EEG/MEG oscillatory synchronization in sensory and cognitive functions

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Mental processes are known to activate distributed networks of specialized neural structures. Neuroimaging techniques provide more and more precise pictures of these networks in different sensory and cognitive situations but the neural mechanisms underlying the network dynamics has been much less explored. It has been proposed that the co-operation within or between brain areas involved in sensory and cognitive processes could be based on the dynamic synchronization of the underlying neural populations in an oscillatory mode (in the beta and gamma ranges). This hypothesis has been supported at different levels, with unit and local field potential recordings in animal studies, and at intermediate (intracranial EEG) and more macroscopic levels (scalp EEG/MEG) in humans. We will review these human findings showing a functional role of beta/gamma oscillations in various mental processes related to perception, attention and memory. The contribution of these different levels of recording to investigate local- versus large-scale cortical synchronization will also be discussed.

Direct intracranial recording of induced beta/gamma oscillations in human cortex

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Neural oscillatory synchronization has been proposed as a dynamic link between the different brain areas engaged into the same perceptual or cognitive process. This hypothesis has mainly been supported by studies in the visual modality, either at the unit level in animals or at a macroscopic level from human scalp EEG/MEG. In this latter case, induced gamma oscillations have been proved to be strongly associated with perception and rehearsal of coherent objects and to be modulated by attentional top-down processes. Similar oscillations have been observed in other sensory modalities but have been much less studied.
We studied the temporo-spatial characteristics and the attentional modulation of induced beta/gamma oscillations in the visual and the auditory systems. For that purpose, we recorded intracranial EEG in the temporal cortex of epileptic patients in several situations: visual short-term memory task, passive listening and active auditory discrimination tasks. Several focal sources of gamma oscillations have been found along the ventral visual pathway, and in the auditory cortex. These gamma sources showed differential modulations by attention. With similar timing, stimulus induced decrease of on-going beta activity (15-20 Hz) was also observed at different focal location of the supra-temporal cortex. The respective time-courses of these beta/gamma oscillatory activities and their modulation by attention will be described and discussed.

Suggested readings (pdf available for references in bold)

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