

Inferring dynamical features from neural data through joint learning of latents factors and weights

Anirudh Jamkhandi^{1,2}, Ali Korojy^{1,2}, Olivier Codol^{1,2}, Guillaume Lajoie^{*1,2}, Matthew G. Perich^{*1,2}



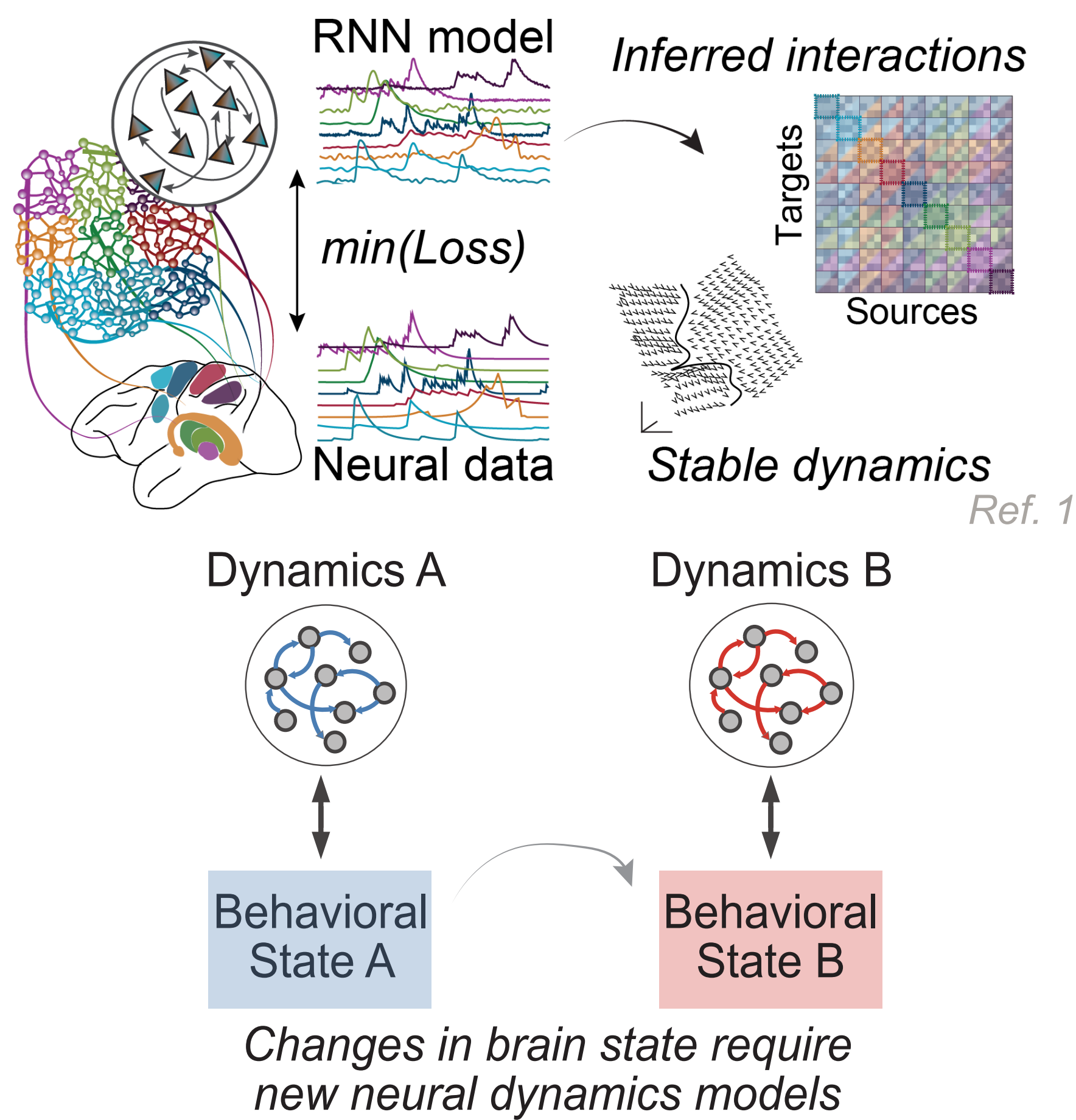
¹University of Montreal, ²Mila
* co-senior authors



TL,DR;

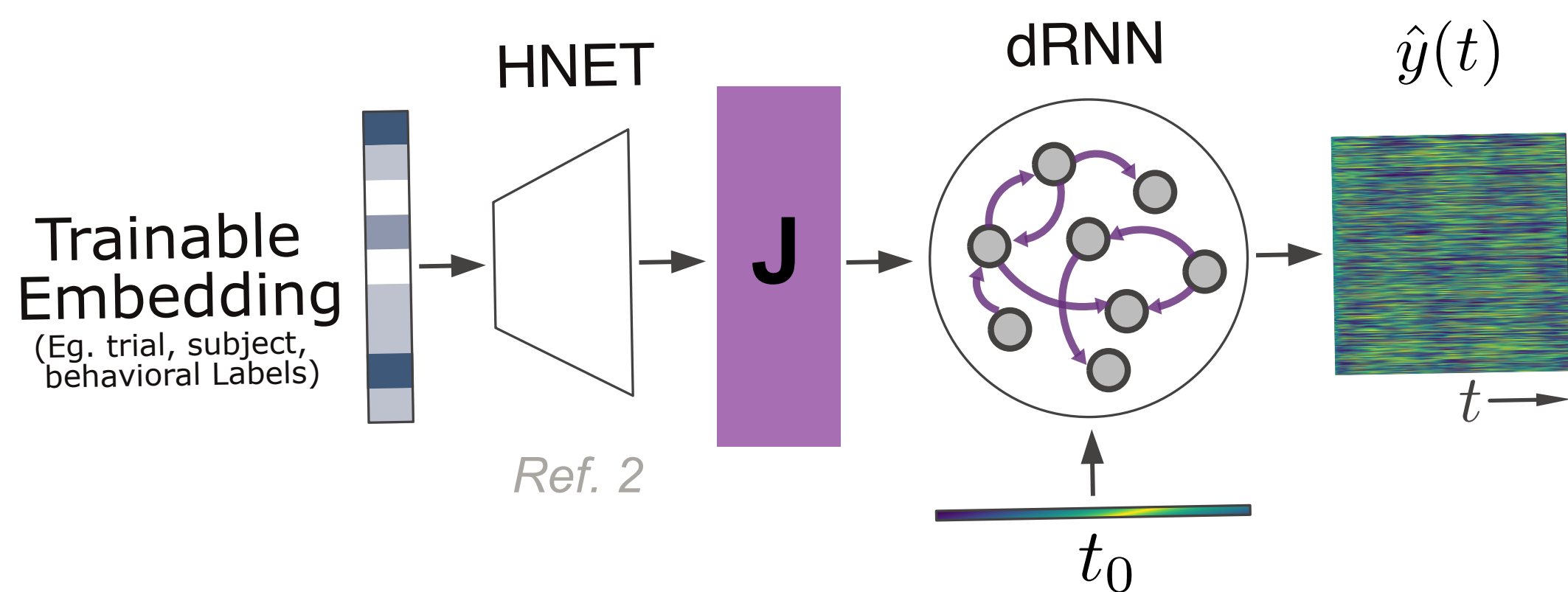
- 1) We propose a hierarchical model that integrates neural population data across tasks, capturing both individual dynamics and shared structure.
- 2) The learned task embeddings enable robust, accurate classification of dynamical regimes, with generalization to unseen neural population activity.
- 3) Spectral analysis of learned weights reveals task-specific dynamical features, specifically showing that motor control operates near the edge of chaos for maximal expressivity.

dRNNs as in-silico models



APPROACH

Embeddings and weights are jointly learned via Hypernetworks



HNET parameterizes downstream rate-based autonomous RNN which follows dynamics :

$$\tau \frac{dr_i}{dt} = -r_i + \sum_{j=1}^N J_{ij} \phi(r_j) + \xi_i$$

To reduce the solution degeneracy, we constrain the output of HNET to low rank :

$$J = \begin{bmatrix} \dots \\ \dots \\ \dots \end{bmatrix} = \begin{bmatrix} \dots \\ \dots \\ \dots \end{bmatrix} \mathbf{n}^{(1)} + \dots + \begin{bmatrix} \dots \\ \dots \\ \dots \end{bmatrix} \mathbf{n}^{(R)}$$

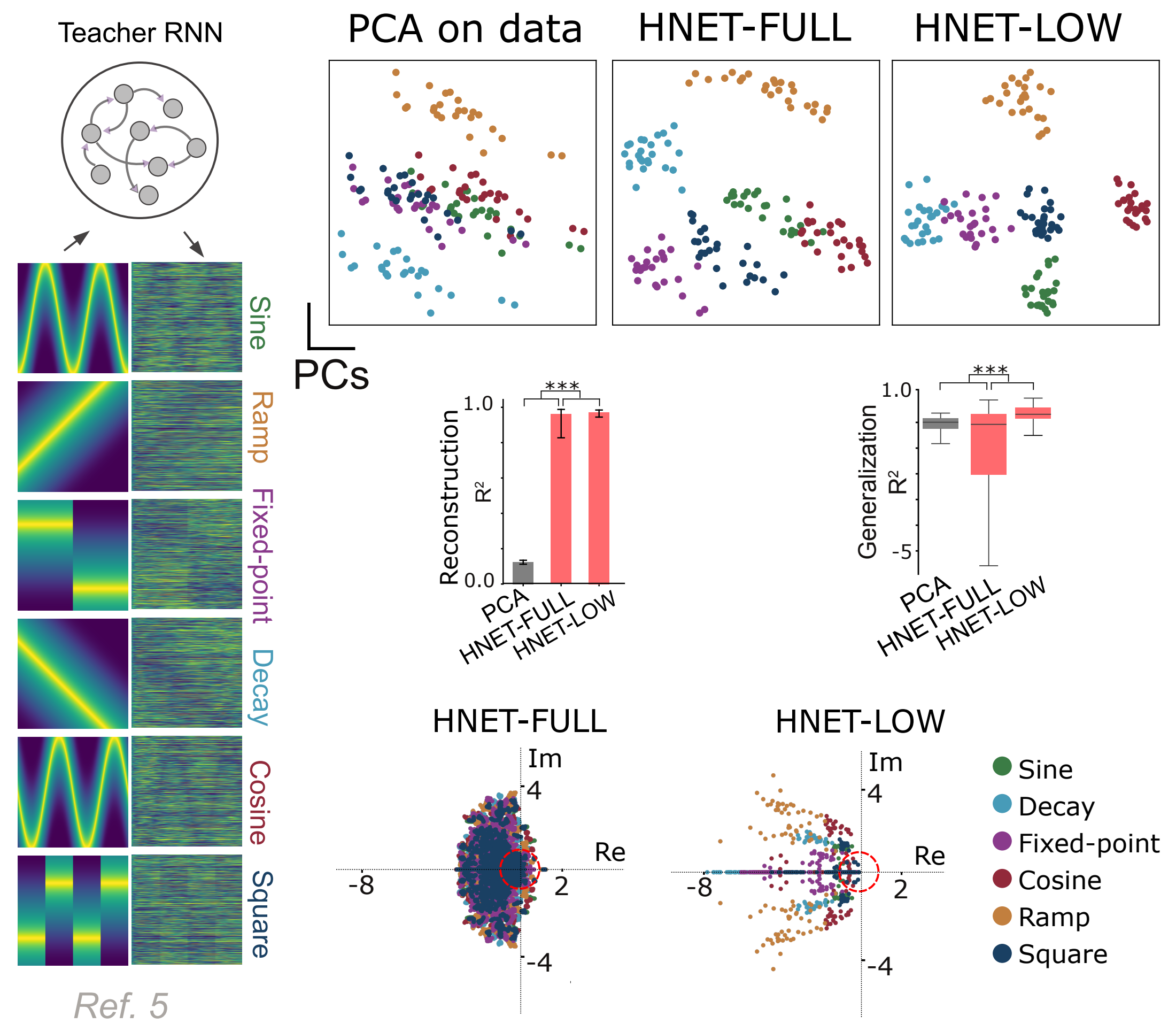
Ref. 3 & 4

REFERENCES

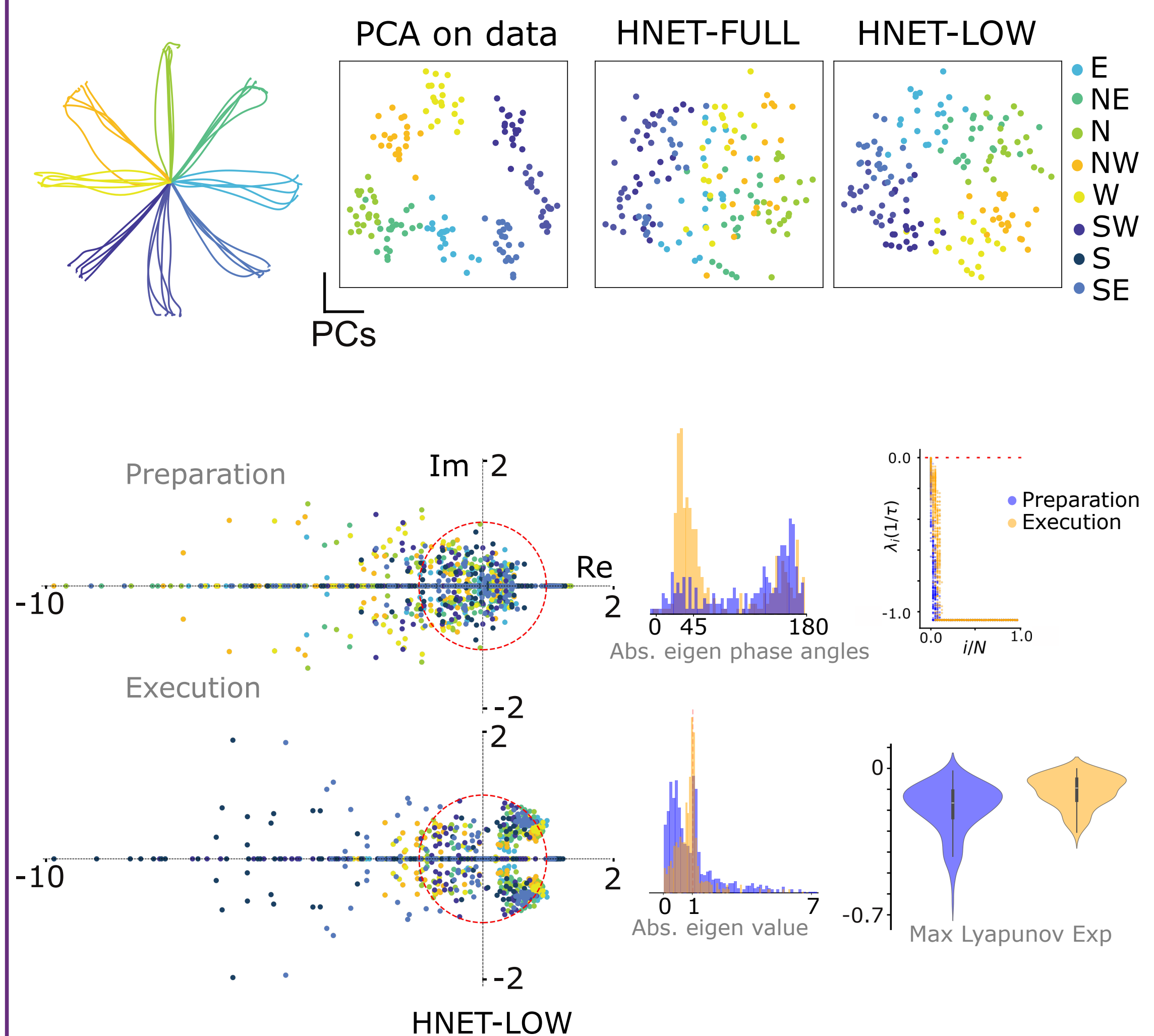
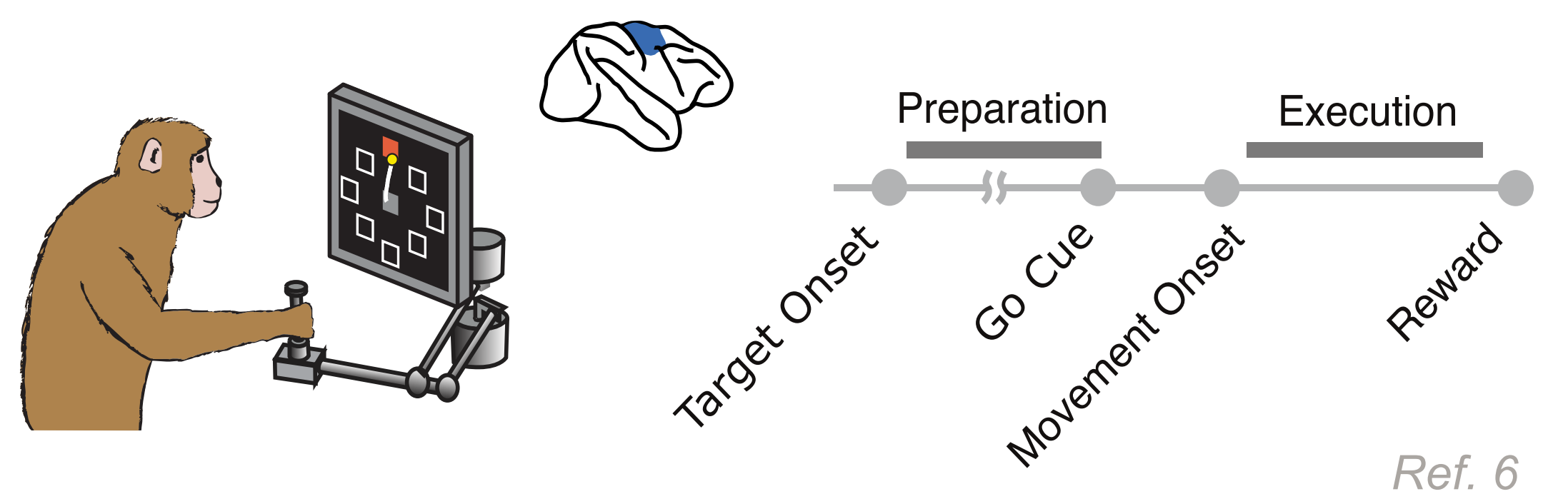
- [1] Perich, et al. '20; [2] Ha et al. '16; [3] Huang et al. '24;
[4] Mastrogiuseppe et al. '18; [5] Saad & Solla et al. '95; [6] Perich et al. '18;

RESULTS

Student-Teacher Setup



Motor Cortex Recordings



ACKNOWLEDGEMENTS

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