Patterns are ubiquitous in the nervous system. These range from the temporal patterns of locomotion (e.g., gaits such as the trot, walk, and gallop) and other motor activity (head bobbing, scratching, tail wagging) to spatio-temporal patterns of neural activity seen during imaging of human brains and in electrical recordings in animal brains. In this talk, I will discuss the mechanisms that underlie the emergence of patterns in space and time. Within this context, I will try to connect paleolithic cave paintings with spontaneous patterns in the excited brain. I will also discuss some recent experimental work on the interactions of external stimuli with the internally generated patterns of neural activity. The talk is free of equations and should be accessible to a general audience.

Neural integrators are circuits that are able to code analog information such as spatial location or amplitude. Storing amplitude requires the network to have a large number of attractors. In classic models with recurrent excitation, such networks require very careful tuning to behave as integrators and are not robust to small mistuning of the recurrent weights. In this talk, I introduce a circuit with recurrent connectivity that has is subjected to a slow subthreshold oscillation (such as the theta rhythm in the hippocampus). I show that such a network can robustly maintain many discrete attracting states. Furthermore, the firing rates of the neurons in these attracting states are much closer to those seen in recordings of animals. I show the mechanism for this can be explained by the instability regions of the Mathieu equation. I then extend the model in various ways and, for example, show that in a spatially distributed network, it is possible to code location and amplitude simultaneously.