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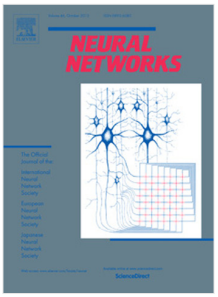

A model of operant learning based on chaotically varying synaptic strength

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A model of operant learning based on chaotically varying synaptic strength☆

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Abstract

Operant learning is learning based on reinforcement of behaviours. We propose a new hypothesis for operant learning at the single neuron level based on spontaneous fluctuations of synaptic strength caused by receptor dynamics. These fluctuations allow the neural system to explore a space of outputs. If the receptor dynamics are altered by a reinforcement signal the neural system settles to better states, i.e., to match the environmental dynamics that determine reward. Simulations show that this mechanism can support operant learning in a feed-forward neural circuit, a recurrent neural circuit, and a spiking neural circuit controlling an agent learning in a dynamic reward and punishment situation. We discuss how the new principle relates to existing learning rules and observed phenomena of short and long-term potentiation.

Keywords: Dynamic Synapse, Operant learning, Chaos, Receptor Trafficking

1. Introduction

Operant learning (also called operant conditioning or instrumental conditioning) is a type of learning in which a new behaviour is increased, or an existing behaviour is suppressed, by pairing it with reward or punishment. For example: (a) In a Skinner box, when a rat occasionally presses a lever, it

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