Computational Neuroscience: Reinforcement Learning and Microzones in the Cerebellum

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The crystalline structure of the cerebellar cortex has inspired the development of theories and computational models of learning in the cerebellum[1,2]. In these computational models, learning is typically based on long-term depression (LTD) between parallel fibres and Purkinje cells in cerebellar cortex[3,4]. More recently, however, plasticity has been shown to be present at different types of cerebellar synapses, and recent observations of reward signals conveyed by both mossy fibres[5] and climbing fibres[6-9] to the cerebellar cortex indicate that the roles of the instructive signals for cerebellar plasticity are more complex than assumed by classic theories. The presence of reward signals suggests that the cerebellum may be involved in reinforcement learning, by predicting the consequences of different actions. A further level of complexity arises from the existence of alternating cerebellar microzones that have been shown to contribute in different ways to cerebellar learning[10].

The proposed PhD project will extend a previously developed detailed network model of the cerebellum. Simulations of the network model will be used to investigate the implications of reward signals and microzones for cerebellar learning. The work will contribute to a better understanding of learning in the cerebellum with potential applications in machine learning and neurorobotics.

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