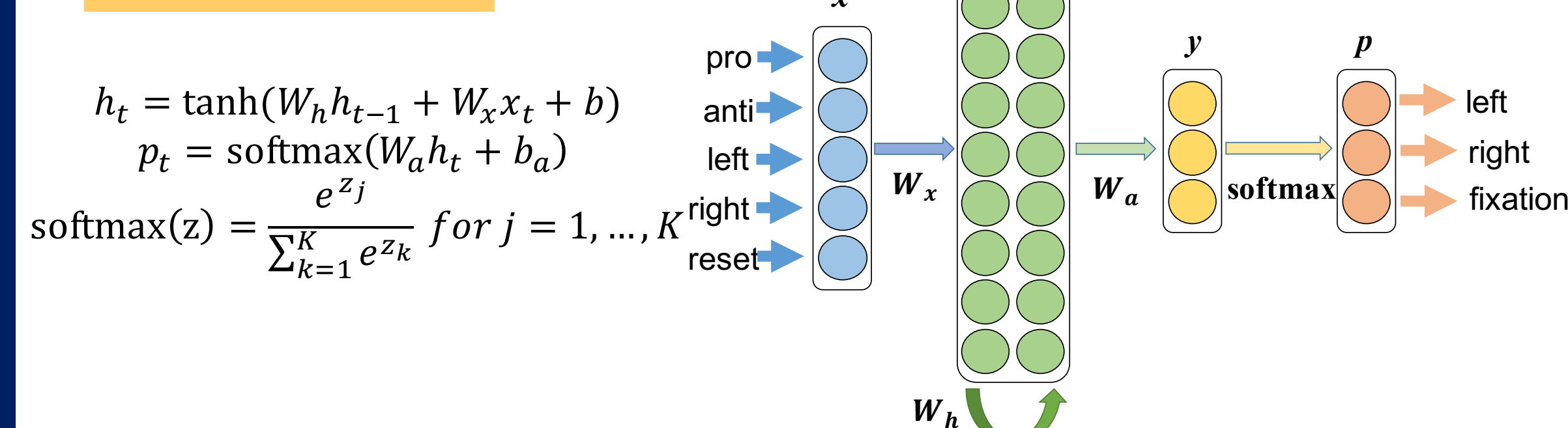


Introduction

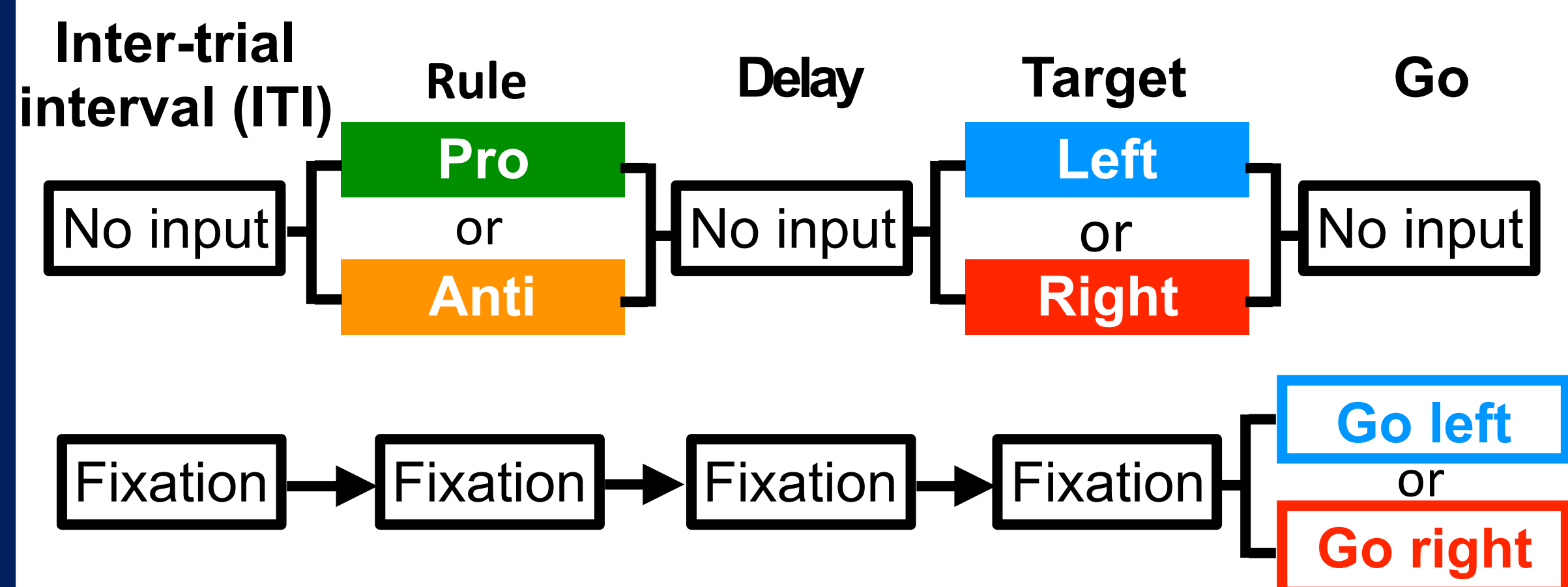
- “Task switch cost” refers to the increase in errors and reaction time observed when subjects switch from one task to another.
 - We focused our modeling efforts on data from rats performing the Pro-Anti orienting task (Duan et al., 2015).
 - We have been especially interested in the mechanism of the asymmetric “switch cost” when rats have larger switch cost when switch from harder “Anti” task to easier “Pro” task than vice versa, which is also observed in human data from similar tasks.
 - A neural network model of asymmetric switch cost allows us to test unresolved questions.
- Is there something special about the anatomical constraints of the mammalian brain which generates switch-cost and switch-cost asymmetry or is experience alone sufficient for generating these phenomena?
 - If we can observe switch cost in a neural network, then we can resolve the source of the switch-cost: is it interference from the memory of the past?

Methods

RNN structure



Inputs and labeled actions



Pro-Anti logic

If Pro-Left or Anti-Right → Go left

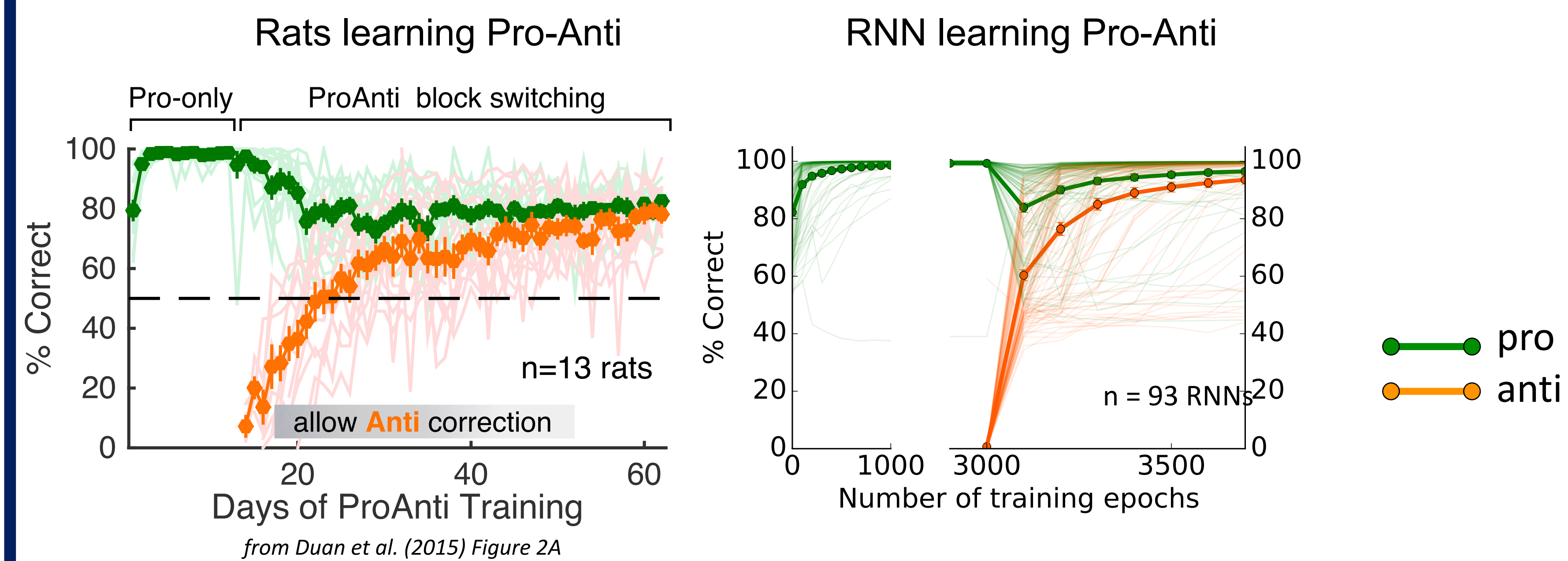
If Pro-Right or Anti-Left → Go right

Training

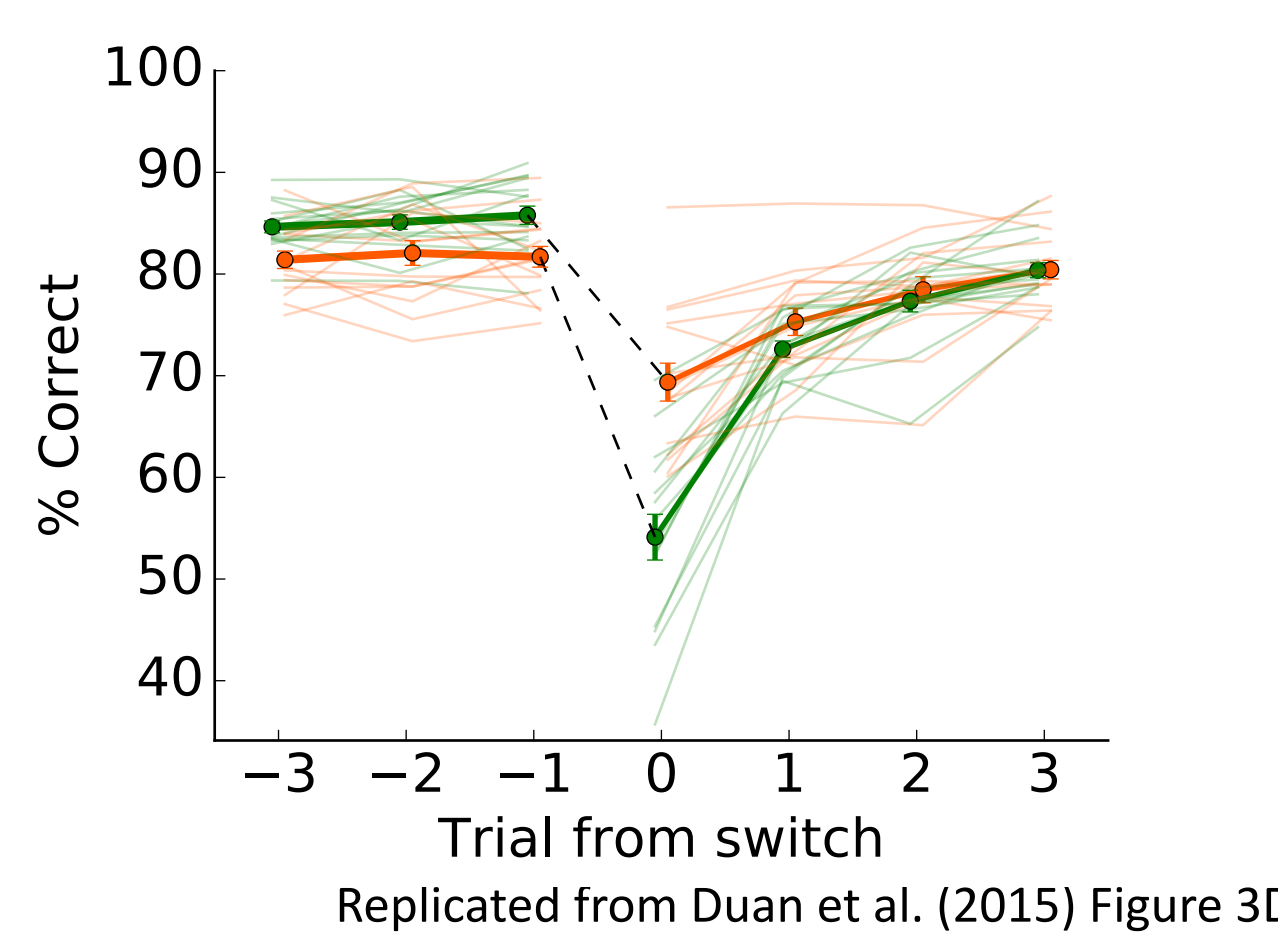
- We trained the RNN in the same way as the rats from Duan et al. (2015)
- We used blocked rule inputs and interleaved target inputs according to Pro-Anti orienting task.
- We used supervised learning with Minpy implementation of backpropagation through time (BPTT) to perform gradient descent
- We used Xavier random initialization and Adam updating rule

Results

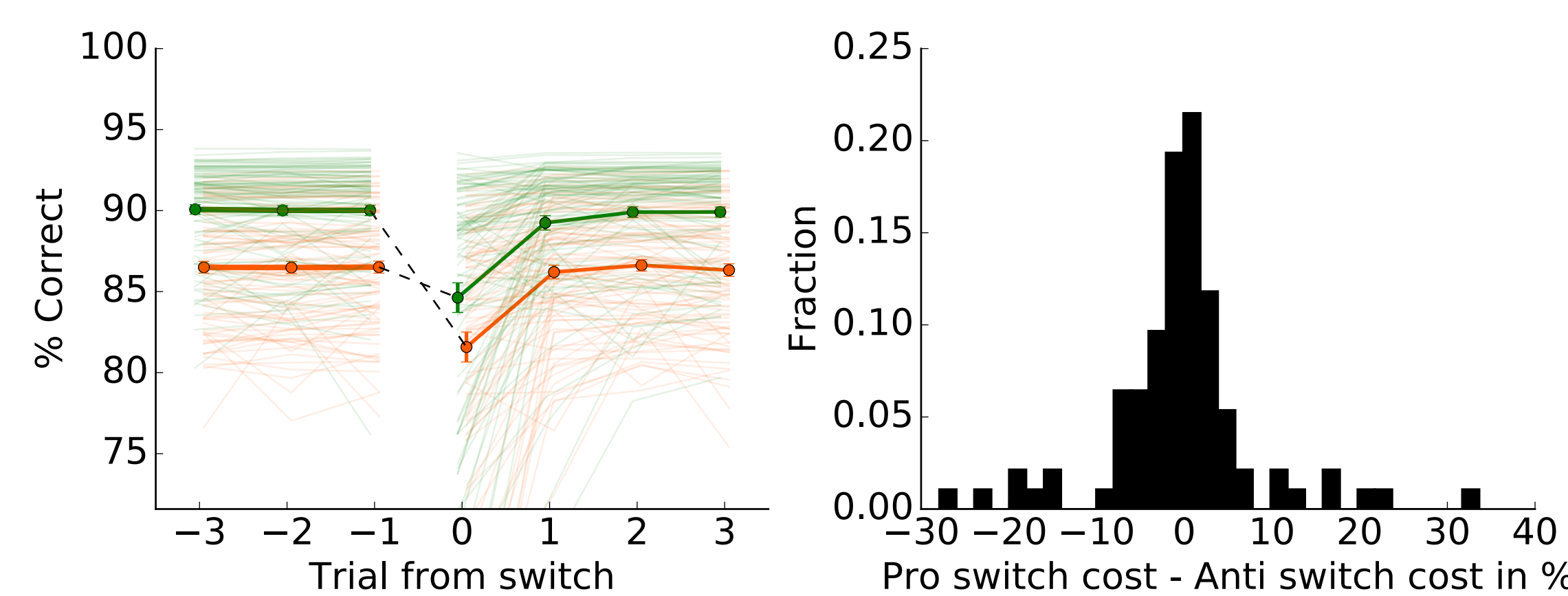
Can RNN produce switch cost and asymmetry?



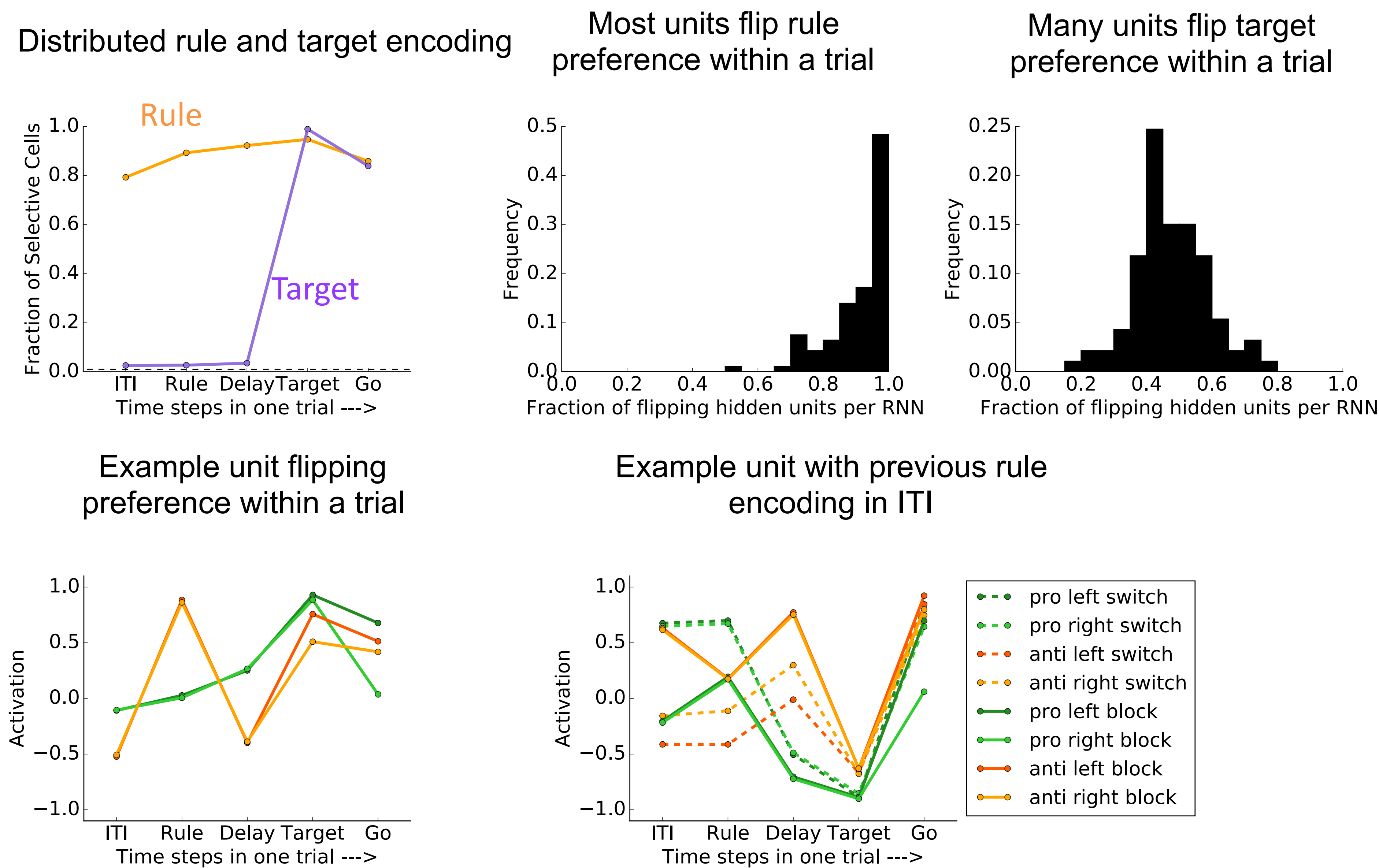
Rats have asymmetric switch cost



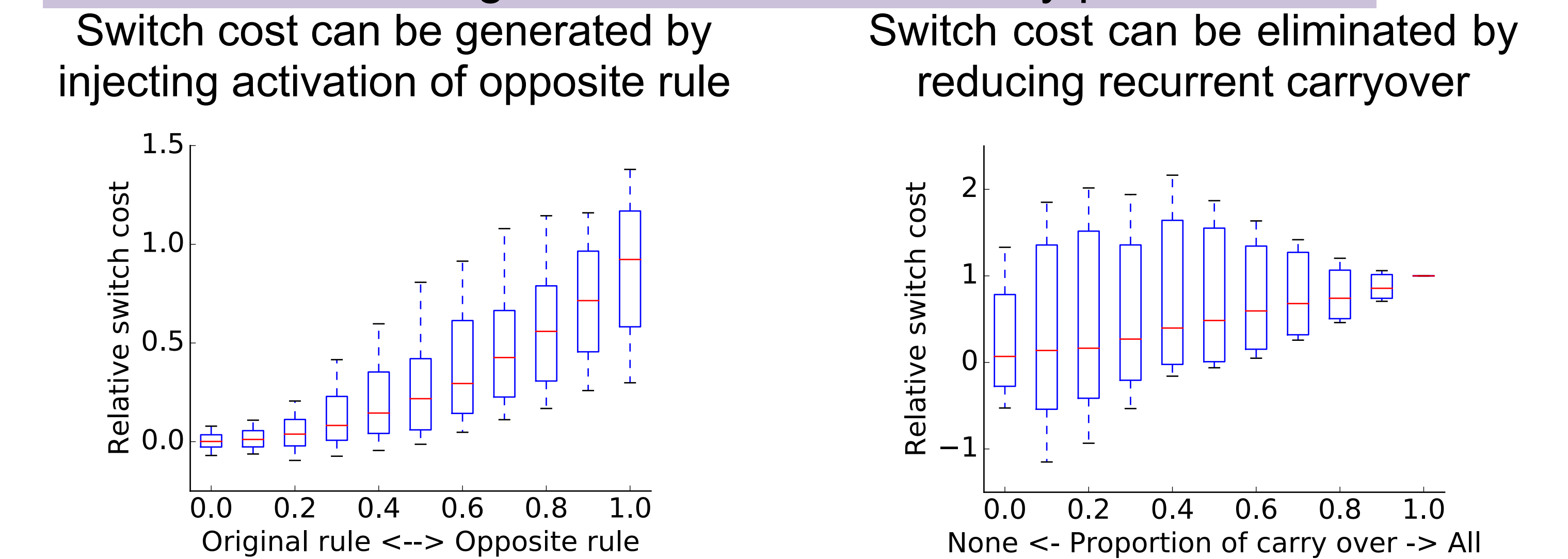
RNN has switch cost, but no asymmetry



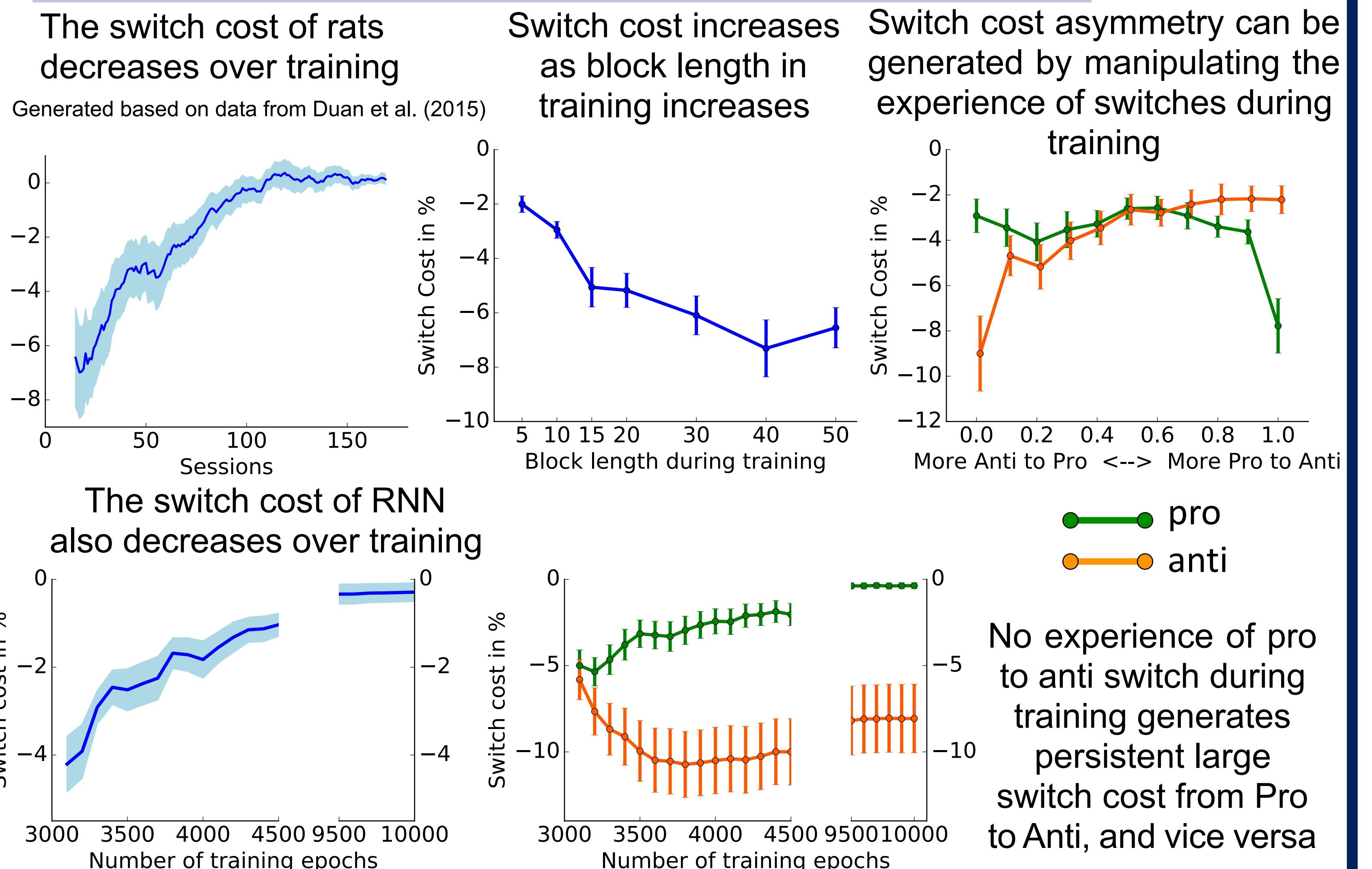
What is the dynamics of the RNN?



Can switch cost be generated or eliminated by perturbation?



Can training experience change switch cost and asymmetry?



Summary

- In our RNN, switch cost is robustly generated purely from experience without anatomical constraints other than recurrent structure.
- Switch cost asymmetry *can* be generated in our RNN based on experience. However because this is only achieved under specific and implausible conditions, there might be other anatomical constraints that generate switch cost asymmetry.
- In our RNN, switch cost is clearly the interference from the memory of the past, as “task-set inertia” theory (Allport, 1994) suggests.

References

- Duan, Chunyu A., Jeffrey C. Erlich, and Carlos D. Brody. (2015) Requirement of prefrontal and midbrain regions for rapid executive control of behavior in the rat. *Neuron* 86.6: 1491-1503.
- Minpy: <https://github.com/dmlc/minpy>
- Allport, D.A., Styles, E.A., and Hsieh, S. (1994). Shifting intentional set: exploring the dynamic control of tasks. In *Attention and Performance XV: Conscious and Nonconscious Information Processing*, C. Umiltà and M. Moscovitch, eds. (Cambridge: MIT Press), pp. 421-452.

Supported by

- (1) Sponsored by Program of Shanghai Academic/Technology Research Leader (15XD1503000);
- (2) Sponsored by Science and Technology Commission of Shanghai Municipality (15JC1400104).