

## **Gamma Oscillations: Types, Neuronal Mechanisms and Functional Correlates**

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Gamma oscillations build the faster range of brain electrical oscillations between ~25 and 90 Hz that can be observed in the local field potentials (LFPs) of various cortical and subcortical brain structures of several species and can be measured by intracranial EEG or ECoG, but also non-invasively through scalp EEG or MEG. While gamma frequency range constitutes a spectral part of the ongoing brain electrical activity, gamma oscillations can also be evoked phase-locked to a transient event, induced in non-phase-locked manner in the peri-event period or can be driven by rhythmic stimuli around 40 Hz. Although the precise mechanisms of these different gamma phenomena are not conclusively explored, they plausibly rely on similar neuronal circuits. The cellular origins of the gamma oscillations seem to depend on the connectivity of inhibitory interneurons with other interneurons (I-I) or with pyramidal cells (E-I). Significant associations of the gamma rhythm with several cognitive functions and with a number of neuropsychiatric conditions point to a fundamental role of the gamma oscillations as a universal operator of the brain function. The correlations of the gamma oscillations with fMRI-BOLD signal and its coupling with slower rhythms of the brain will be included in this overview.

## **Gamma Frequency Entrainment and Metacognition in Early State Psychosis**

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Metacognition, the process of thinking about one's own thinking, involves a range of faculties that allow an individual to form representations of mental states of the self and others. Persons with schizophrenia usually show impaired metacognition, but the neurocognitive basis for this impairment is not well characterized. We hypothesized that metacognitive capacity might depend on capacity of neural circuits to synchronize at gamma frequencies. In the present study, metacognition, insight and the 40 Hz auditory steady state response (ASSR) were assessed in eighteen adults with first episode psychosis. Metacognition was assessed with the Metacognition Assessment Scale Abbreviated, and insight was assessed with the Scale of Unawareness of Illness-Abbreviated. The electroencephalographic auditory steady state response to gamma range stimulation (40 Hz) was used to assess neural synchronization. Pearson correlation coefficients revealed that increases in 40 Hz ASSR power were associated with poorer metacognition and insight. These results suggest that altered neural synchronization may contribute to impairments in metacognitive processes required for insight into mental processes in one's own self and others.

## **Biomarkers for predicting suicide risk**

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Previous studies have indicated that the abnormalities of brain activity are associated with suicidal behavior. However, few studies have investigated neurophysiologic biomarkers of suicide attempt (SA) and suicidal ideation (SI) in depressed patients. Here, we examined alterations of quantitative EEG (QEEG) in brain regions associated with SA and SI in patients with depression. Resting QEEG data were recorded from 533 patients with depression. According to this, there were a non-suicidal group (n = 218), a suicidal group (n = 211), a suicide attempters group (n = 74) and a healthy control group (n = 30). We found a significant correlation with absolute power in high gamma band at F4, Fz, C4, Cz, O2, F8, T5 and T6 electrode sites of suicide attempter group. Results showed that suicide attempted group elicited significantly higher gamma absolute power at all these electrode sites compared to the other groups. In the light of these results, it can be said that high gamma absolute power could be seen as a predictor of suicide attempt in patients with depression. EEG activity in high gamma absolute power in given regions has clinical potential as a biomarker for preventing suicide.

## **Gamma oscillations in depression**

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Gamma oscillations represent oscillations faster than 25Hz in EEG frequency spectrum. Although gamma oscillations are commonly linked to cognitive and intellectual processing, their clinical significance was not explored extensively. Studies indicated that gamma oscillations could be related to cognitive functions in depressed patients as well as their suppression could be associated with clinical improvement. In addition, gamma oscillations may also be used as a biomarker. In the study that I will present, we explored prognostic value of gamma oscillations in patients with depression. The results showed that the patients with increased pre-treatment gamma power responded worse to treatment as compared to patients with lower gamma power. As Prof. Arikan will present in his talk, we also found that elevated gamma is associated with greater risk of suicide. These results show that EEG data of patients with depression should also be examined for gamma power, as elevated gamma is associated with worse antidepressant response, lower cognitive functioning and greater suicide risk.