

Maintaining stable perception during active exploration

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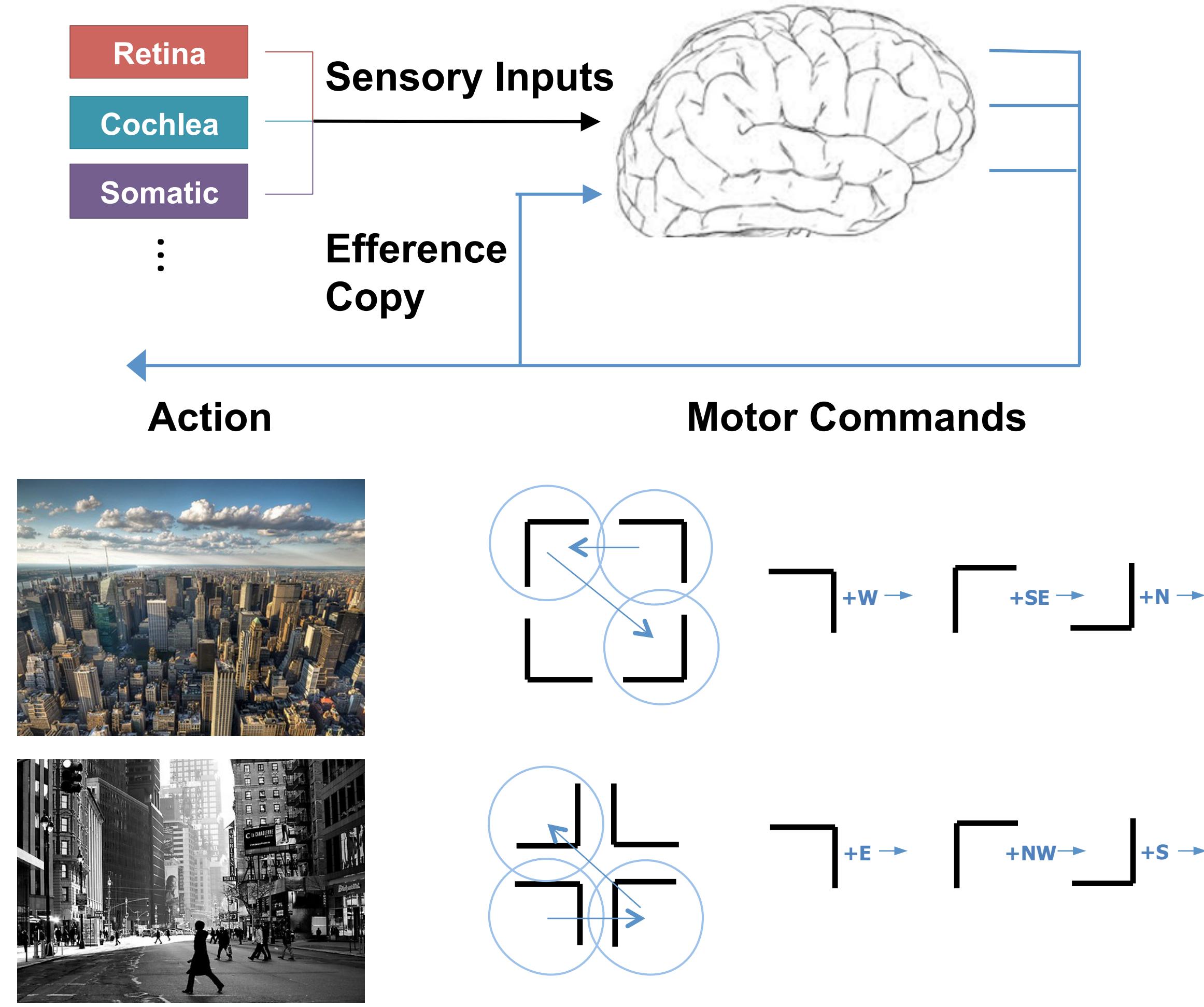


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Overview

1. Cortex builds a sensorimotor model

- Most sensory changes are rapid and due to our own behavior ...but our perception of the world is amazingly stable
- We know the cortex receives a copy of motor commands

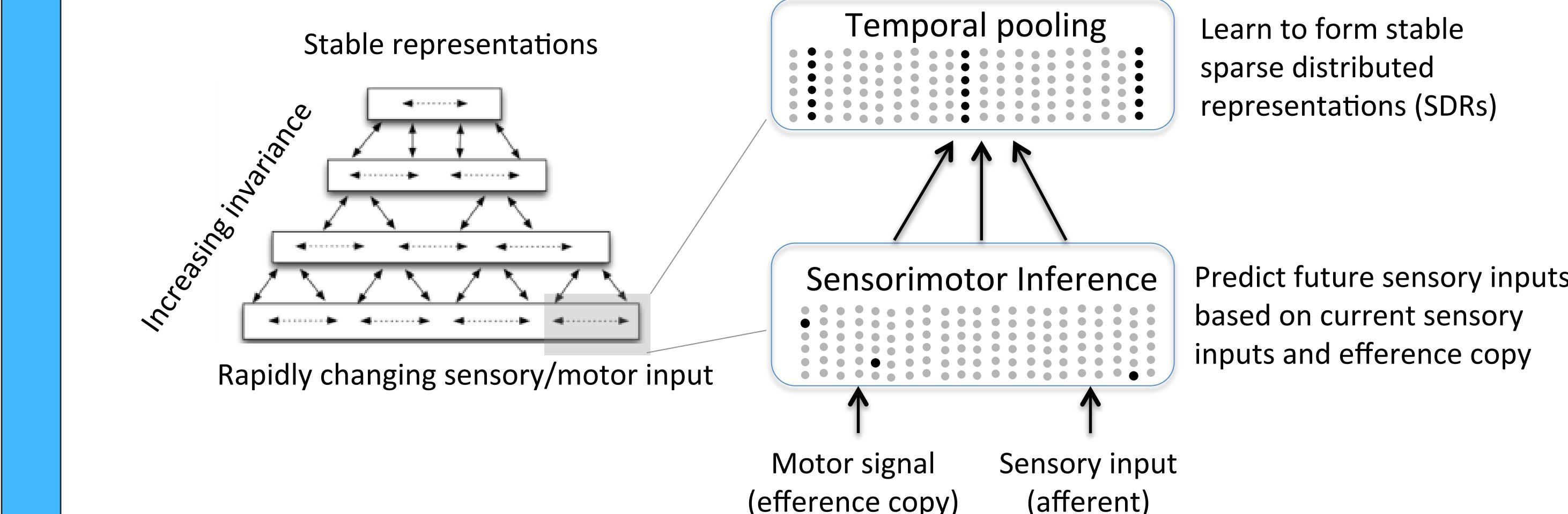


2. How do we learn a sensorimotor model?

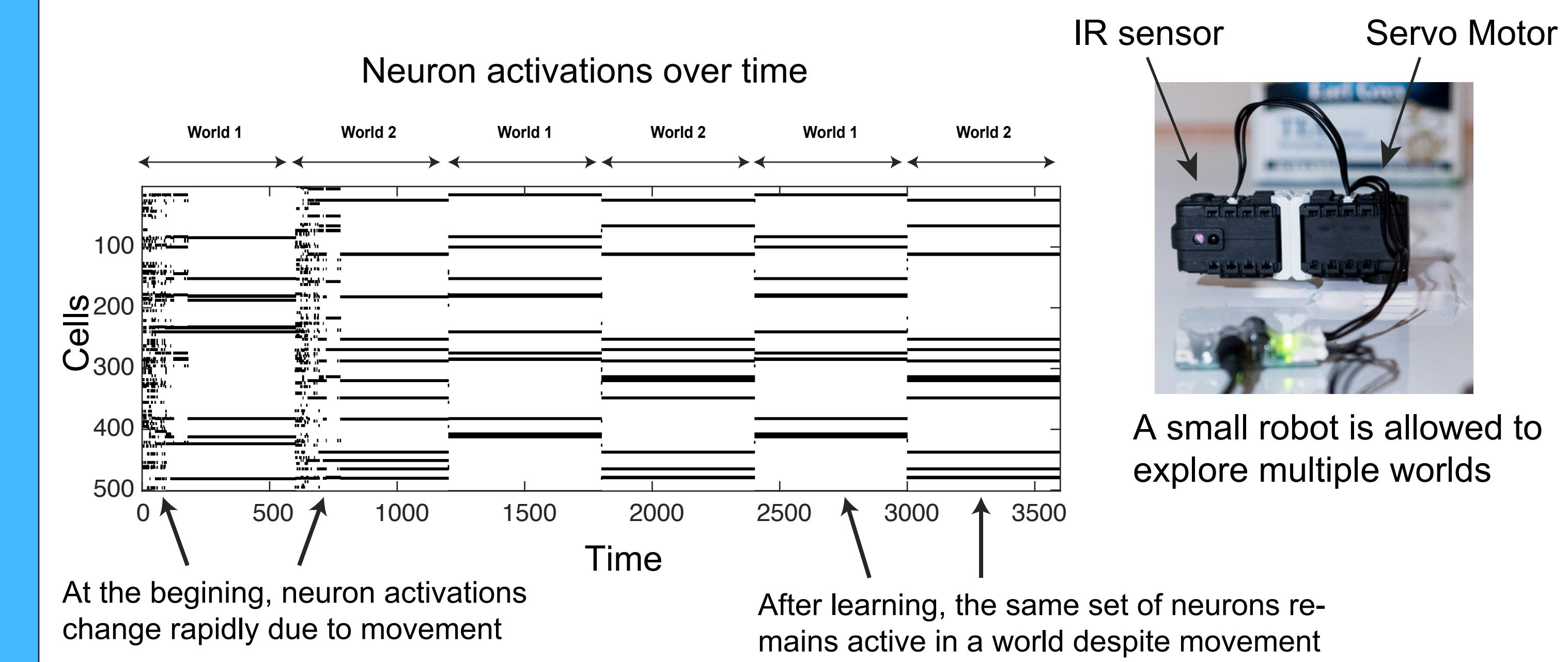
Basic Approach

- Predictable transitions lead to invariant representations
- Learn predictive model of sensorimotor changes
 - Learn stable representations of predicted changes

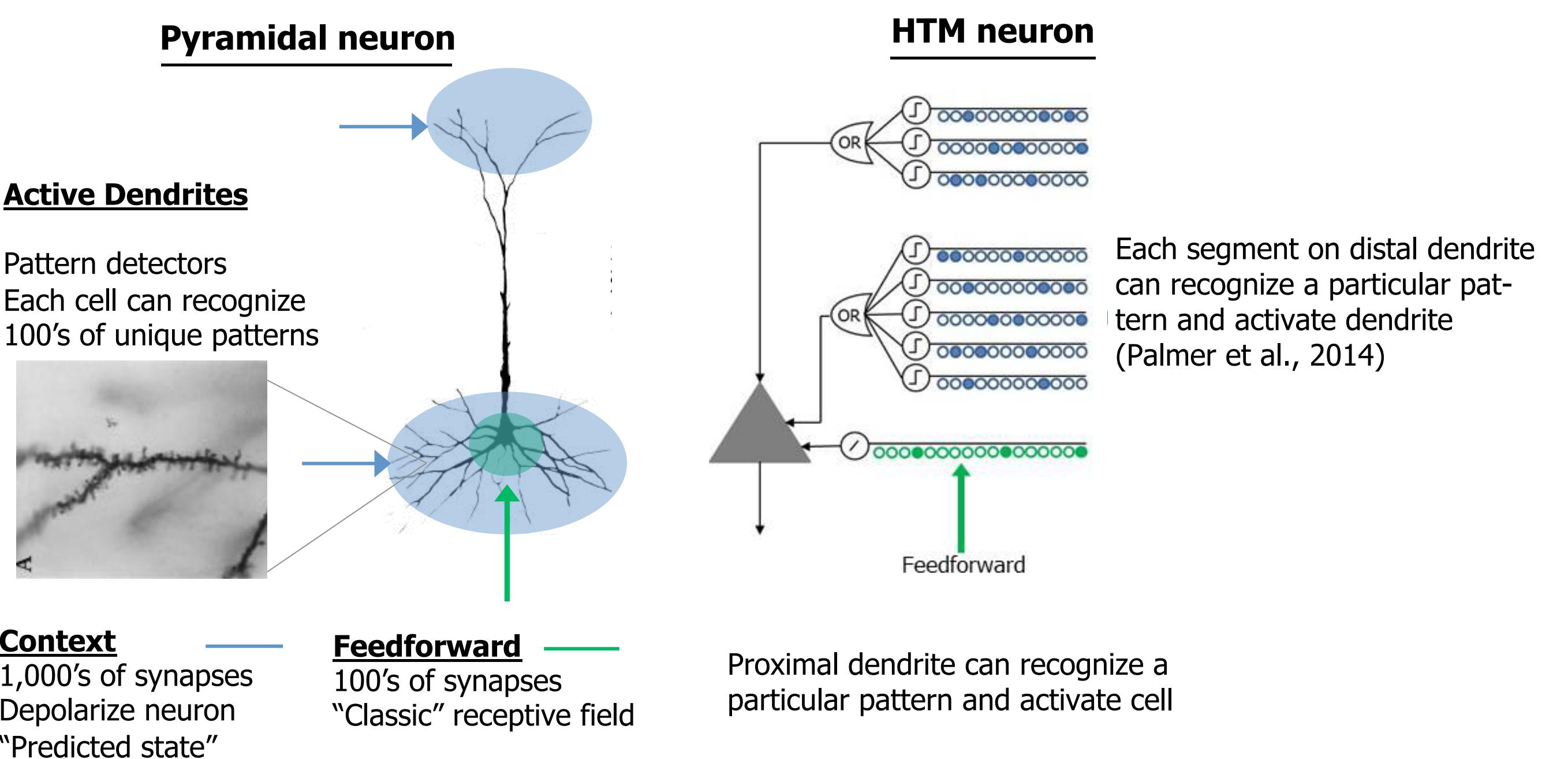
Hierarchical Temporal Memory (HTM)



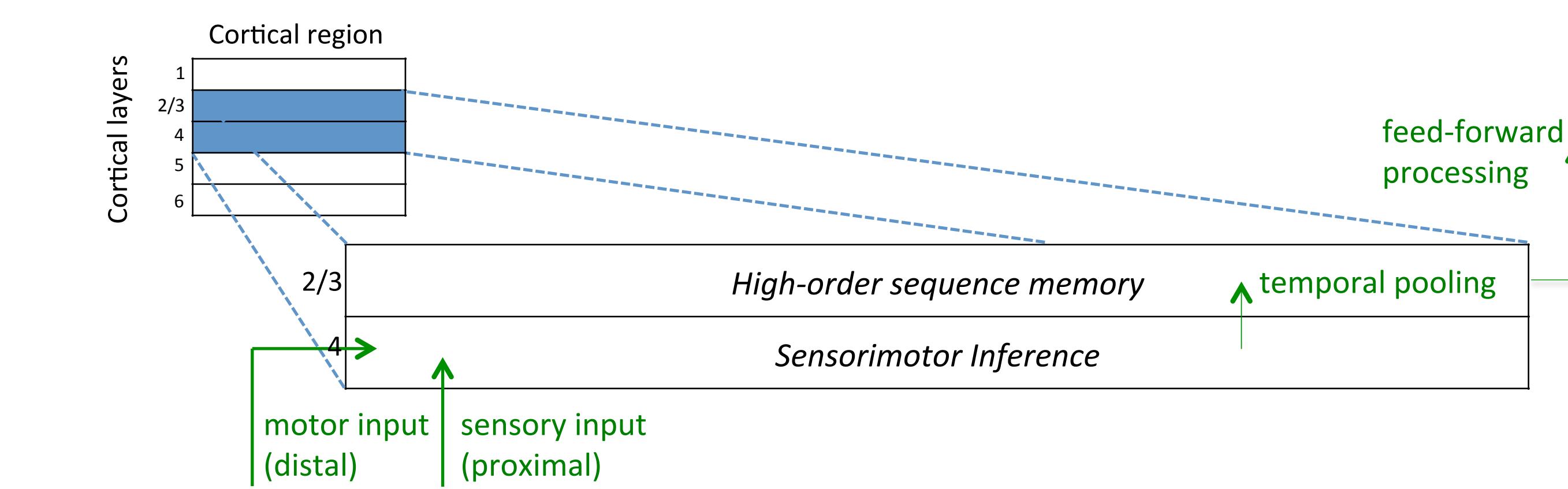
3. Experimental results



Neural implementation



Cortical circuits underlying sensorimotor inference

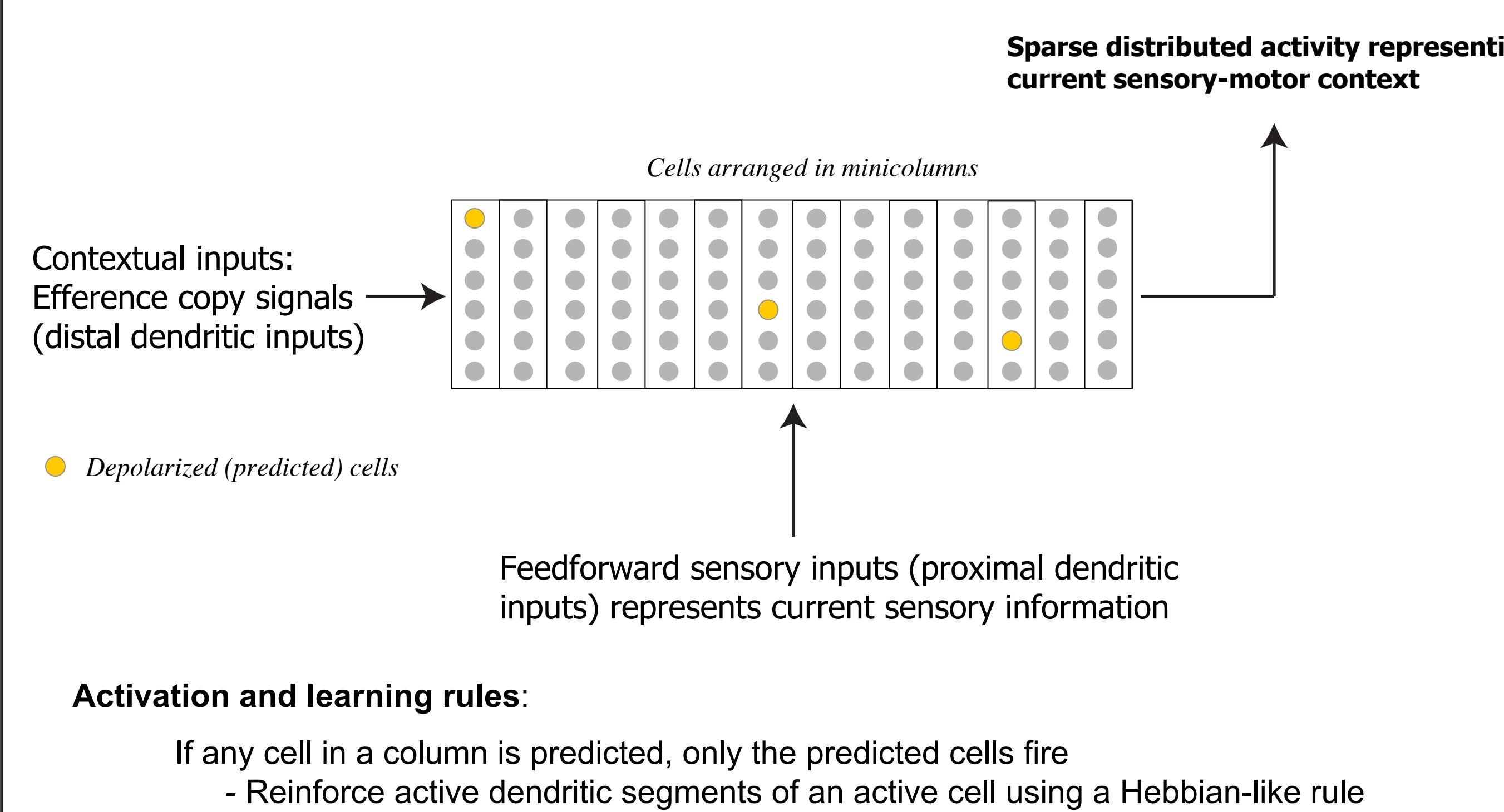


4. Summary

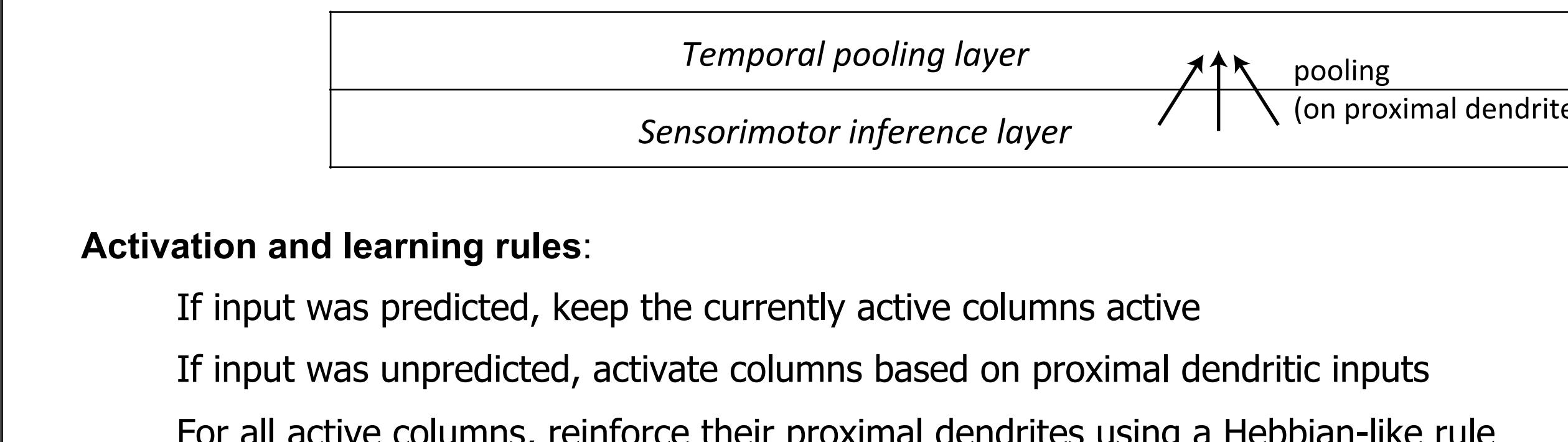
- We asked the question: how can the cortex build a sensorimotor model of the world?
- We proposed a biologically detailed model of sensorimotor inference.
- We built and tested the model on a robotic testbed as well as artificial scenarios.

Algorithm details

Sensorimotor inference layer predicts future sensory inputs



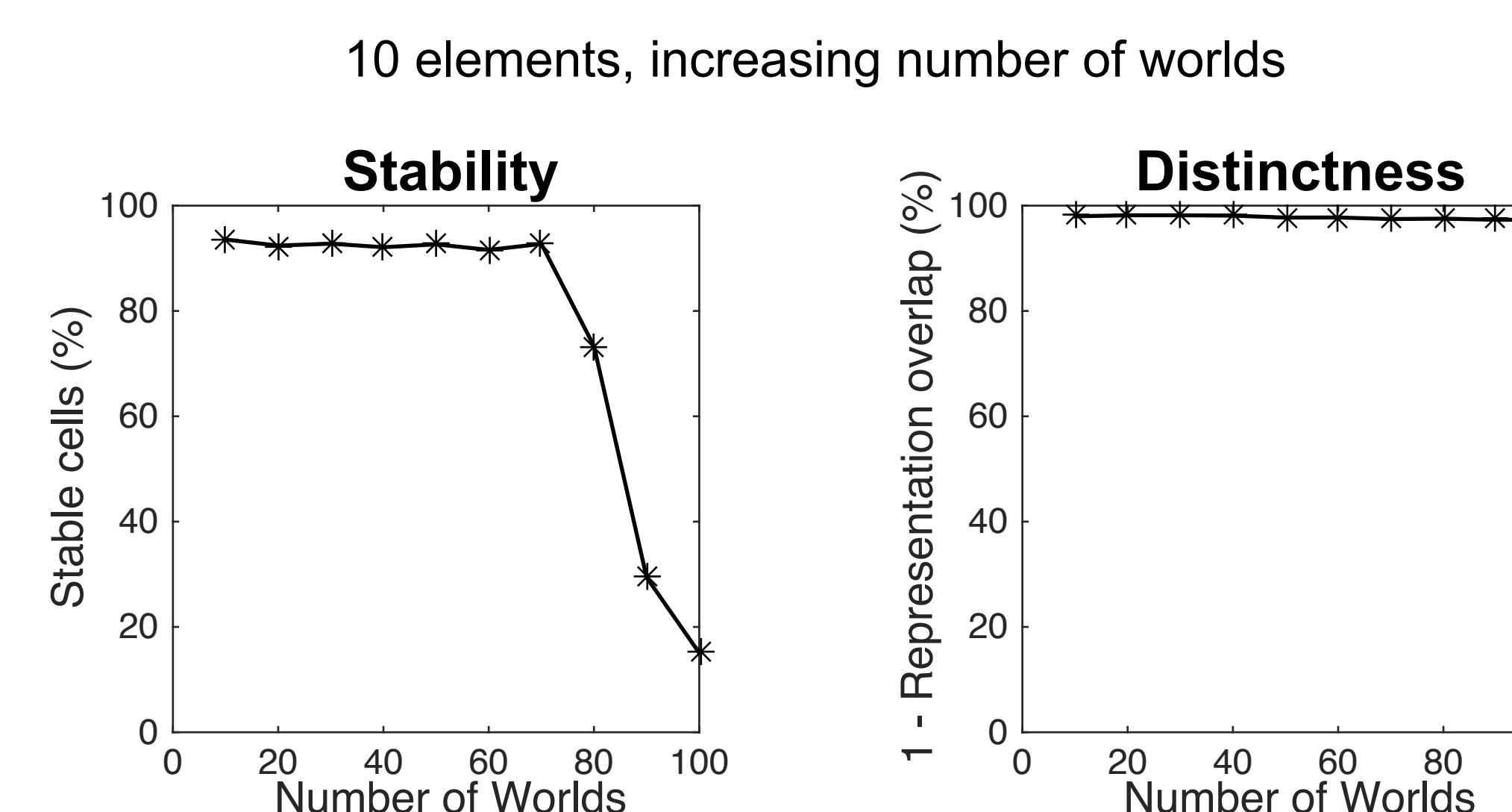
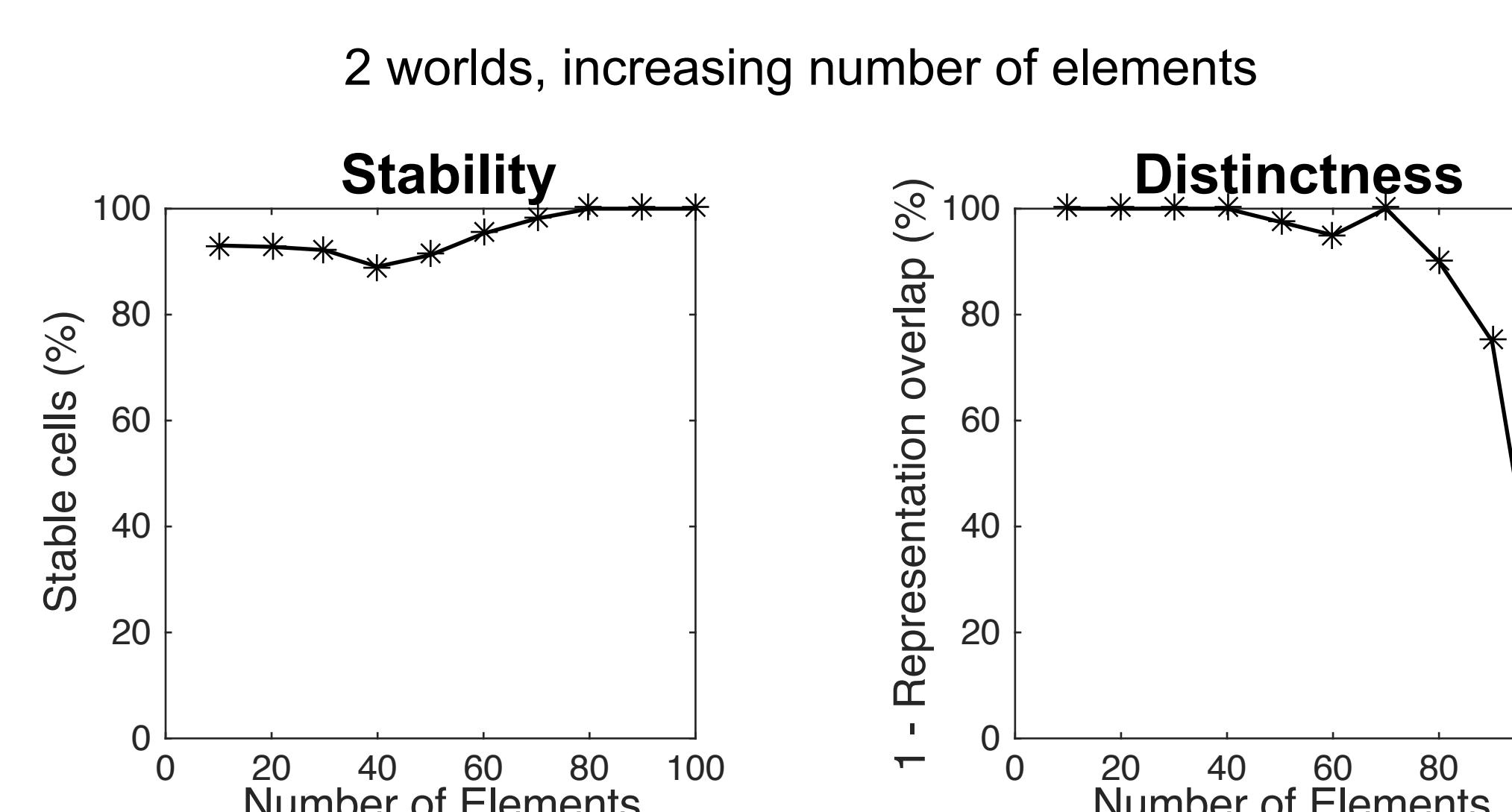
Temporal pooling layer forms stable representations



Scaling experiments: single small level

Model performance metrics:

Stability indicates whether the same cells are active each time the same world is seen.
 Distinctness indicates whether cells that are active in a world are different from cells active in other worlds.

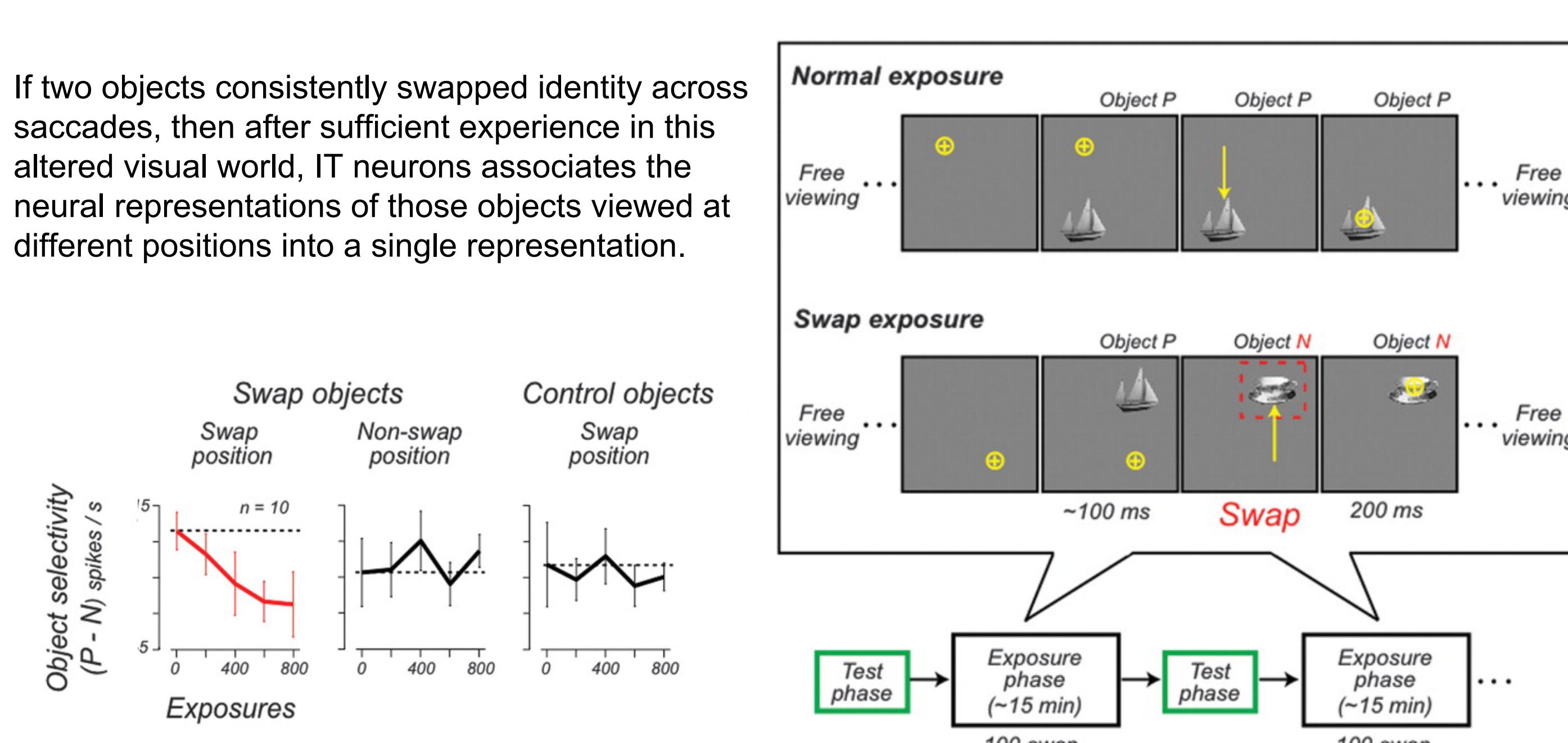


Model parameters: 1024 mini-columns, 2% active at any time

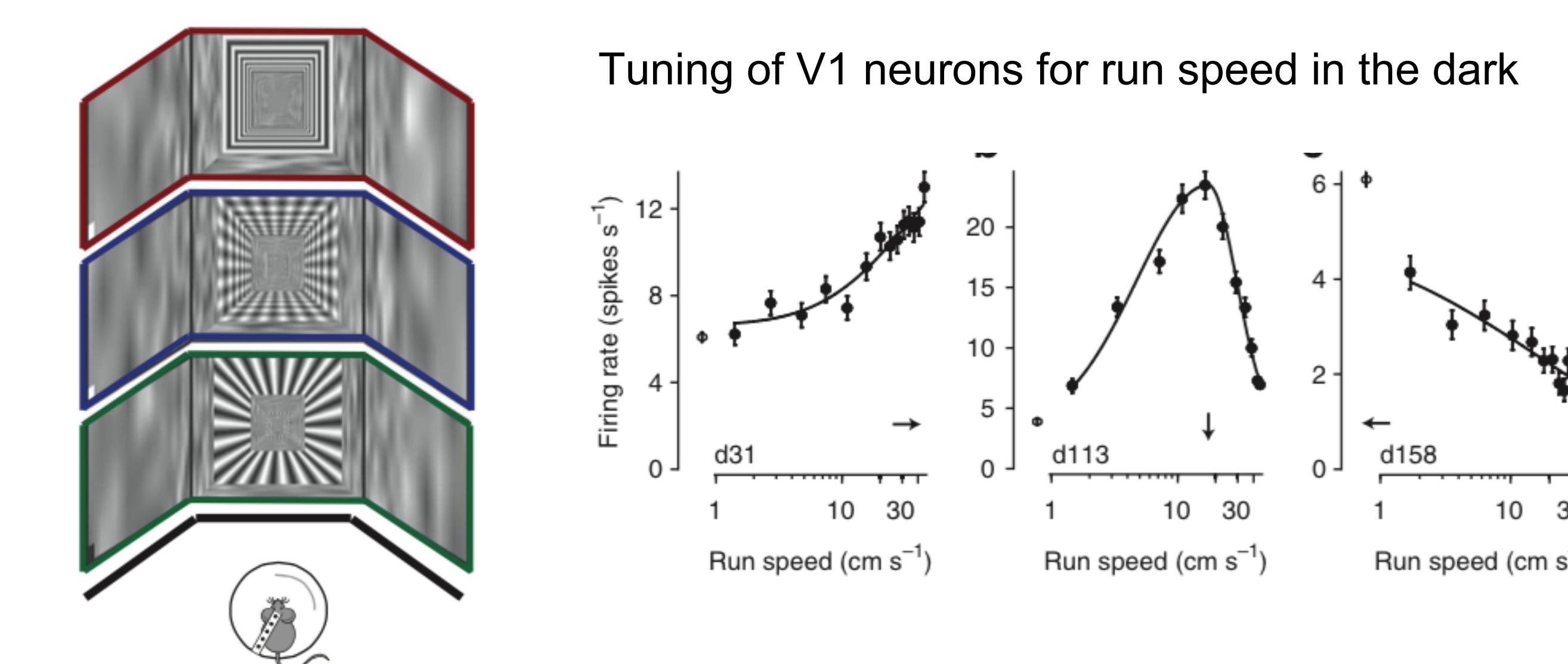
Related experiments

Temporal Pooling in area IT of awake, behaving macaque (Li & Dicarlo 2008)

If two objects consistently swapped identity across saccades, then after sufficient experience in this altered visual world, IT neurons associate the neural representations of those objects viewed at different positions into a single representation.



Motor action related signals in sensory cortex (Saleem et al., 2013)



References

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Acknowledgements

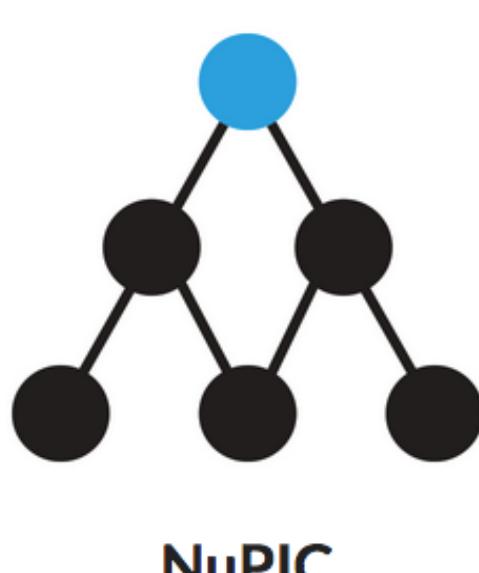
We thank Scott Purdy, Jay Gokhale, Alex Lavin, Ryan McCall for helpful discussions on the algorithm, and Ian Danforth for providing us the robot to test the algorithm.

Our code is open source

We believe in open research, full transparency, and producing high-quality software. Numenta's research and algorithm code is part of the open-source project Numenta Platform for Intelligent Computing (NuPIC). A fast growing project, NuPIC currently has 2,800 "Stars" on Github, 730 forks, and over 1,200 members on three mailing lists.

The core NuPIC algorithm code is used in commercial applications.

We would love to have you involved. For full details please see <http://github.com/numenta> or contact one of the authors.



Numenta Platform for Intelligent Computing

