Comparing population of cortical activity while rats perform decision making tasks

L.M. CALDERAZZO, A.D. HAYES, M.J. FRANCOEUR, B. M. GIBSON, and R. G. MAIR

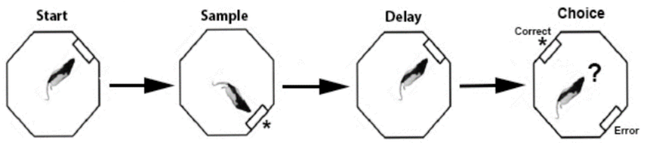
Psychology Department, University of New Hampshire

BACKGROUND

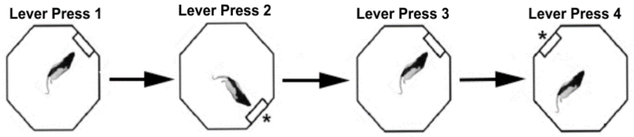
- Prefrontal Cortex (PFC) is the hub of executive functions, responsible for organizing and executing complex cognitive behaviors
- PFC has numerous connections to brain regions facilitating sensory, memory, and motor processes, supporting adaptive decision-making.
- Previously, we have found single neurons in PFC responding to task-relevant actions and outcomes during a delayed non-match to position (DNMTP) task.
- Here, we examine how PFC neurons update when decision-making components of a task are removed.

METHODS

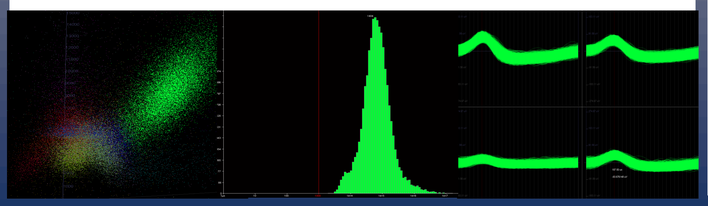
The dynamic delayed nonmatch to position (dDNMTP) task



The serial lever press (SLP) task



- Activity was recorded from single cells in PFC while rats performed a delayed non-match to position (DNMTP) or a novel serial lever press (SLP) task.
- Both tasks consist of a sequence of four lever press actions (start, sample, delay, choice) with reinforcement delivered on sample and choice. During DNMTP the rats must make a choice between two response alternatives. In SLP the choice is removed.
- Once rats reached criterion on DNMTP or SLP, tetrode arrays were implanted into PFC.
- Using SpikeSort 3D, we identified single cells in PFC. Peri-event time histograms (PETH) and raster plots were used to identify event-related responses. Normalized activity show trends across the population of response types.
- PFC activity was compared between rats performing either DNMTP or SLP, and from rats that switched tasks halfway through the session.
- We examined differences in response types, firing rate, and signal-to-noise properties of PFC neurons found in either the SLP or DNMTP task and neurons that were tracked when rats switched tasks.



RESULTS

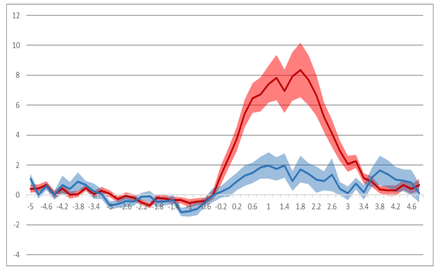
DNMTP VS. SLP

DNMTP

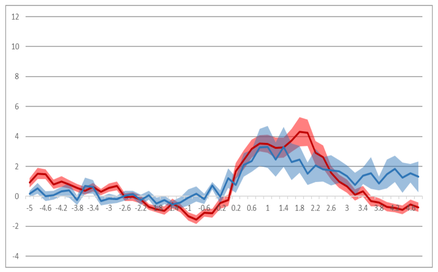
SLP

Reinforcement Excitation

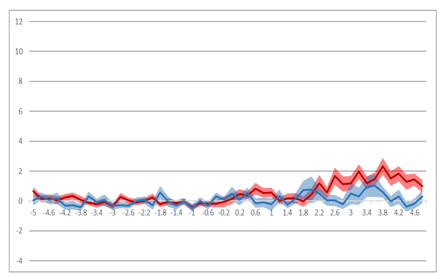
Sample



Correct

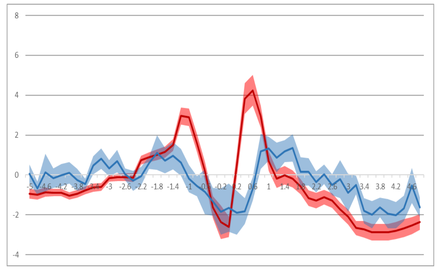


Error

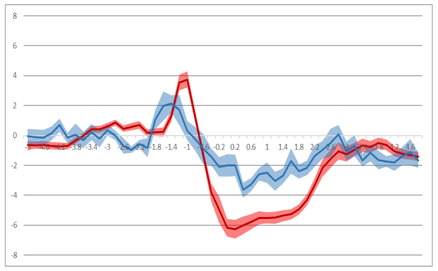


Movement 1

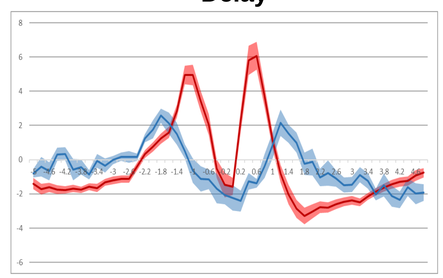
Start



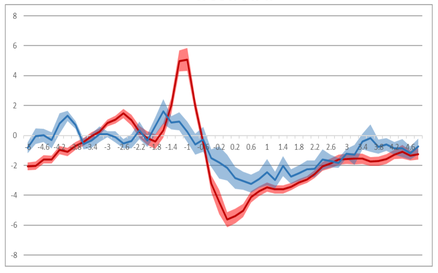
Sample



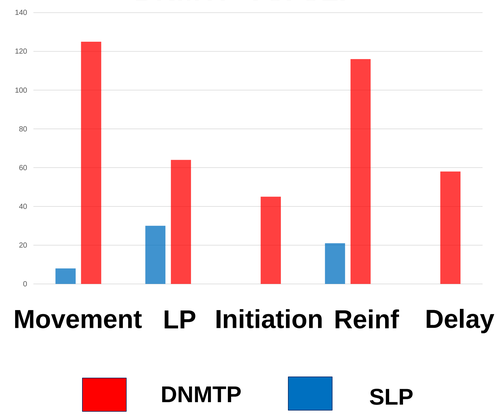
Delay



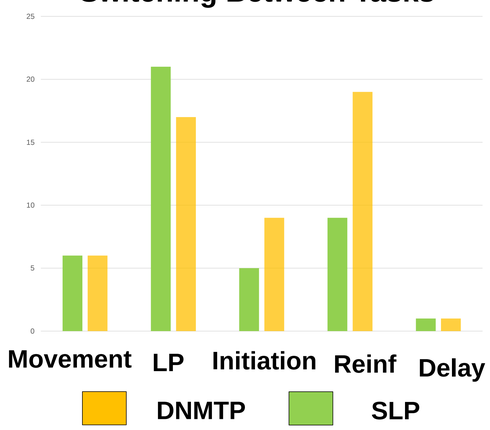
Choice



Number of Response Types in DNMTP VS. SLP



Number of Response Types in Switching Between Tasks



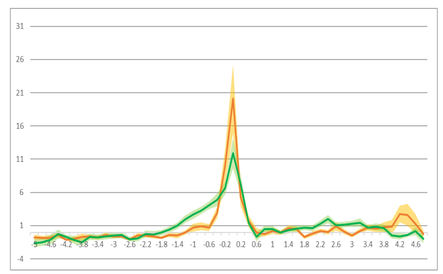
Switching Between Tasks

DNMTP

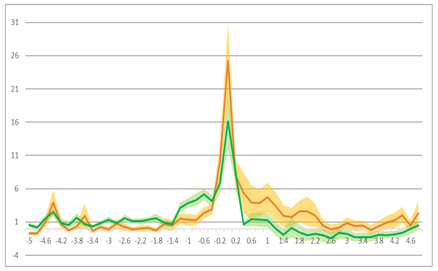
SLP

Lever Press Excitation

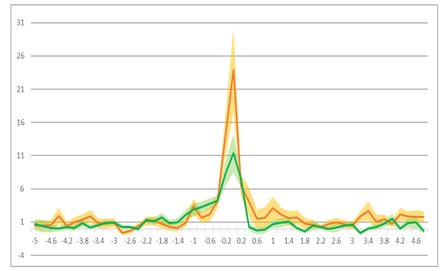
Start



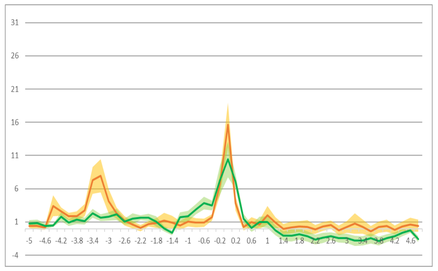
Sample



Delay



Choice



CONCLUSION

- Overall, there were fewer neurons collected when rats ran SLP. Response types associated with movement, delay, and initiation are seen in DNMTP and not SLP.
- When switching between the tasks, neurons responded selectively for one task or sustained their event-related response for the whole session.
- Neural responses surveyed during DNMTP have higher signal-to-noise and firing rate properties compared to neurons firing during SLP.
- When switching between tasks, there were no significant differences between PFC activity collected during DNMTP or SLP.
- These findings show that neurons in PFC are dependent on task requirements. Cortical neurons adapt to reflect changes in task demands.