Interplay of rhythms makes brain centers communicate

April 25 2014

Tübingen neuroscientists say differing rhythms coordinate the neural activity governing movement.

Although we are seldom aware of it, even simple motor actions like lifting a hand depend on complex communication processes between multiple structures in different parts of the brain. Recent studies show that rhythmic activities of groups of neurons may be fundamental to neuronal communication. However, we still have only a poor understanding of the exact roles of different brain rhythms and how they interact.

A recent study by Constantin von Nicolai and Markus Siegel from the Werner Reichardt Centre for Integrative Neuroscience (CIN), University of Tübingen sheds new light on these issues. In collaboration with colleagues from Hamburg and Oxford, von Nicolai and Siegel investigated the coupling of different brain rhythms in the cortex and the striatum. The striatum is a subcortical structure that is part of the basal ganglia and plays an important role in movement generation. In their study, published in the latest *Journal of Neuroscience*, von Nicolai and his colleagues recorded neuronal activity during running on a treadmill. They observed two prominent brain rhythms - a slow and a fast rhythm - that both depended on the running speed. These rhythms were not independent, but instead showed a characteristic pattern of interaction. The slow rhythms systematically modulated the strength of fast rhythms through phase-amplitude coupling. Furthermore, the slow rhythms were tightly synchronized between the cortex and the striatum. Von Nicolai and colleagues showed that, together, these phenomena led to a temporal coordination of bursts of fast rhythms between brain structures.

These results point to a new basic mechanism in the ways different brain rhythms may cooperate to mediate interactions between brain structures. The synchronization of slow rhythms is important for neuronal interactions on a global scale, while fast rhythms are important for neuronal processing on a local scale. Thus, the coordination of fast rhythms across different brain structures by slow rhythms might be a fundamental mechanism to integrate neuronal processing across different spatial scales.

The results of von Nicolai and his colleagues also have implications for the study of different brain diseases. Rhythmic processes are not only found in the healthy brain, but likely also play an important role in various neuropsychiatric disorders, such as Parkinson's disease. The main brain system affected by pathological processes in Parkinson's disease are the basal ganglia and the cortico-striatal axis investigated in this study. Thus, their results may open a new window for understanding the mechanistic disturbances that underlie motor dysfunctions and cognitive impairments in Parkinson's and similar diseases.

More information: von Nicolai C, Engler G, Sharott A, Engel AK, Moll CK and Siegel M: "Corticostriatal Coordination through Coherent Phase-Amplitude Coupling." *Journal of Neuroscience* 34(17):5938-5948, April 23, 2014

Provided by Universitaet Tübingen