Neuronal synchrony as underlying mechanism for learning and memory.

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Neuronal synchronization has for the past 15 years been a hotly debated feature of cortical signal processing. Although we still don't understand the role of synchronization for cortical processing, a growing number of experimental results suggests that synchonized firing of neurons could be a fundamental constituent of all cortical operations that require rapid integration of distributed information. During the past ten years, a number of experiments have demonstrated that the induction of synaptic plasticity highly depends on the precise timing of pre- and postsynaptic activation (spike timing dependent plasticity). The observations that synchrony could serve as a mechanism for postsynaptic integration via spatial summation and the need for synchronization of pre- and postsynaptic activity for the induction of plasticity suggests that at the system's level integration and plasticity are tightly linked. We have been performing experiments in which we tried to explore both the formation of spatially distributed assemblies defined by the synchronization of their firing and at the same time modifications of response propoerties as a sign of functional plasticity. In particular we used the primary visual cortex of anesthetized cats as a model system for synchronization of large neuronal populations and their orientation preference as a measure of their response properties. To investigate whether synchronization is functionally relevant, we performed experiments in trained monkeys and recorded widespread cortical areas simultaneously. The results support the notion that synchronization is a widespread feature of cortical circuits under various functional conditions which is correlated with processes subserving attention, memory and the generation of motor responses.

Selected Bibliography

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