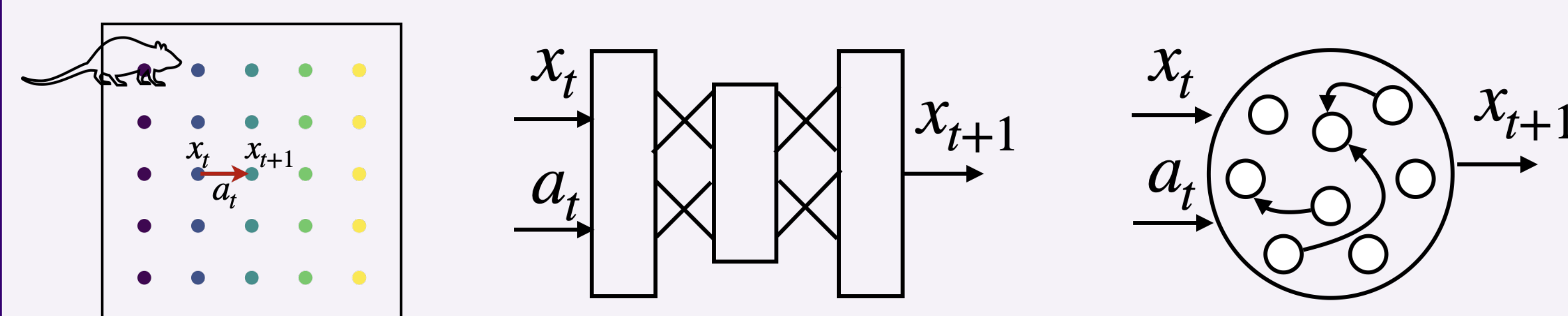


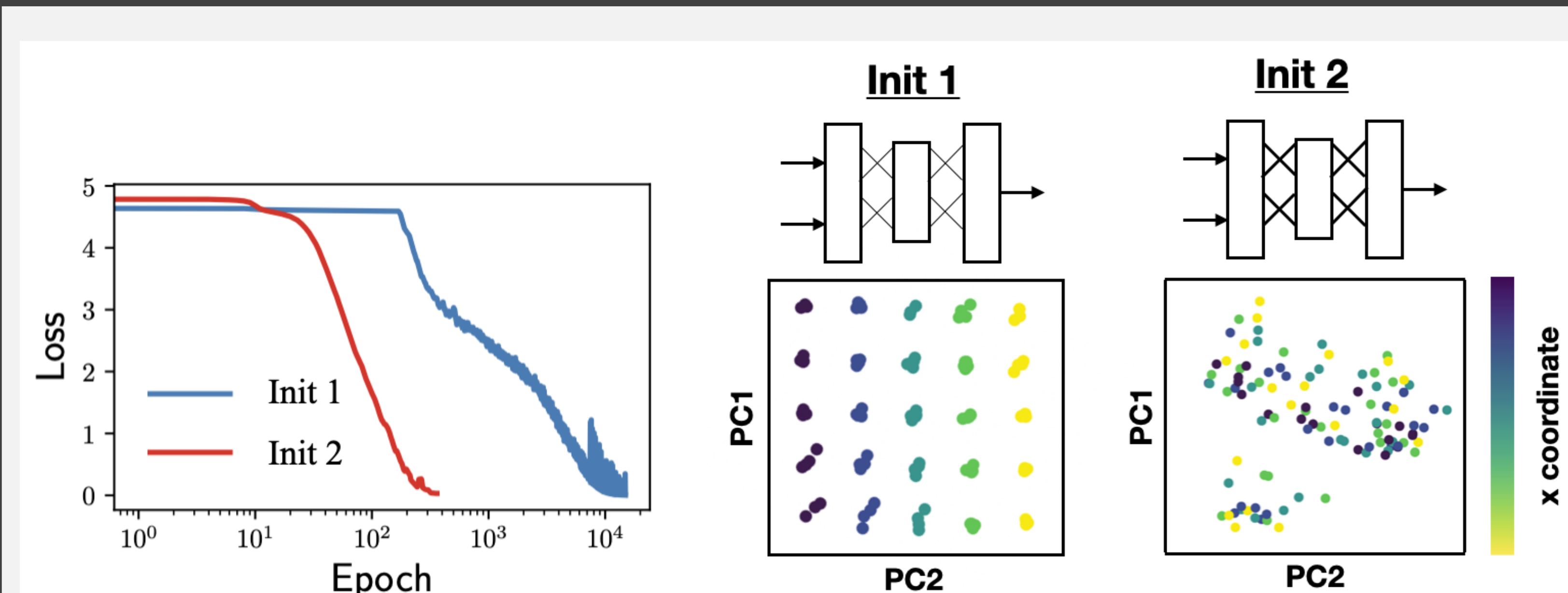
Introduction

- **Predicting future states** is fundamental to the formation of cognitive maps. Artificial neural networks (ANNs) trained with predictive objectives can develop spatially organized internal representations [1][2][3].
- The internal representations learned by ANNs can vary widely—even for the same predictive task—depending on **architecture**, **weight initialization**[4], learning rate, and optimization algorithm.
- This variability underscores the importance of identifying which condition best supports the emergence of cognitive map.

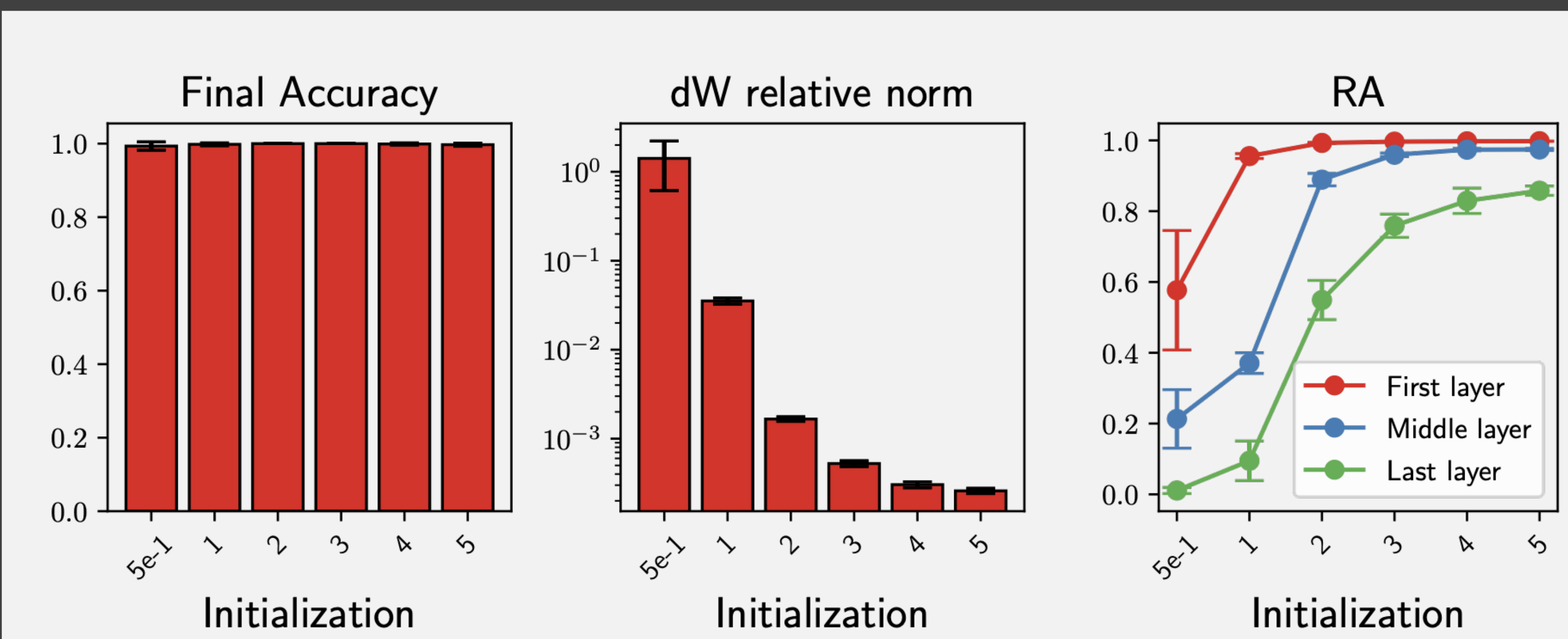
Task: random exploration in square arena



Not all predictive networks form cognitive maps



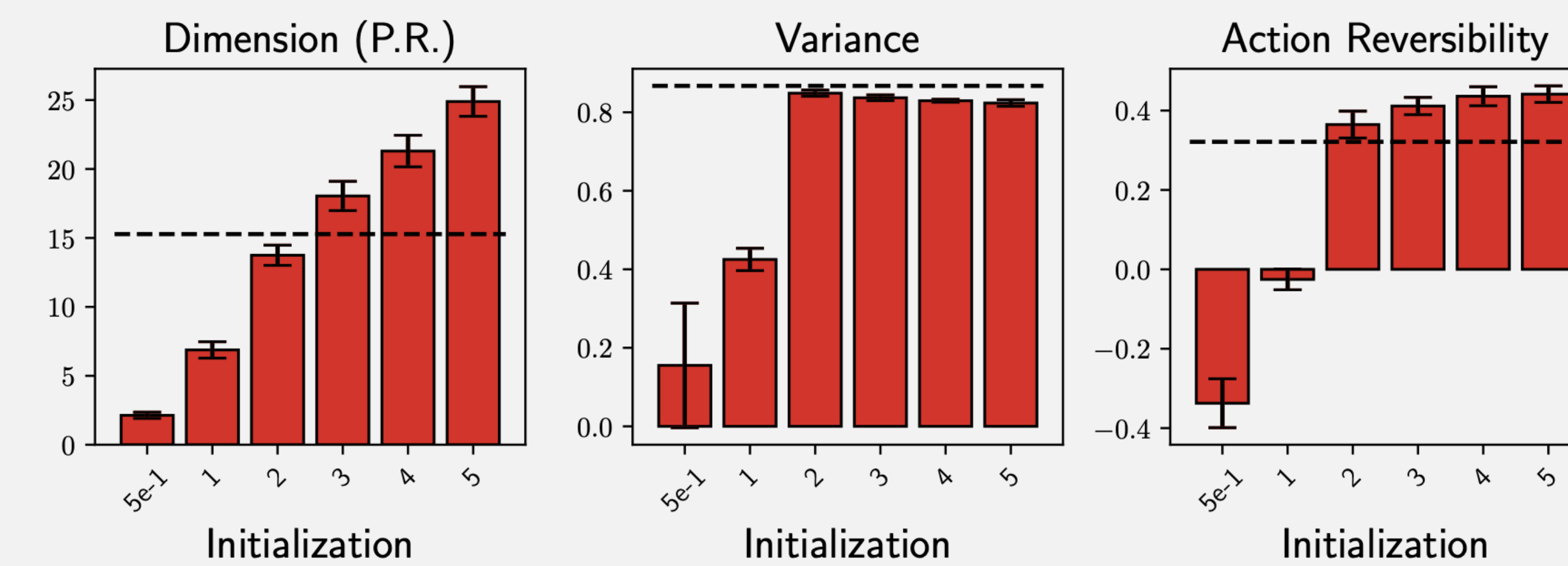
Smaller initialization leads to richer training



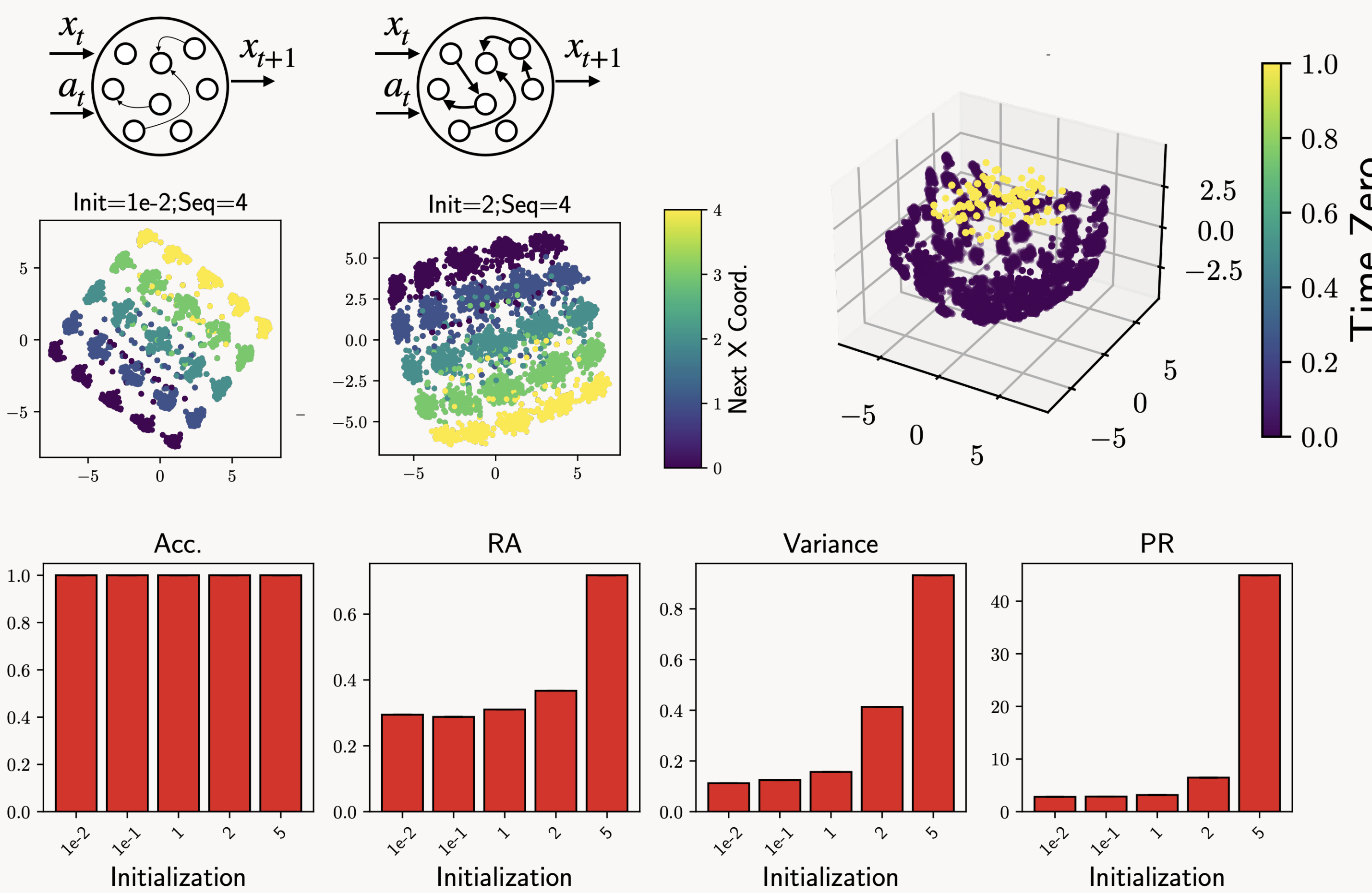
Highlight

We found that cognitive map-like representations in predictive networks depend not just on task performance but on the learning trajectory, shaped by initialization and temporal contexts.

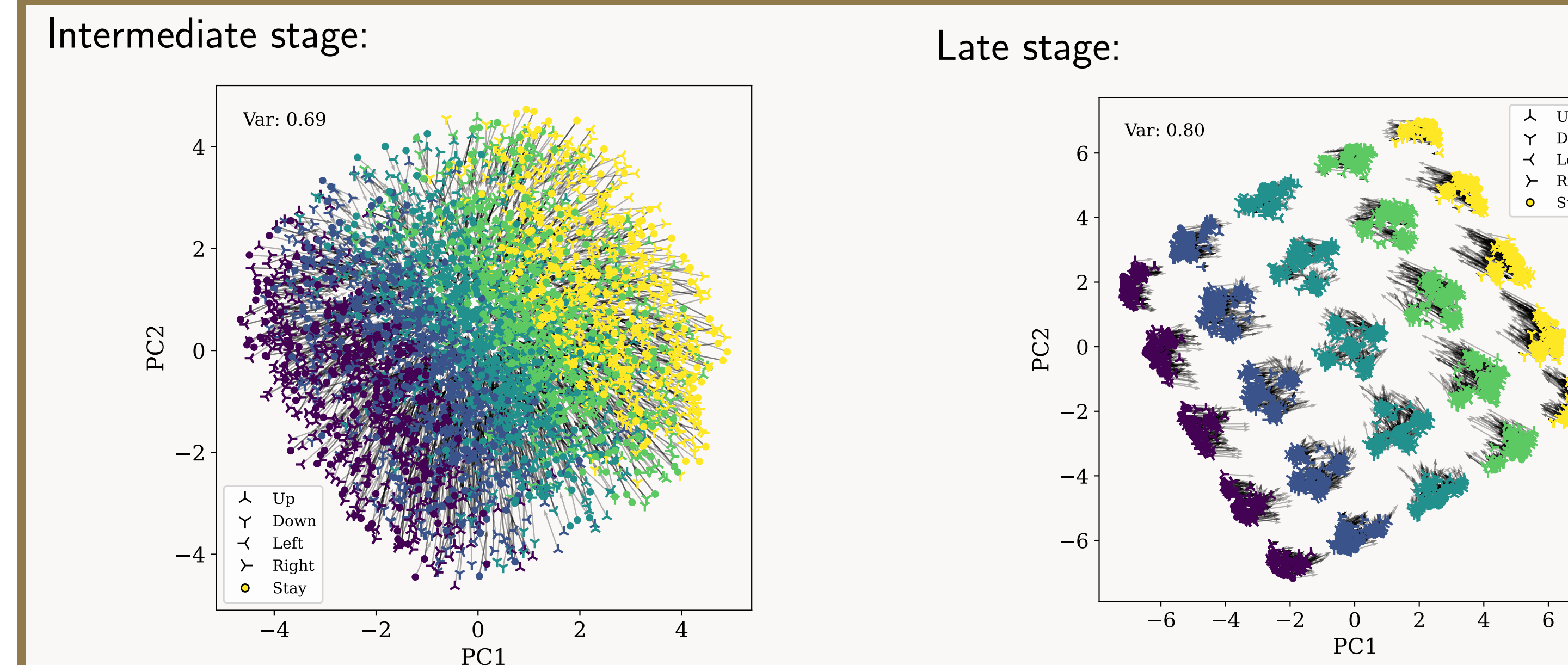
Richer training leads to compressed, structured cognitive maps



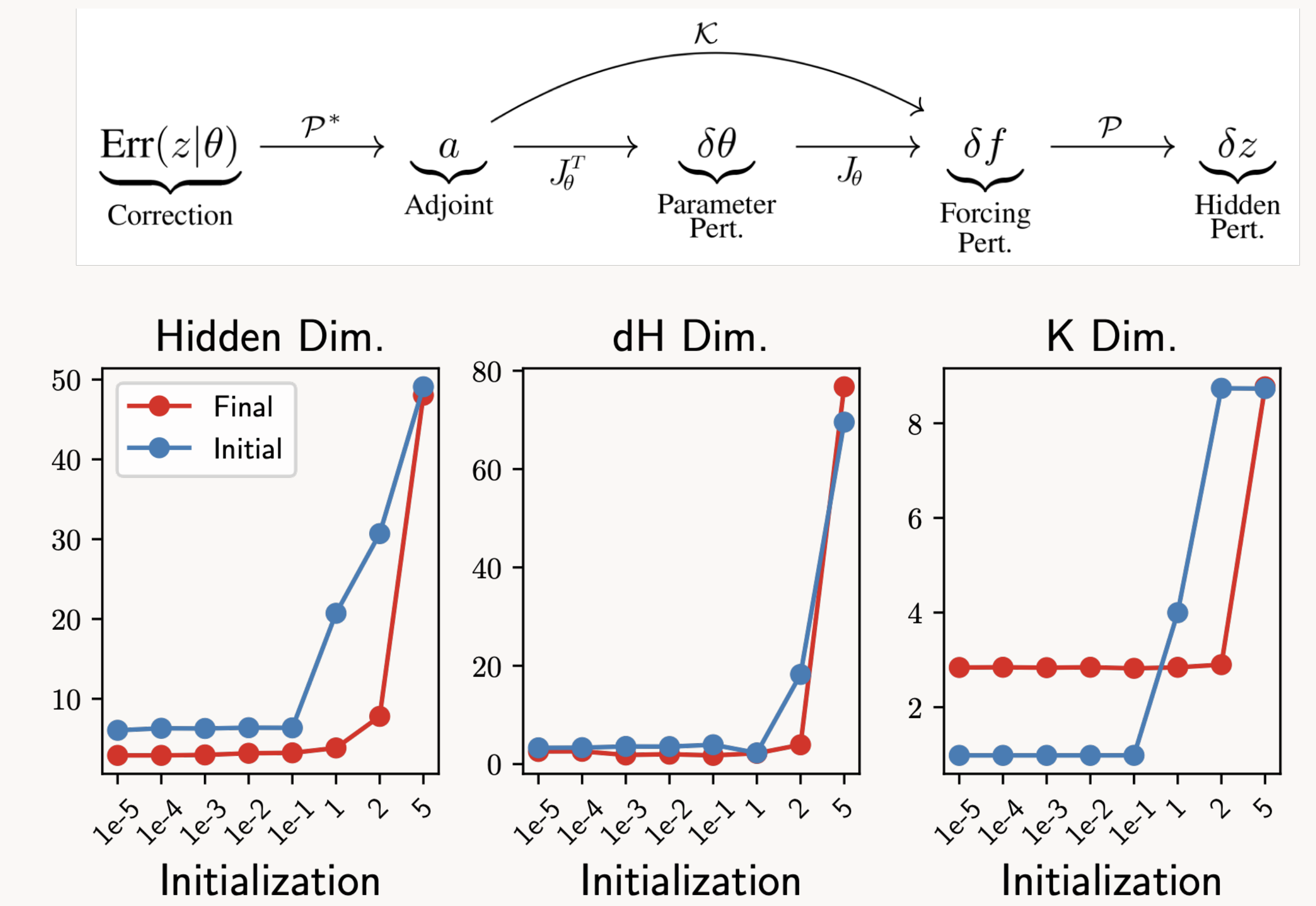
Smaller initialization lead to rich training in RNN



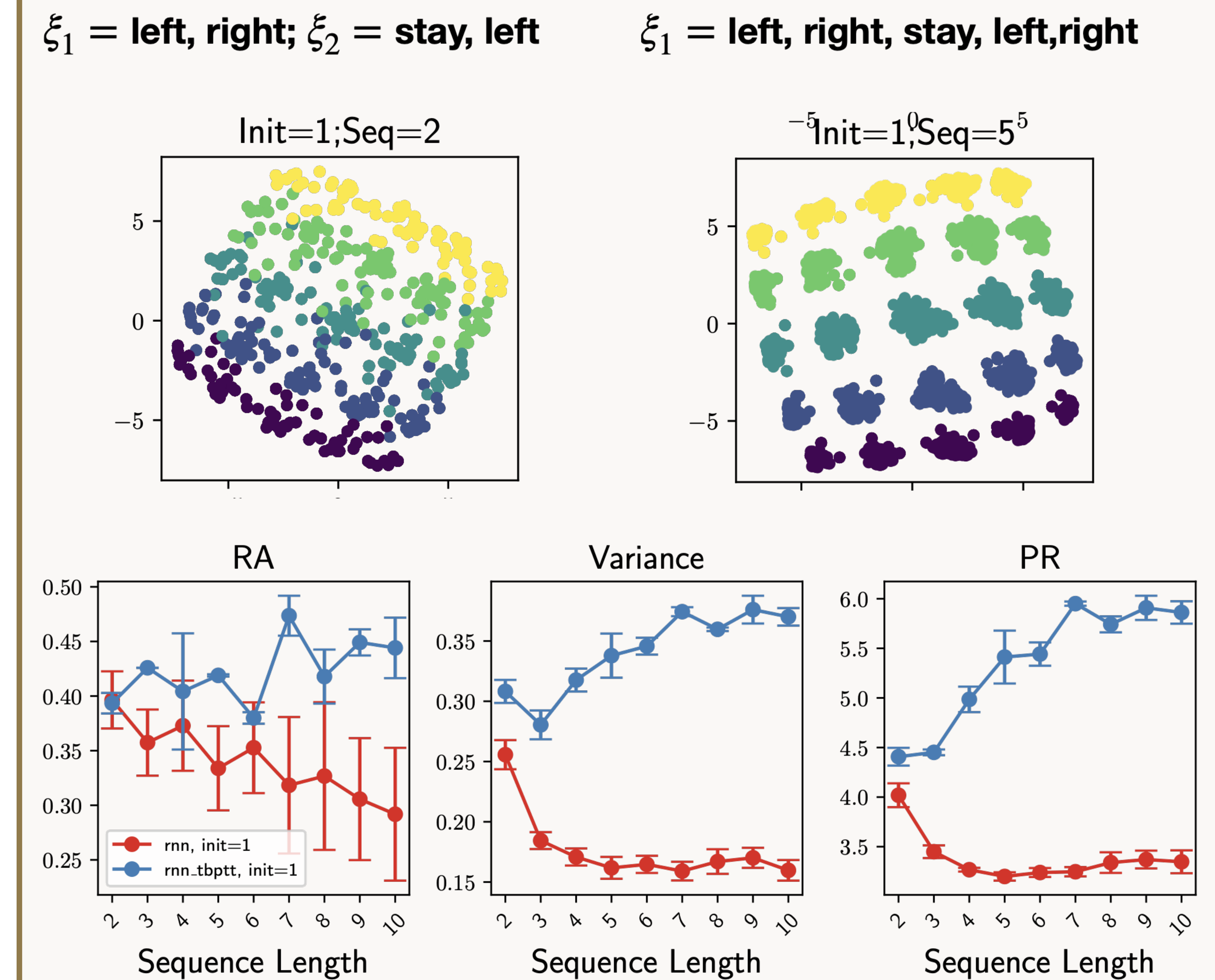
Visualization of gradient flow



Smaller initialization led to low-D representation update



Longer sequence leads to richer training



References

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