The reward-attention circuit model: Nicotine’s influence on attentional focus and consequences of attention deficit hyperactivity disorder

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Abstract

In this work we investigate the influence that nicotine exerts on attention focusing, modelling the coupling of reward and thalamocortical circuits. Each neurone in the neural networks that replicate such circuits is described by a carefully designed coupled system of nonlinear differential equations that details essential neurophysiological properties.

Computer simulations of the reward-attention circuit reflect the spiking behaviour of each individual neurone in the network, under the presence or absence of nicotine. It becomes clear that changes in the dopaminergic levels in the reward circuit due to nicotine strongly influence the nigral dopaminergic activity, that modulates the thalamocortical filtering mechanism.

Our results indicate that nicotine strengthens the attentional focus on a particular stimulus, decreasing the smoker’s mental flexibility. Also, the simulations highlight aspects of clinical inattention symptoms, particularly in the attention deficit hyperactivity disorder. They show why patients suffering from attentional lability might improve the attentional focus when exposed to nicotine.