

Learning-related changes in coordinated fast oscillations (35-45 Hz) in the basolateral amygdala (BLA) and rhinal cortices during the acquisition of a trace-conditioning task

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The BLA is thought to facilitate memory formation by the medial temporal lobe in emotionally-arousing conditions. To study how the BLA mediates this effect, we simultaneously recorded neuronal activity in the BLA, perirhinal and entorhinal cortices. Given earlier findings suggesting that neuronal oscillations coordinate the activity of cerebral networks, we first tested whether there are correlated fluctuations in the power of BLA and rhinal field activity at any frequency. Field potentials were simultaneously recorded during the waking state and segmented in one second windows. FFTs were computed for each window, then pairs of these spectrograms were correlated to reveal how well each pair of channels was correlated over time at each frequency. With the exception of low frequencies (<4 Hz), correlated power fluctuations occurred only in the 35-45 Hz band. These fast oscillations were not volume conducted since, in each structure, firing probability fluctuated rhythmically with the fast oscillations recorded at the same site. Moreover, in all cats (n=3), the power of these fast oscillations was highest in the BLA.

To test whether fast oscillations coordinate BLA and rhinal activity during learning, cats were trained on a trace-conditioning task where a visual CS predicted a food reward 3s later. The predictive value of the CS was learned gradually over 10 days. We computed the power at 35-45 Hz in all recorded channels normalized by the total power. As learning progressed, there was an increase in power at 35-45 Hz within the BLA and rhinal cortices. This increase was specific to the delay period between the CS presentation and reward delivery. To determine whether learning produced changes in the correlation of 40Hz oscillations between the BLA and rhinal cortices, we computed the power spectra for all channels and correlated pairs of these spectrograms, as before. This analysis revealed an increase in correlated 35-45Hz power fluctuations during the delay period on late training days. These results were corroborated by computing perievent histograms of BLA and rhinal unit discharges using the positive peaks of fast field oscillations recorded in the BLA as references. BLA and rhinal neurons became rhythmically entrained with BLA oscillations during the delay phase. Thus, our data suggests that neuronal interactions are coordinated by fast oscillations in the BLA-rhinal network. By telescoping the periods of effective neuronal interactions in short recurring time windows, these fast oscillations may facilitate synaptic plasticity.

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