Abstract View

DOPAMINE FACILITATES THE SUSTAINED FIRING OF RAT LAYER V PREFRONTAL PYRAMIDAL CELLS IN VITRO

J.M. Fellous*; T.J. Sejnowski

Computational Neurobiology Lab, The Salk Institute, La Jolla, CA, USA

In delayed match-to-sample tasks in monkeys, recordings from some neurons in prefrontal cortex (PFC) in vivo show sustained increases in the firing rate during the delay period between the stimulus onset and the response. The performance on the task is impaired when the dopamine levels in the PFC are either too low or too high, suggesting that dopaminergic modulation is involved in encoding the stimulus. We examined the effects of dopamine on rat PFC neurons recorded in vitro coupled by a dynamic clamp to a simulated population of impinging cortical synapses. Conductances were injected into the PFC cell to simulate particular mixtures of AMPA, NMDA and GABA_A inputs triggered in response to the cell own firing, in a feedback loop with the simulation. The amplitudes, time spread, durations and time delays of these conductance injections were adjusted to mimic realistic cortical inputs. Short (100 ms) somatic depolarization of the cell yielded little or no sustained firing in the hybrid network. When 40 μM dopamine was added to the bath, and the simulated NMDA currents were increased by 30% in accordance with in vitro data, the same depolarization elicited increases in firing rates that lasted several seconds, mimicking the activity observed in vivo. The probability of the establishment and the average duration of this sustained increase in firing rate were studied as a function of dopamine concentration. These results are consistent with the hypothesis that delay period activity in PFC neurons is sustained by network activity and that dopamine modulation may be central in supporting sustained activity. Supported by the Howard Hughes Medical Institute.

close