**INTRODUCTION**

Many executive tasks require the formation and maintenance of working memory (WM) or sustained attention (SA), or both, for extended intervals. Recent experiments show that neurons in the frontal cortex and central thalamus can participate in one or both of these tasks. Among those neurons that participate in both, some become active at similar times during the delay period for both tasks. Others become active at different times for the two tasks. We propose a feed-forward network through which pulses of activity travel. The spatio-temporal characteristics of the pulses are determined by which neurons receive the external stimulus. We utilize an established model of cortical propagation (Pinto and Ermentrout) in a 2-D feed-forward network to demonstrate a possible mechanism for the observed delay period activity in flexible neurons, those capable of participating in multiple tasks.

**NEUROPHYSIOLOGY**

Two distinct tasks, each containing a variable delay period. During this delay period, we observe the response of neurons in the frontal cortex and the central thalamus.

**Simulation of the network**

We simulate the network on a 50x50 grid of cells. In the figure shown on the left, the stimulus is applied along the top edge. A stimulus along the left edge will result in the transverse of that shown. The individual panels of this figure are 6 time snapshots, time increases from left to right. The horizontal and vertical axes of each panel are location coordinates in the rearranged configuration described above. Stimulus A is applied to the top edge, and stimulus B is applied to the left edge (not shown). Along the left edge, the input is too weak to support propagation and so these cells will only participate in task B (stimulus applied along the left edge). Away from the left edge, the cells receive sufficient input to become active (they receive more inputs, which sum). A line showing the cutoff location between cells specific to stimulus B and those that receive only one stimulus is shown in each panel. To the right of this line, activity arising due to task A pulses through the medium. To the left, cells will not respond to task A, but they will respond to a stimulus along the left edge (task B). In the lower figure, the time traces are shown for three of the cells (yellow dots) chosen to show how the activity patterns generated by the network can produce cells that respond "specifically," "similarly" and "differently" to the various task specific inputs. In each of these, the red curve results from a side edge stimulus and the black curve is the evolution resulting from a top edge stimulus.

**SUMMARY & CONCLUSIONS**

- We suggest a mechanism that would give rise to the activity patterns seen by recording neurons in the frontal cortex and the central thalamus during two distinct tasks.
- A traveling pulse originates at a task-specific location in the brain, causing rising and falling activity levels during the delay period for each task.
- The functional location of a given cell in the network determines when, if at all, its activity level will rise. Cells closer (functionally) to the stimulated location will be most active early in the delay period, and those farther away will be most active later.
- Varying temporal responses can provide insight into the relative "location" of the stimulating event, providing insight into the connectivity within and between the frontal cortex and central thalamus.

**REFERENCES**

1. Mark S. Goldman, Memory without feedback in a neural network, Neuron 61 (2009)