BMC Neuroscience

BioMed Central

Poster presentation

Dopamine D1/D2 modulation of synaptic plasticity in the prefrontal cortex

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from Eighteenth Annual Computational Neuroscience Meeting: CNS*2009
Berlin, Germany. 18–23 July 2009

Published: 13 July 2009

BMC Neuroscience 2009, **10**(Suppl 1):P193 doi:10.1186/1471-2202-10-S1-P193

This abstract is available from: http://www.biomedcentral.com/1471-2202/10/S1/P193

Introduction

It is widely assumed that dopamine plays a crucial role in reinforcement learning due to the ability of dopamine neurons to signal reward prediction errors. However, it is not clear how such a signal could affect neurons in the prefrontal cortex and whether or not the experimentally demonstrated effects of dopamine on long-term synaptic plasticity are by themselves be enough to cause the animal to learn to predict future rewards. The aim of this study was to investigate the effect of dopamine modulation on synaptic plasticity via both the D1 and D2 dopamine receptors.

Methods

In this study, the effect of dopamine modulation on synaptic plasticity was determined by simulating a selection of plasticity protocols under both control conditions and a simulated bath of D1 or D2 agonists. The effects of dopamine D1 and D2 agonists on both intrinsic and synaptic parameters of PFC neurons were quantified using data obtained from in vitro recordings. In addition to the effects of dopamine on the single neuron f/I curve, D1 agonists enhanced calcium influx, NMDA and GABAA currents in the model whilst reducing the effect of AMPA conductances. D2 agonists acted oppositely on calcium influx and synaptic conductances. Changes in synaptic efficacy were quantified using an existing calcium-based model of synaptic plasticity [1].

Results

In states where D1 modulation dominated, there was enhanced LTP of active synapses, an effect that is attenuated by D2 receptor stimulation, which by itself results less potentiation, or an increased likelihood of LTD. The effect of dopamine modulation on STDP showed a complex timing-dependence and cannot be simply interpreted in terms of an increase or decrease in plasticity (see Figure). Together our results indicate that calcium dependent models of plasticity are highly sensitive to neuromodulators which effect calcium influx, and therefore a more detailed understanding of single neuron calcium dynamics will be required to accurately characterize the effect of dopamine on synaptic plasticity.

References

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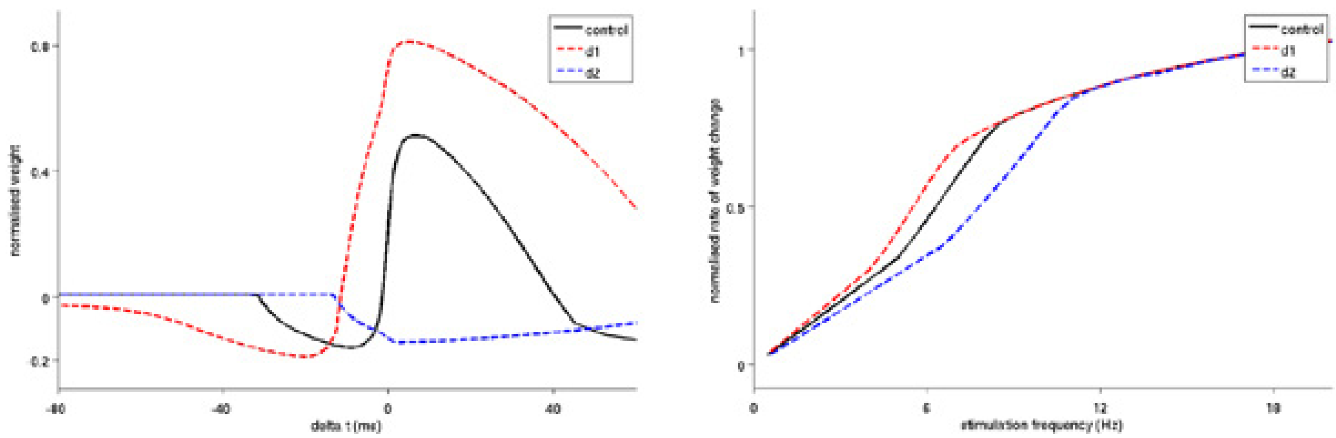

Figure 1
The effect of dopamine modulation on STDP in a frequency dependent plasticity protocol.