Abstract

Oscillations facilitate a fast and flexible communication between distant neuronal networks. In this way they provide a basis for cognitive functions. In the neocortex oscillations in different frequency bands occur already during early development. This early activity patterns play a role for the formation and connectivity of developing networks regarding their future functional requirements. The temporal and spatial organisation of early activity patterns in relation to the age-dependent refinement of networks is largely unknown.

Aim of this study was the investigation of neuronal processing and communication within local networks of the prefrontal cortex (PFC) during early development. Network activity was measured *in vivo* with extracellular electrodes in different cortical layers of the PFC of neonatal, pre-juvenile and juvenile rats. Earlier investigations have shown that the prefrontal network activity during development progressively switches from a discontinuous rhythm, consisting of two distinct activity patterns – spindle bursts (SB) and nested gamma spindle bursts (NG) – to a continuous rhythm. Part of this work was the development of a method to automatically detect and classify this activity patterns. This method allows their subsequent investigation concerning their frequency components, synchronisation patterns and their influence on neuronal firing.

Frequency analyses show that the base rhythm of all prefrontal oscillations lies within the *theta/alpha*-band (4-12 Hz). During NG this rhythm alternates with a faster rhythm in the *beta/low gamma*-frequency band (16-40 Hz). Additionally, NG are accompanied by high frequency oscillations (HFO) between 100 and 400 Hz. This HFO appear superimposed on the NG rhythm. In the neonatal age the oscillatory power shows differences between the upper and lower layers of the PFC. This difference is most prominent for the HFO and dimishes with age. Similar dependence of age and cortical depth was found for the synchrony within single frequency bands that was investigated using a coherence analysis. While *theta/alpha*-oscillations show a strong intralaminar coherence, the *beta/low gamma*-activity is synchronized in a

column-like manner. This synchrony patterns diminish with age. Mainly during early staged of development the amplitude of HFO is strongly modulated by the phase of the base rhythm. Spiking of prefrontal neurons is in turn highly coupled to the phase of the HFO.

Network activity in the developing PFC shows a complex spatio-temporal structure that changes during maturation. Each developmental stage is characterized by distinct activity and synchronisation patterns that are strongly related to the anatomical maturation of the PFC and could have an influence on the formation of connectivity within the PFC.