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Multiple olfactory gamma oscillations: roles in sensation and attention

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This project is aimed at describing the functional role of oscillatory synchrony in olfactory processing. Olfactory bulb and cortex oscillations occur at the level of neural populations, and we studied activity at this level in rats performing olfactory discrimination and attention tasks. Several types of oscillatory activity are seen only in alert and attentive states, and these unique oscillations provide a tool by which to understand the dynamic balance that exists in these neural circuits. We show that there are multiple types of fast oscillations that represent cooperative activity within and between olfactory cortical areas. Type 1 gamma oscillations represent high levels of principal neuron (mitral cell) synchrony within the olfactory bulb. When rats perform difficult odor discriminations in a two-alternative forced choice paradigm, the power of these oscillations during odor sniffing is significantly enhanced over the oscillatory power during easy discriminations. Previous studies showed that artificial disruption of this oscillatory synchrony impaired difficult odor discriminations and artificial enhancement of gamma 1 oscillatory power improved difficult odor discriminations, but we show here that rats change the amount of synchrony dependent on task demands. This is the first evidence in any olfactory system that animals modulate neural synchrony in a context dependent fashion. We also show that the type of oscillations (beta or gamma) and the role of cortical feedback to the olfactory bulb depend on the type of behavioral response that the rat has to produce. In a Go/No-Go task, beta oscillations strongly coherent with the olfactory cortex and the hippocampus predominate. In the two-alternative forced choice task, odor processing appears to be accomplished within the olfactory bulb circuit; type 1 gamma oscillations predominate and show low coherence with olfactory cortex. Our modeling efforts address the role of cortical feedback to the olfactory bulb in the maintenance of beta and type 1 and 2 gamma oscillations.

Project (or PI) Website

http://kaylab.uchicago.edu

Publications

1. Kay, L.M. and Stopfer, M. (2006) Information processing in the olfactory systems of insects and vertebrates. *Seminars in Cell and Developmental Biology*, in press.

Posters:

2. Beshel, J. and Kay, L.M. (2005) Changes in gamma oscillatory power in the rat olfactory bulb as a function of odor learning and task difficulty. Society for Neuroscience Annual Meeting, Washington D.C.

3. Martin, C. and Kay, L.M. (2005) Sniffing-related linking of theta rhythms between the olfactory bulb and hippocampal subfields. Society for Neuroscience Annual Meeting, Washington D.C.