A dynamic attractor network model of memory coding

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Empirical evidence shows that memories that are frequently revisited are easy to recall, and that familiar items involve larger hippocampal representations than less familiar ones. In line with these observations, we developed a computational modeling approach, based on a dynamic attractor network model, to show how hippocampal neural assemblies may evolve differently, depending on the frequency of presentation of the stimuli (Boscaglia et al., 2023). Specifically, we built a dynamic attractor network model starting from a standard rate attractor model to which we added an online Hebbian learning rule, background firing activity, neural adaptation, and heterosynaptic plasticity. We show that a dynamic interplay between online learning and background firing activity can explain the relationship between the memory assembly sizes and their frequency of stimulation (i.e. the higher the frequency, the larger the assembly). Frequently stimulated assemblies representing uncorrelated memories increased their size independently from each other (i.e. creating orthogonal representations that did not share neurons, thus avoiding interference), in line with findings with single-cell recordings which suggest neglectable amounts of overlap between neural assemblies encoding non-associated items. Furthermore, we show that connections between neurons of assemblies that were not further stimulated became labile and these neurons could be recruited by other assemblies, providing a neural mechanism of forgetting.
REFERENCES: Boscaglia M, Gastaldi C, Gerstner W, Quian Quiroga R (2023) A dynamic attractor network model of memory formation, reinforcement and forgetting. PLoS Comput Biol 19(12): e1011727.