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Title: Respiration-related Oscillations and Theta Rhythms in the Mouse Brain

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Different kinds of brain oscillations occur during different behavioral states. Theta oscillations (4-12 Hz) dominate during locomotion, exploratory behavior and REM sleep, and they are believed to be involved in spatial learning and memory consolidation. Meanwhile, faster gamma oscillations (30-160 Hz) amplitudes are modulated by the theta phase. Another kind of slow oscillation (1-12 Hz) was found in the olfactory bulb (OB) and dorsal hippocampus (DHC). The frequency of these slow oscillations is correlated with respiratory cycles, such that they were called 'respiration-related oscillations' (RR). However, whether RR also exist in other brain regions, and whether they can modulate gamma oscillations is still unclear.

Firstly, I recorded local field potentials (LFPs) from several brain areas *in vivo*, including ventral hippocampus (VHC), prelimbic cortex (PLC), parietal cortex (PaC), OB, and DHC during different behavioral states (active waking (Awk), quiet waking (Qwk) and rapid eye movement (REM) sleep). Then I analyzed RR, theta and gamma oscillations, and phase-amplitude coupling of gamma oscillations to RR and theta oscillations. Finally, in order to investigate whether RR share pharmacological features with theta oscillations, we infused tetrodotoxin (TTX) or muscimol into DHC to inhibit local network activity, and then we compared the power of RR and theta oscillations in OB, PLC, DHC and PaC.

The study shows that during Qwk, RR dominate LFPs in multiple brain regions and exclusively modulate 80-120 Hz (γ2) oscillations. When theta oscillations are present, RR coexist with theta oscillations in all recorded brain regions. In frontal brain regions (OB and PLC), γ2 oscillations are specifically coupled to RR. However, in limbic brain regions (VHC, DHC, and PaC), 40-80 Hz (γ1) and 120-160 Hz (γ3) oscillations are exclusively modulated by theta oscillations.

Additionally, theta oscillations in all recoded areas are suppressed by the infusion of TTX or muscimol in DHC, leaving RR unaffected.

In conclusion, theta oscillations and RR can coexist and are independent from each other. The region- and state- dependent coupling of different gamma sub-bands to slow oscillations may contribute to specific brain functions.