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Towards a time-scale specific subspace for brain inter-area communication

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Brain-wide neural function involves the communication between neural networks from distinct anatomical areas and different evolutionary antiquity, as in the mammal cortico-thalamo-cortical loop formed by S1, M2, and TH [1, 2]. Despite its evident importance, the mechanisms by which the information is relayed in this "inter-area" communication remain hazy. Additionally, it is still unknown how the operation at criticality, a property of neural networks that contributes to their computational capabilities [3-5], integrates into the inter-area picture. Dynamics at criticality can be understood through disordered random networks and entail a wide distribution of correlations and eigenmodes—representing neurons acting in unison—with diverse time scales [6-9]. The orchestrated action of different areas must derive from the evolutionary optimization of networks at criticality in a way that conserves local operation and also allows for efficient inter-area communication. In this work, we explore if the projection neurons between areas belong to a linear subspace of communication composed of modes coupling in a manner that respects the time-scale hierarchy of the local networks. We couple two recurrent networks of linear rate neurons with input noise via the eigenmodes of the connectivity matrices of each network. Preliminary results sending a signal between two real coupled modes show that the transfer function acts as a double low-pass filter with cutoff frequencies depending on the eigenvalues of the modes. Future work will include the connection of an arbitrary number of complex modes and experimental validation of the inter-area connections for the S1-M2-TH loop in mice.

Acknowledgements

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Models and applications

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