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Understanding olfactory information processing by combining a physiologically realistic model of the olfactory bulb and olfactory cortex

Simon O'Connor

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The hypothesis that olfactory recognition depends on a distributed associative memory function embedded in the olfactory cortex (OC) was proposed by Haberly and Bower [1]. Since then, a number of abstract OC models have been constructed based on this hypothesis [2-4]. In large part, the associative memory hypothesis was founded on the seemingly random and distributed pattern of both mitral cell afferents to the olfactory cortex, and associative pyramidal connections within the cortex itself [5,6]. However, more recently an analysis of the oscillatory properties of a physiologically realistic model of the olfactory cortex has predicted that the olfactory cortex may contain distributed, but highly specific and separable sub-networks interacting with a similar sub-network structure in the olfactory bulb (OB) [7]. We will present the work of a new multi-laboratory collaboration (Steuber, University of Hertfordshire, Bower, University of Texas Health Science Center San Antonio; Metzner, University of Lübeck), built around linking realistic models of the olfactory bulb [8,9] and cortex [7]. The olfactory bulb model is being extended to explore how neuronal modulation of ion channels as well as bulbar inhibitory effects could support a sub-net organization of output to the olfactory cortex, as well as how sub-net structure in the OB and OC contribute to recorded patterns of oscillatory behaviour [10]. If a sub-network structure exists in both the OB and OC, it will have important implications for the neuronal representation of olfactory stimulus space as well as the process of olfactory perception.

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School of Computer Science, Biocomputation Group, University of Hertfordshire, UK