The computational geometry of flexible decision making in prefrontal cortex

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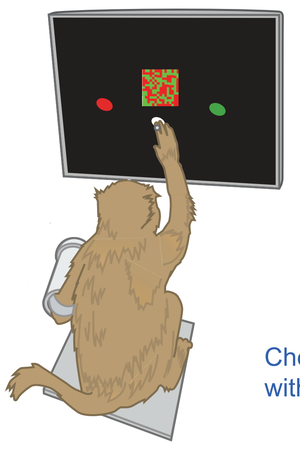
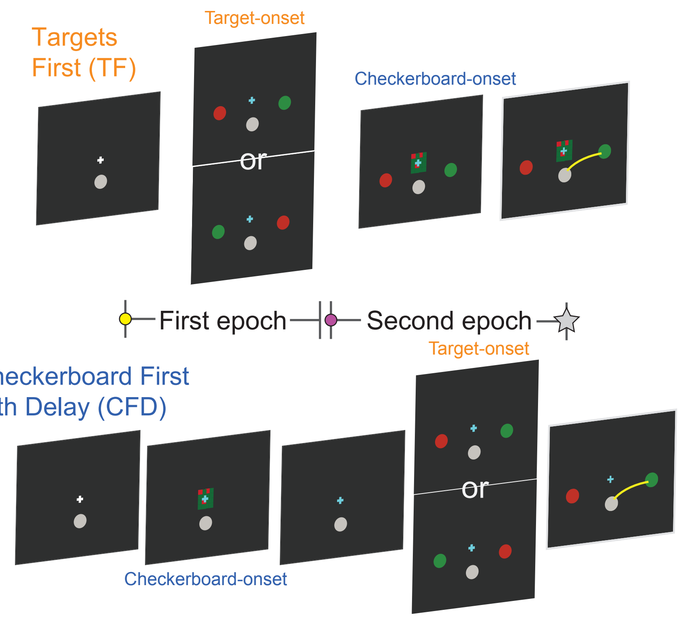
Introduction

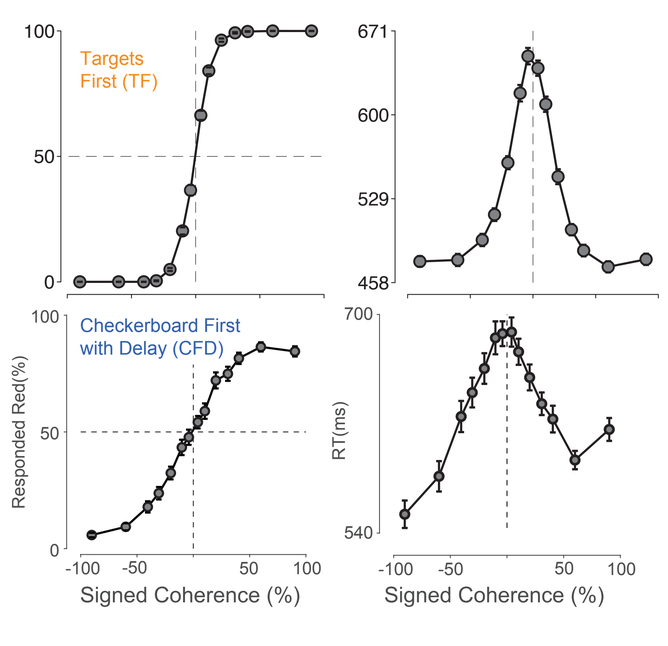
Dorsolateral prefrontal cortex (DLPFC) is well-studied for its role in perceptual decision making but it's unclear how similar neural computations (here, when the order of targets and stimuli are temporally switched) are represented. Furthermore, it's unclear how this compares to recurrent neural networks (RNNs) which are a common testbed for multi-task representations.

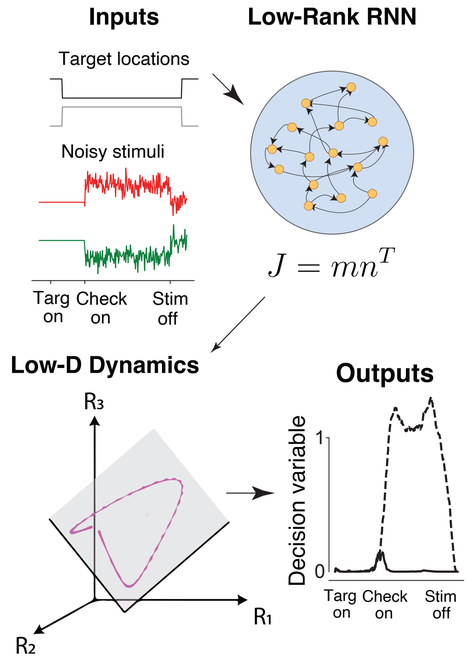
In this work, we compare high-density single unit recordings to a low rank recurrent neural network (LR-RNN; Valente 2022, NeurIPS) examining the same units across the same pair of tasks.



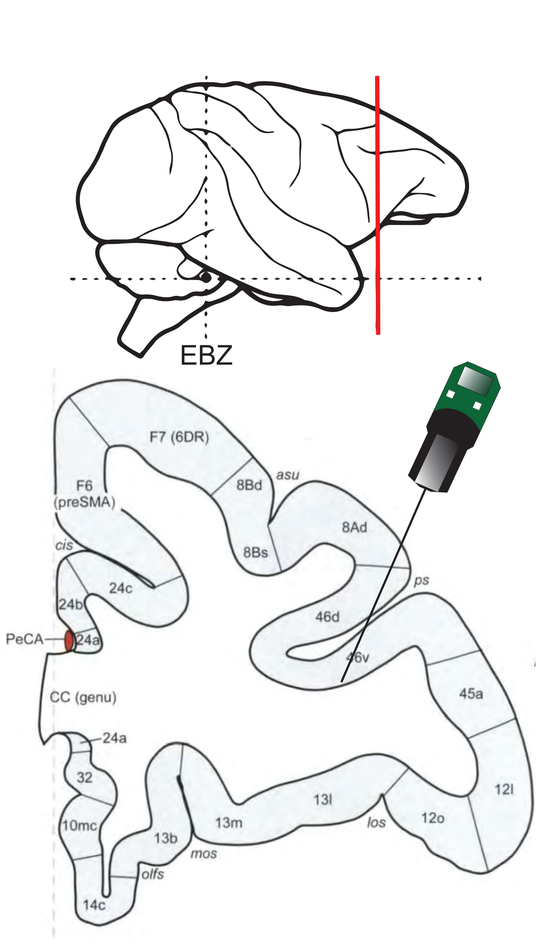
Task: discriminate if the dominant color of the checkerboard is red or green

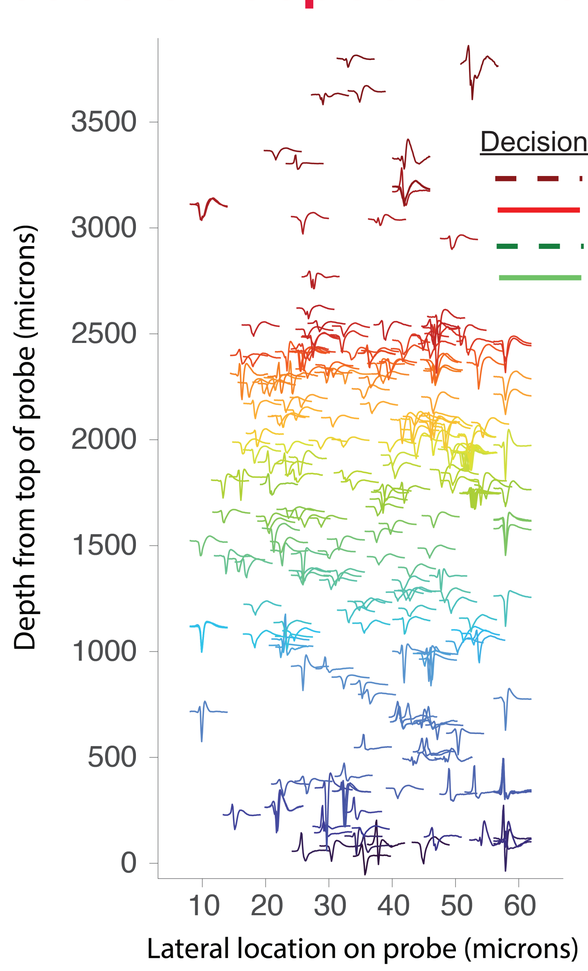


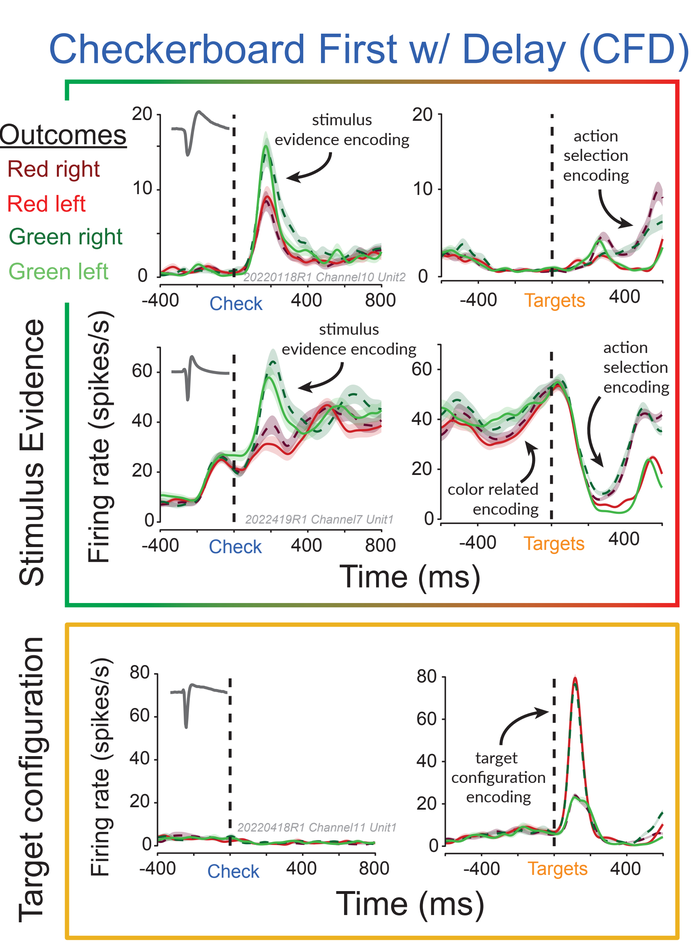


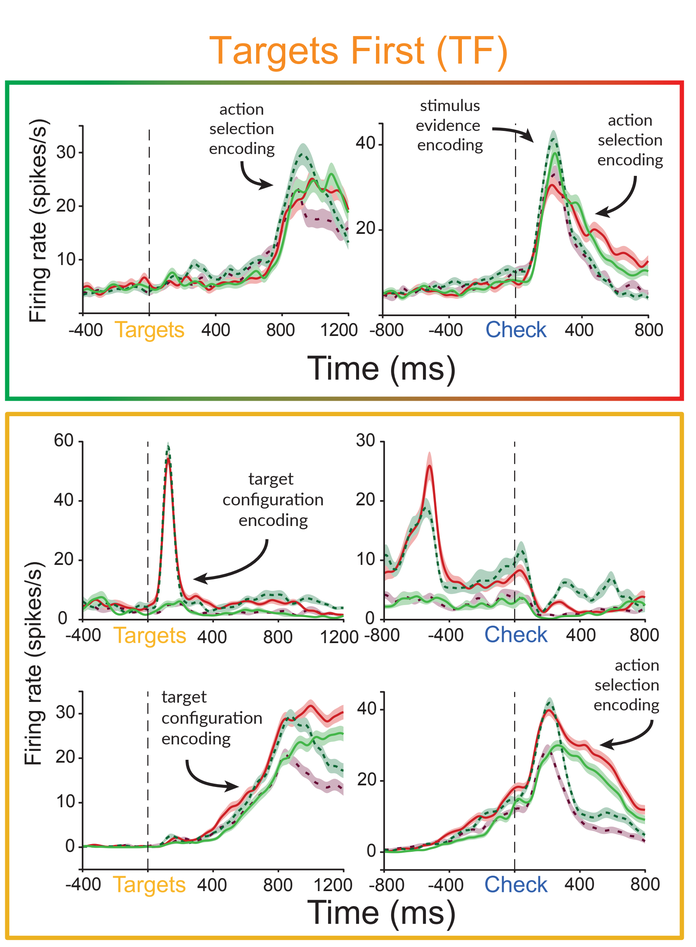


DLPFC neurons encode all aspects of both tasks

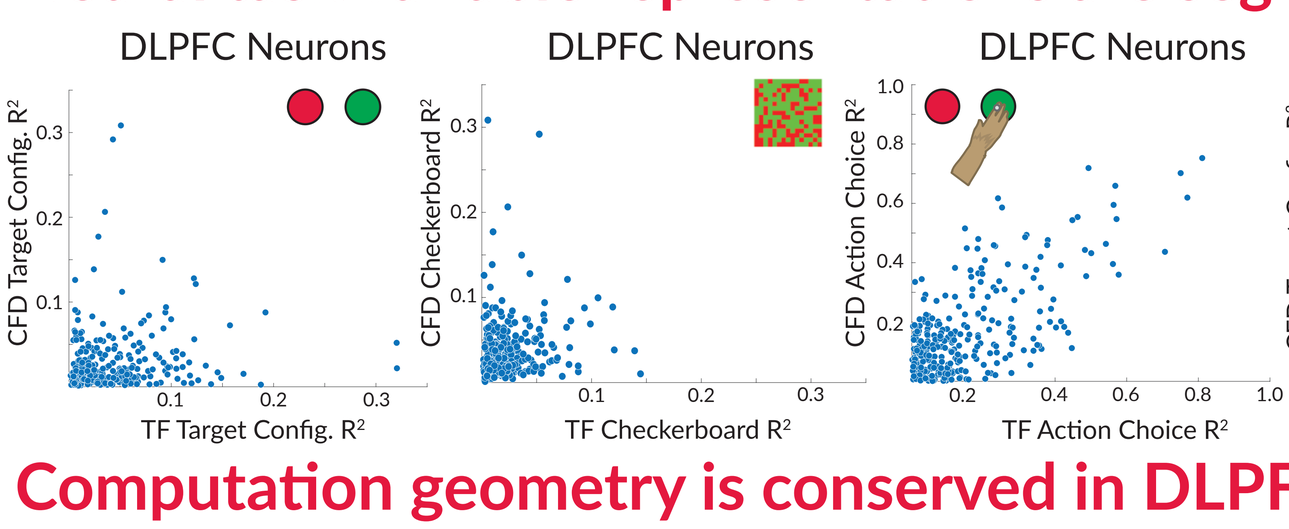




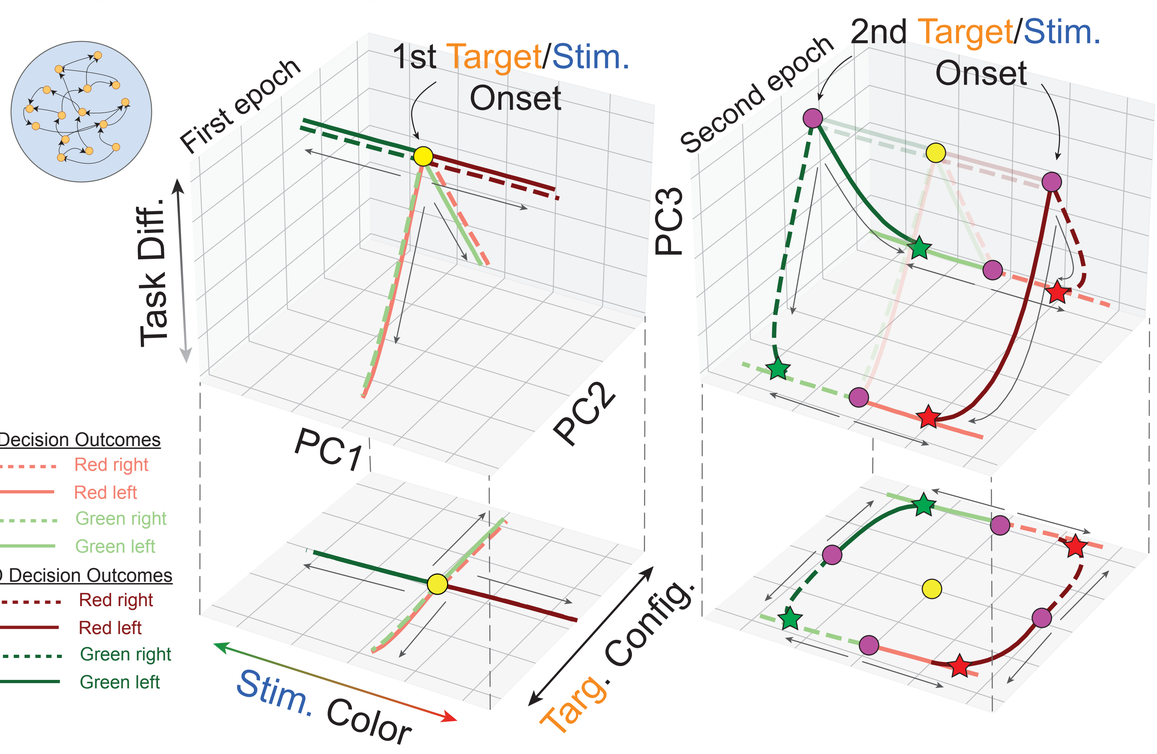


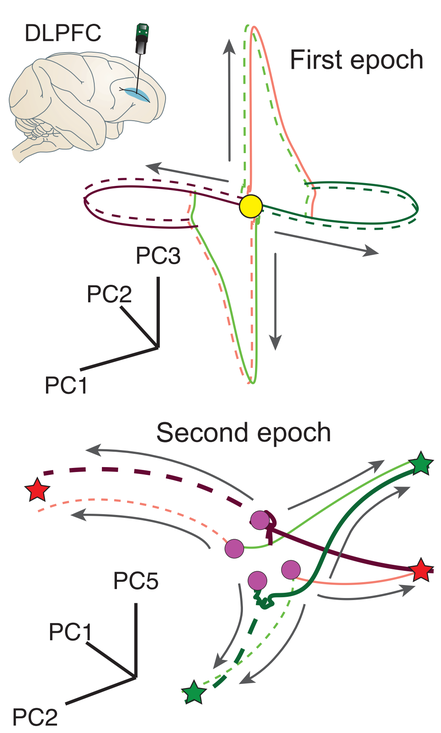


Neural task variable representations are segregated but actions are not



Computation geometry is conserved in DLPFC & RNN's





Conclusions

We compared both the single neuron and population level activity during two decision making tasks in which the presentation of targets and stimuli are swapped. This was done across the same units in both primate DLPFC and a low rank RNN. We found that,

Both DLPFC and the RNN encode all aspects of the task: target configuration, predominant stimulus color, and action choice.

Single neuron encoding of specific task variables tended to be task-specific but encoding of actions was not. RNN unit encodings are conserved across tasks.

Population activity computation, across both DLPFC and RNNs, of each task variables are constrained to unique, orthogonal planes in PC-space but converge to a common action choice axis.