DISCHARGE PROFILES OF JUXTACELLULARLY LABELLED NUCLEUS INCERTUS NEURONS RECORDED IN ASSOCIATION WITH HIPPOCAMPAL FIELD POTENTIAL IN URETHANE ANAESTHETISED RAT

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Theta oscillations occurring in the mammalian brain are characterized by the frequency of 3-12 Hz. This rhythm is likely to be observed in local field potential in the cortex and hippocampus, with the highest amplitude in the stratum lacunosum-moleculare within the CA1 field. Hippocampal network activity underlying theta oscillations plays an important role in numerous brain controlled functions, such as navigation in space, memory formation or generation of different behavioral states. Recent studies has shown that one of the key elements of the ascending reticular activating system, involved in the induction of hippocampal theta rhythmicity, is nucleus incertus (NI) located in the dorsal tegmental pons. NI is a bilateral structure formed of GABAergic projection neurons, adjacent to the brainstem midline right below the fourth ventricle. A subpopulation of NI neurons containing neuropeptide relaxin-3 gives rise to the relaxinergic system involved in stress response and behavioural activation of the animal. However, our knowledge of nucleus incertus and its involvement in mechanisms of theta rhythm generation remain poorly understood. The aim of our study is to characterize NI neurons on the base of their electrophysiological and also biochemical properties in reference to hippocampal oscillations.
All experiments were conducted on Sprague-Dawley rats under deep urethane anaesthesia which is characterized by sleep-like alternations of the brain state. The juxtacellular technique was used to record electrical activity and label single neurons in the NI. At the same time field potential from the hippocampus was recorded using 32 channel multielectrode arrays. After the electrophysiological experiment recorded and labelled cell was histochemically visualized and its neurochemical content was immunocytochemically determined.
Our results show that electrical activity of nucleus incertus neurons is brain state dependent. In majority of cases (ca. 90%) recorded NI neurons increased firing rate during hippocampal theta oscillations comparing to the slow wave activity (SWA). Only the minor population (ca. 10%) of NI neurons showed opposite relation and could be additionally distinguished by firing bursts at delta frequency during SWA. Action potential firing of majority of NI neurons was theta-locked regardless of their pattern of the activity (irregular, regular or bursting) however our preliminary results did not reveal dominant theta phase preference at the level of the whole population of NI neurons.
Results of this research indicate that neurons of the nucleus incertus show activity patterns that are more complex than has been previously described. Combining electrophysiological characterisation and biochemical identification of these neurons may help us to better understand the mechanisms underlying brain stem derived induction of hippocampal theta oscillations.

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