

Cerebellum-like structures are found in many brains and share a basic fan-out-fan-in network architecture. How the specific structural features of these networks affect their ability to learn remains largely unknown. Previous theoretical studies have suggested that purely random connections between input neurons and encoding neurons are optimal for associative learning. However, recent experimental studies of the *Drosophila melanogaster* mushroom body have identified two principal connectivity patterns that deviate from purely random connections. To investigate this structure–function relationship, we developed a four-layer network model of the early *Drosophila melanogaster* olfactory system with particular attention paid to the structure of the feedforward excitatory connections from the projection neurons of the antennal lobe to the Kenyon cells of the mushroom body (Fig. 1A). The first connectivity pattern, biases, deviates from the purely random case (Fig. 1Bi) by allowing the likelihoods at which individual projection neurons connect to Kenyon cells to substantially deviate from uniformly random (Fig. 1Bii). The second connectivity pattern, groups, allows projection neurons to connect preferentially to the same Kenyon cells (Fig. 1Biii). Finally, we consider a network class that exhibit both biases and grouping (Fig. 1Biv). We compared the representations of olfactory stimuli generated by the KC layer qualitatively and quantitatively; we also assess the ability of a network to perform associative learning via a novel, biologically inspired learning rule (Fig. 1C). We find that biases allow the mushroom body to prioritize the learning of particular, ethologically meaningful odors while incurring a minimal loss in overall associative learning ability relative to the optimal, purely random case (Fig. 1D). Second, we find that groups facilitate the mushroom body generalizing learned associations across similar odors while maintaining the ability to discriminate across most odors (Fig. 1E). Altogether, our results demonstrate how different connectivity patterns shape the representation space of a cerebellum-like network and impact its learning outcomes.

P18 Astrocytes can sharpen spatial patterns in neuronal networks by restricting synaptic volume

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Astrocytes are glial cells that make up 50% of brain volume, with each one wrapping around thousands of synapses. However, the exact role astrocytes have in governing the dynamics of the synapse and neuronal networks is still being debated. Previous computational modeling work has helped tease out possible mechanisms driving this interaction at the synapse level, with micro-scale models of calcium dynamics [1,2] and neurotransmitter diffusion [3]. Little computational work has been done to understand how astrocytes may be influencing spiking patterns and synchronization of large networks, partly because it is computationally infeasible to include the intricate details found in this previous work in such a network-scale model.

We overcome this issue by first developing an “effective” astrocyte that can be easily implemented to already established network frameworks. We do this by showing that the astrocyte proximity to a synapse makes synaptic transmission faster, weaker, and less reliable. Thus, our “effective” astrocytes can be incorporated by considering heterogeneous synaptic time constants, which are parametrized only by the degree of astrocyte proximity at that synapse. This parametrization makes sense in light of experimental evidence showing that the degree of astrocyte ensheathment varies by brain region and that it is a crucial component in certain disease states such as some forms of epilepsy [4]. We then apply our framework to a network of 20,000 exponential integrate-and-fire neurons, similar to the one presented by Rosenbaum et al. [5]. Depending on key parameters, such as the number of synapses ensheathed, and the strength of this ensheathment, we show that astrocytes have the ability to push the network to a synchronous state and to enhance and sharpen patterns of spatial correlation exhibited by the network.

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P19 EEG based emotion recognition while playing computer games

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Emotions are central to human experience and therefore, the use of machine learning to accurately classify human emotions has been an area of popular research in recent times. Most of the available research is based on data collected while the subject is kept stationary and exposed to an external stimulus, such as listening to an audio or watching an audio-visual clip. In this paper, we extend work done by [1], which focuses on studying the emotions when the subject is involved in doing a more complex physiological activity, such as playing computer games. We aim to establish a relationship between emotions and lobes of the brain by examining the EEG signals from those lobes. Additionally, we wish to examine, if deep-learning-based architecture like long-short term memory (LSTM) and its variants can offer better results for emotion classification on GAMEEMO

dataset. LSTM is believed to perform better on temporal data having long-term dependencies. The GAMEEMO dataset contains EEG data collected from 28 subjects who played 4 different games, known to elicit a particular kind of emotion. To analyze the dataset, we have used a 4-layered network including LSTM, Bidirectional LSTM and Gated Recurrent Unit (GRU) models. The input data from GAMEEMO dataset is fed to the network and it learns to associate EEG data with the emotion class label. In addition, we also learn to associate the emotion class label with the lobe of the brain by segregating the EEG electrodes as per their position.

We have achieved an average accuracy of greater than 80% for all the channels with each of the 3 models, which is significantly better than the earlier work (Fig. 1). The spatial analysis of results also suggests that there exists a strong relationship between Occipital lobe and HANV (High arousal Negative Valence) emotion class and Parietal lobe and LAPV (Low Arousal Positive Valence) emotion class. We observed that Bidirectional LSTM outperforms the other two models when it comes to overall average classification accuracy. Out of the three models, classes HANV and LAPV show much better classification results as compared to HAPV (High Arousal Positive Valence) and LANV (Low Arousal Negative Valence). HANV class emotions such as anger, nervousness, horror, etc., and electrical activity in the Occipital lobe seem to have a strong relationship, as this lobe produced the best results for HANV class. HANV is associated with emotions such as horror (as tagged in Game G3 in our dataset). One reason for this could be that the stimulation of the occipital lobe is associated with heightened emotions.

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Fig. 1 Comparison of the emotion prediction accuracy using different models

