Theta activity in amygdalo-hippocampal pathways related to fear expression and fear memory

Hans-Christian Pape, Institute of Physiology, Medical School, Otto-von-Guericke-University, Magdeburg, Germany

The amygdala has been implicated in a variety of functions, including emotional interpretation of sensory information, emotional memory, fear and ansiety, and related clinical disorders. Despite the clinical and functional importance of the amygdale, it is only recently that some general principles of intra-amygdaloid mechanisms of signal processing have emerged from electrophysiological, anatomical and pharmacological studies. Some of these findings, particularly those that relate to theta oscillations in the limbic system, will be discussed during the seminar. Among the various subnuclei of the amygdala, the lateral nucleus (LA) is considered the major input station of sensory signals arriving via thalamic and cortical afferent inputs, and the major site for receiprocalinteractios with other temporolimbic areas. To a large extent, projection neurons in the LA are capable of producing oscillatory electrical activity at the theta frequency range (4-10 Hz). Oxcilallations reflect intricnsic properties of the neurons and rely on the periodic interaction between specific sets of membrane conductances. Evidence obtained from studies in freely behaving mice *in vivo* and from LA neurons *in vitro* indeed indicates that these neuronal properties fulfill two important functions: (i) the facilitation of synaptic plasticity in the LA, and (ii) the entrainment of amygdaloid activity into theta wave oscillations, resulting in synchronized theta waves in extended circuits of the amygadalo-hippocampal-prefrontal cortical system during the retrieval and extinction of fear memory. Therefore, synchronized theta waves may represent a basic neural correlate of fear memory and expression in these pathways.