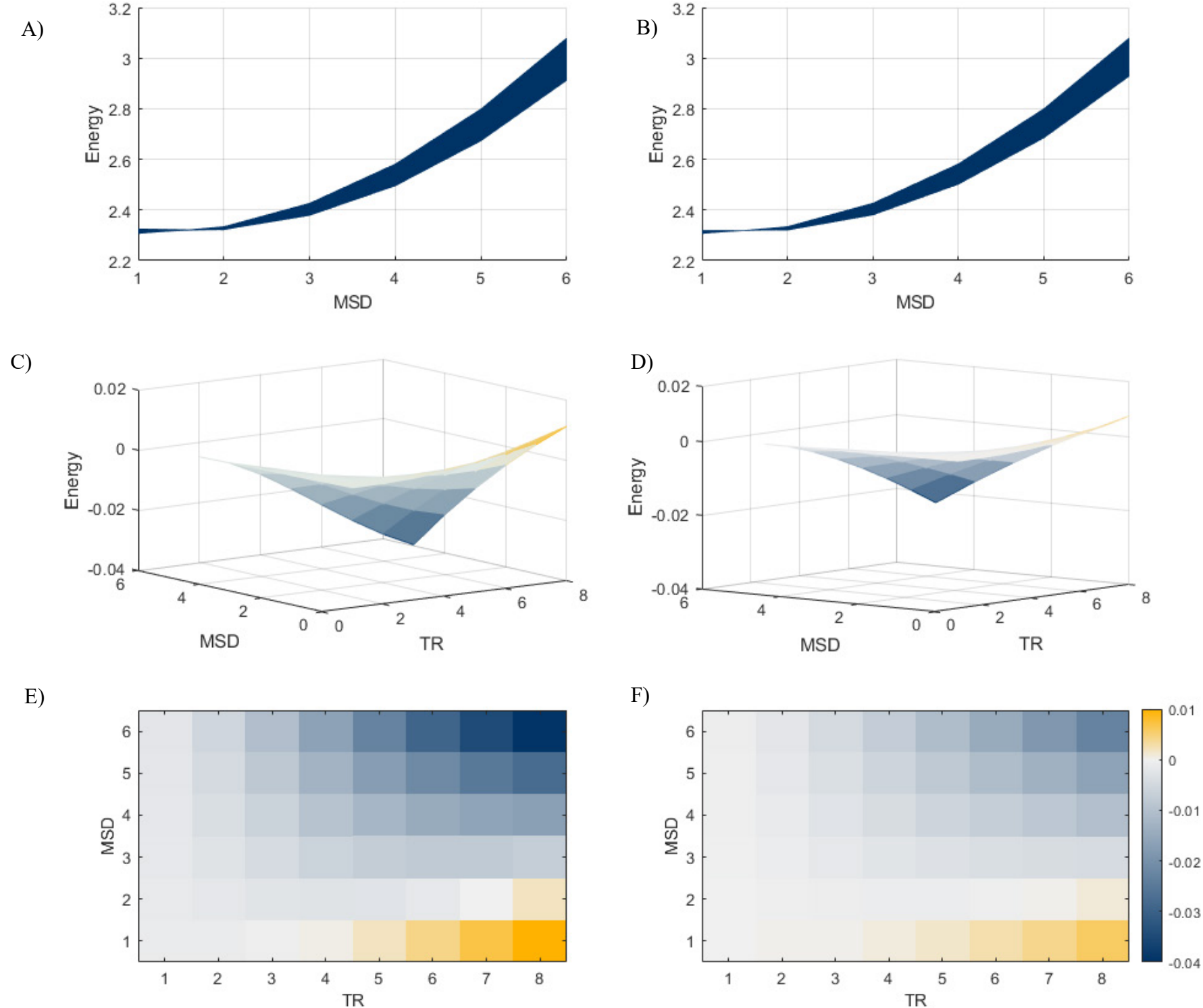


Figure S2 Related to Figure 2– No Observed Hemispheric Differences in Attractor Landscape

A) Plot of the average (both monkeys) attractor landscape (changes in fMRI signal activity being measured by MSD and MSD energy being the likelihood of transitioning) during inhibition of left nbM across all ROIs. B) Plot of the average (both monkeys) attractor landscape (changes in fMRI signal activity being measured by MSD and MSD energy being the likelihood of transitioning) during inhibition of right nbM across all ROIs. C) Average difference (both monkeys) in attractor landscape between the left nbM inhibition compared to no inhibition ($p < 0.05$, paired t-test), differences in MSD energy are represented on the colour bar. D) Average difference (both monkeys) in attractor landscape between the right nbM inhibition compared to no inhibition ($p < 0.05$, paired t-test), differences in MSD energy are represented on the colour bar. E) 2D plot of average difference (both monkeys) in attractor landscape between the left nbM inhibition compared to no inhibition ($p < 0.05$, paired t-test), differences in MSD energy are represented on the colour bar. F) 2D plot of average difference (both monkeys) in attractor landscape between the right nbM inhibition compared to no inhibition ($p < 0.05$, paired t-test), differences in MSD energy are represented on the colour bar. No significant differences between left and right nbM inhibition average attractor landscape.

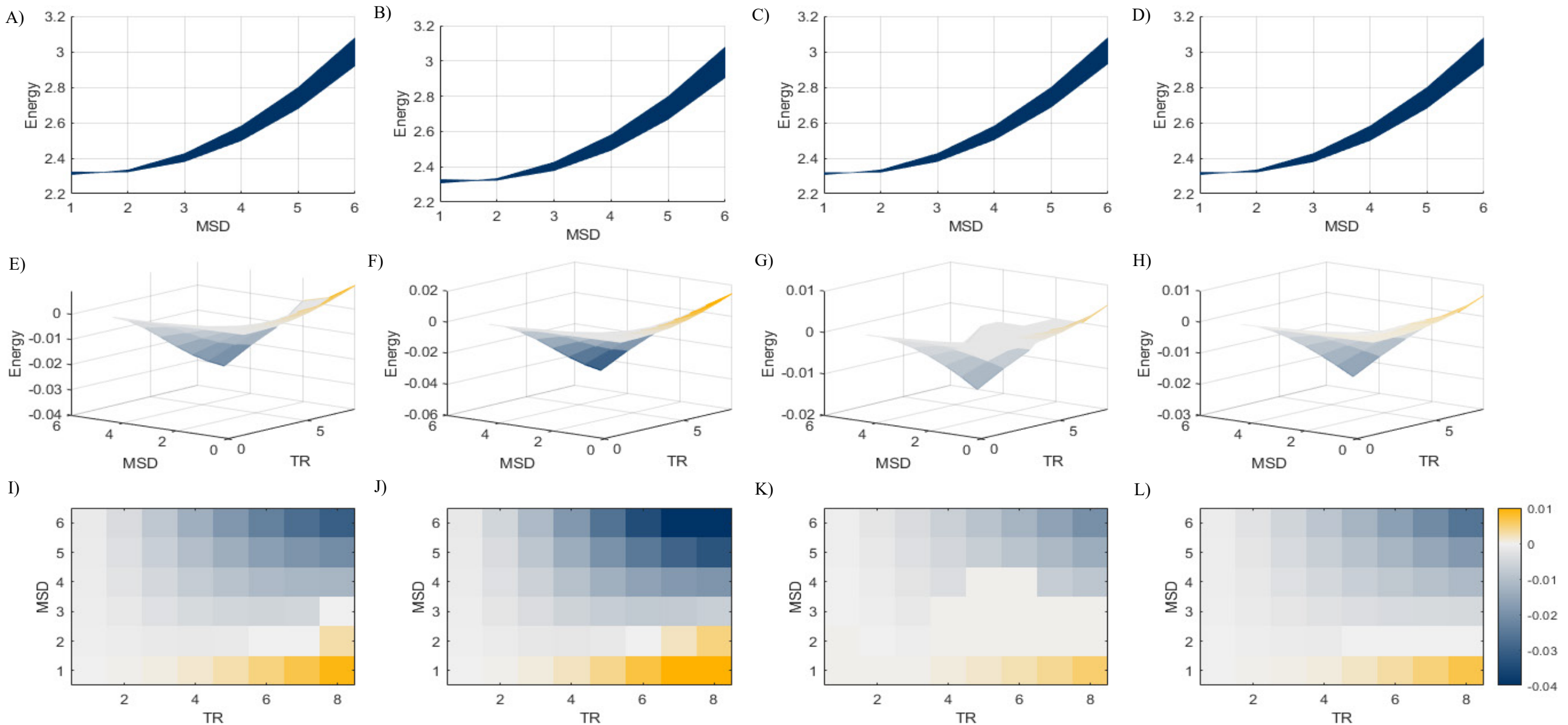


Figure S3 Related to Figure 2– Ipsilateral and Contralateral Hemispheric Differences in attractor landscape between nbM inhibition compared to sham control.

A) Average (both monkeys) attractor landscape during inhibition of left nbM across all ipsilateral ROIs. B) Average (both monkeys) attractor landscape during inhibition of left nbM across all contralateral ROIs. C) Average (both monkeys) attractor landscape during inhibition of right nbM across all ipsilateral ROIs. D) Average (both monkeys) attractor landscape during inhibition of right nbM across all contralateral ROIs. E) Average difference in attractor landscape between the left nbM inhibition compared to no inhibition for ipsilateral ROIs. F) Average difference in attractor landscape between the left nbM inhibition compared to no inhibition for contralateral ROIs. G) Average difference in attractor landscape between the right nbM inhibition compared to no inhibition for ipsilateral ROIs. H) Average difference in attractor landscape between the right nbM inhibition compared to no inhibition for contralateral ROIs. I) 2D plot of average difference in attractor landscape between the left nbM inhibition compared to no inhibition across ipsilateral ROIs. J) 2D plot of average difference in attractor landscape between the left nbM inhibition compared to no inhibition across contralateral ROIs. K) 2D plot of average difference in attractor landscape between the right nbM inhibition compared to no inhibition across ipsilateral ROIs. L) 2D plot of average difference (both monkeys) in attractor landscape between the right nbM inhibition compared to no inhibition across contralateral ROIs. All significance plotted as $p < 0.05$, paired t-test. Differences in MSD energy are represented on the colour bar.

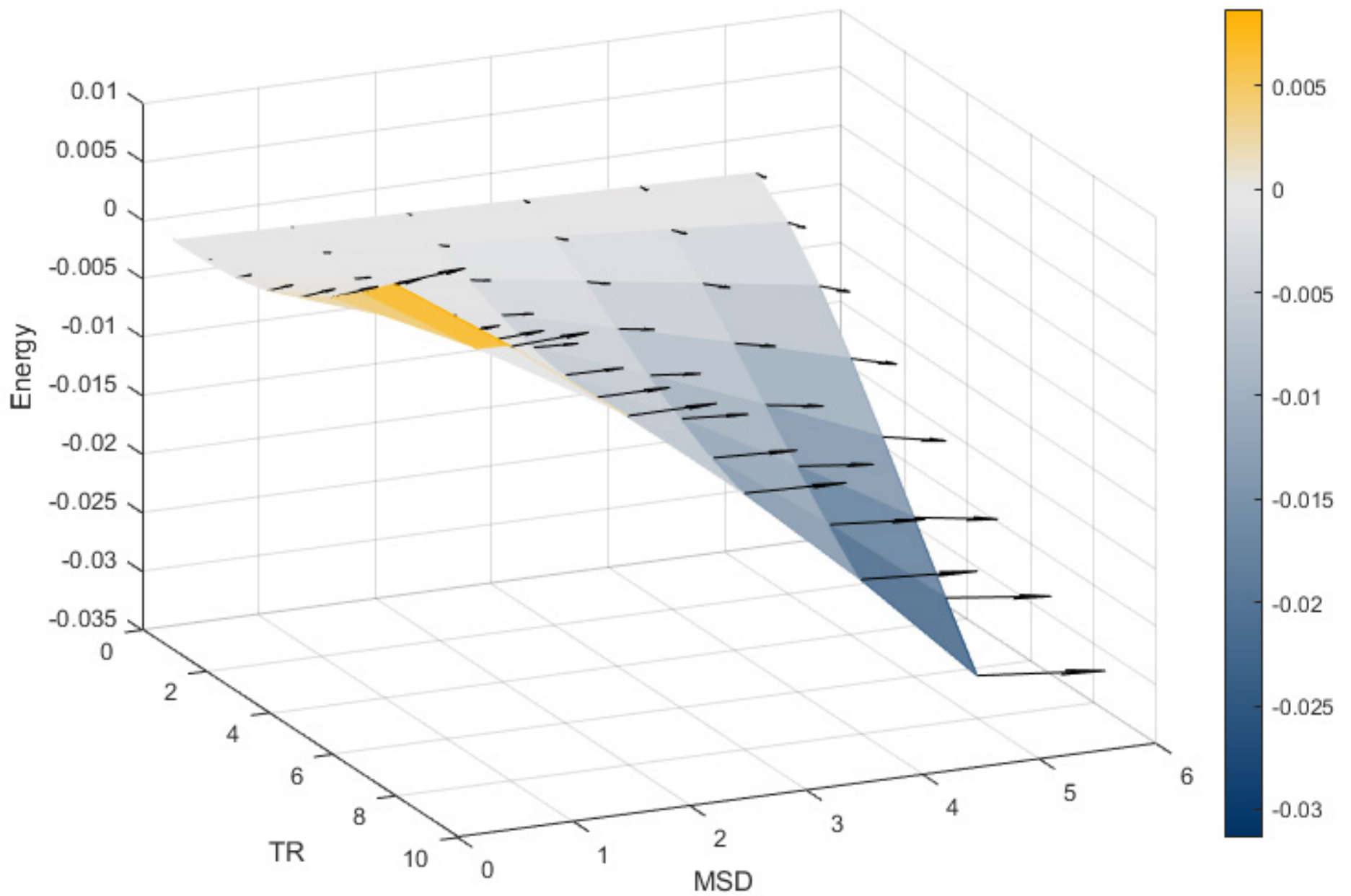


Figure S4 Related to Figure 2– Gradient trajectories of the difference in attractor landscape between nbM inhibition and sham control.

A) Plot of the average difference (of both monkeys) in attractor landscape (changes in fMRI signal activity being measured in relation to MSD value, and time represented by TRs) between the nbM being inhibited vs no inhibition; significantly ($p < 0.05$, paired t-test), with the vector gradient of the magnitude of the slope represented as arrows, showing the gradient trajectory of the landscape.

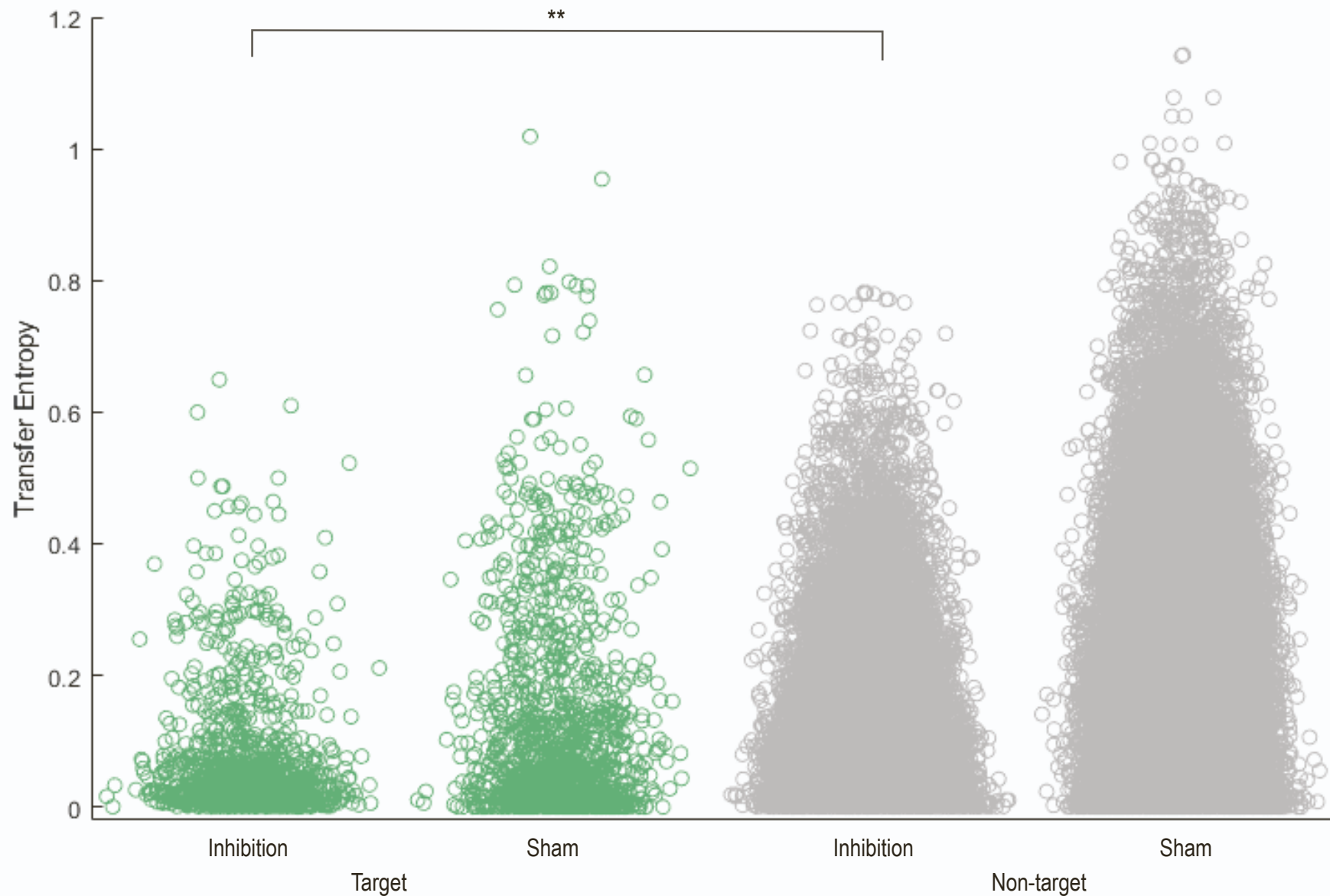
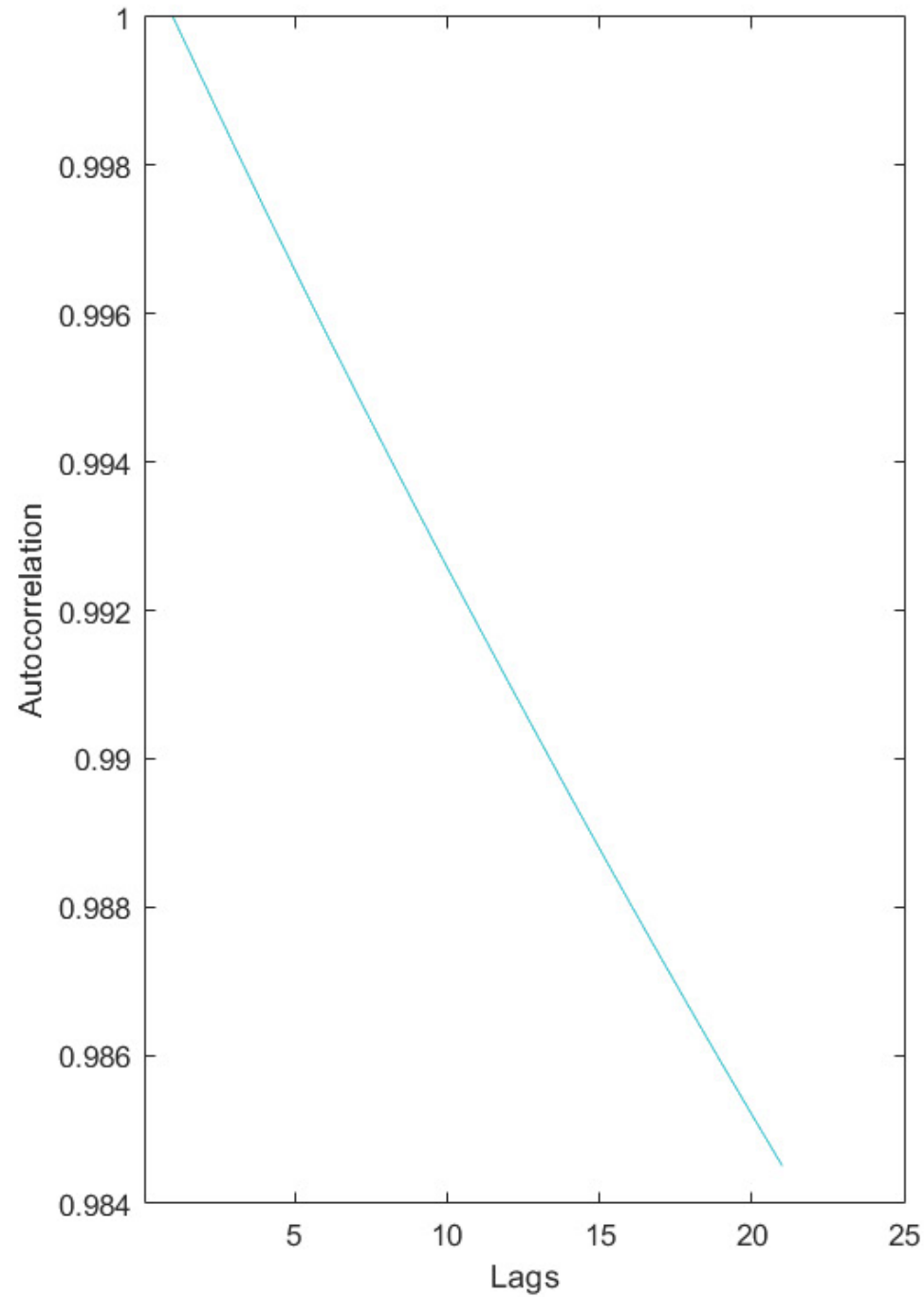


Figure S5 Related to Figure 3– Decreased transfer entropy overall in both directed projections and indirect projections during cholinergic inhibition compared to ‘sham’ control. Plot of directed projections of significant transfer entropy for each region-to-region after 1000 permutations, in green representing transfer entropy for region-to-region which received direct projections from nbM subnuclei (pulled for both monkeys) and grey representing the transfer entropy for region-to-region with ‘sham’ control. Significant difference between inhibited direct projection regions and non-direct projection regions during cholinergic inhibition.

A)



B)

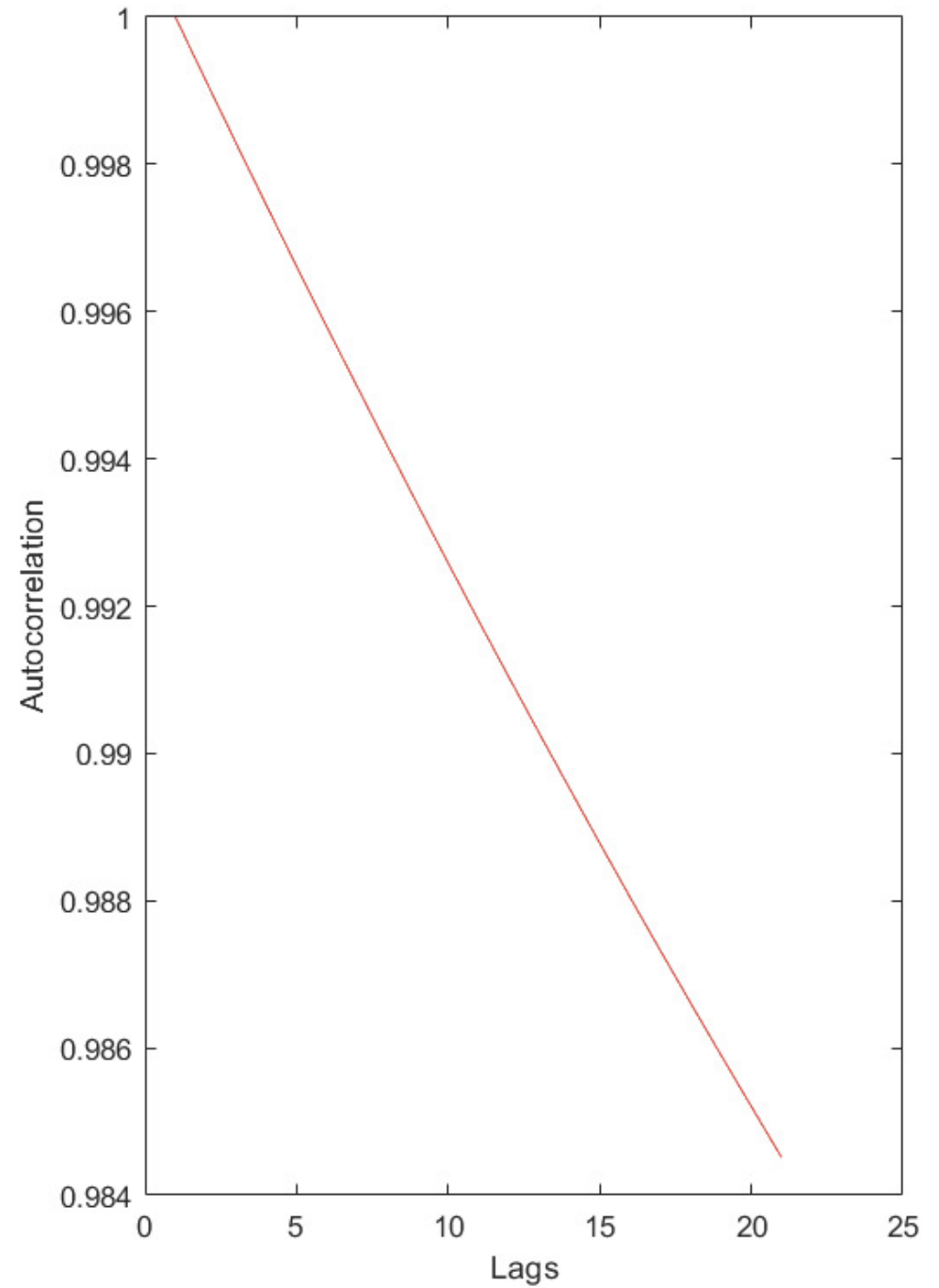


Figure S6 Related to Figure 4– Zero-lagged correlation in time-series from E1 and E2 neural masses preserved.

A) Plot of autocorrelation of the down-sampled time-series of the E1 population during reduced adaptation ($d=0.05$). B) Plot of autocorrelation of down-sampled time-series of the E2 population during reduced adaptation ($d=0.05$).

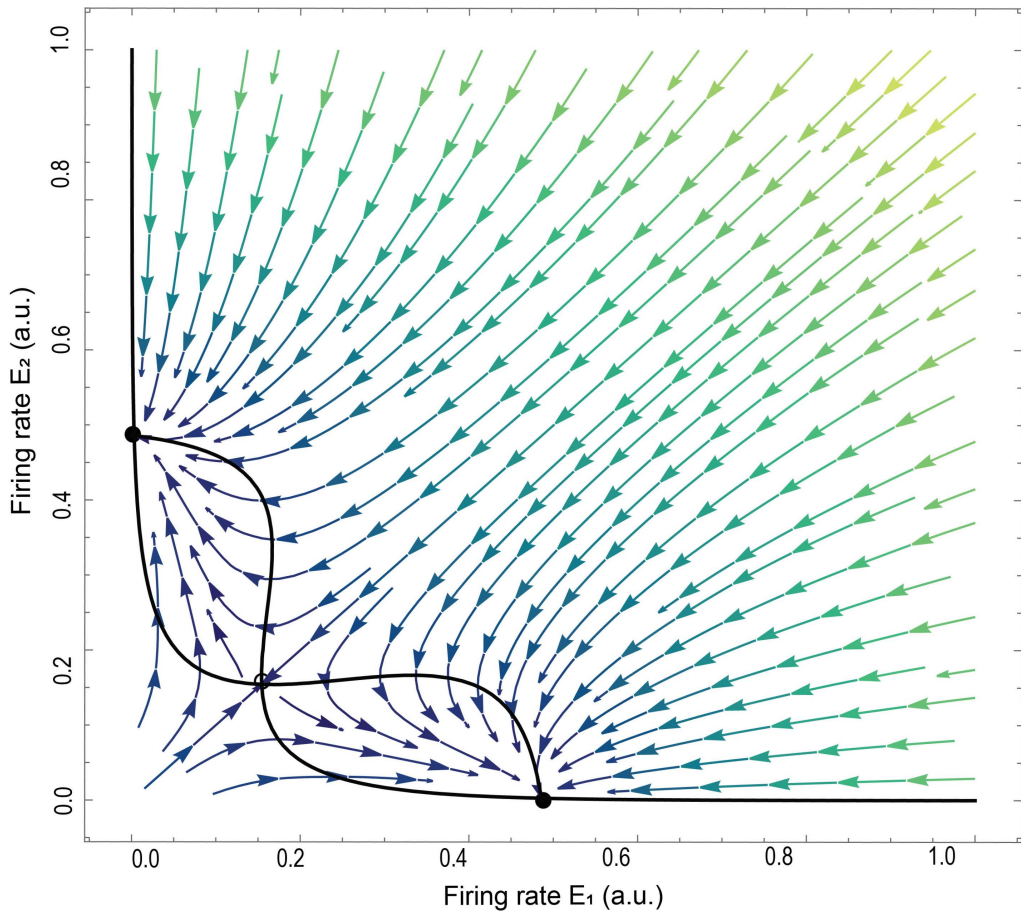


Figure S7 Related to Figure 4– Vector field plot of the neural mass population dynamics.

A plot of the vector field with the nullclines of the two neural mass populations with dynamics that consisted of noisy excursions around the two stable fixed points (E_1^* , E_2^*) of the system that are separated by a saddle