Title:
Neuronal synchronization during saccade planning and execution in the human brain.

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Abstract:
Saccadic eye movements are crucial for natural human vision, yet little is known about the underlying cortical dynamics. Various experiments addressing covert attention, working memory and sensory-motor mapping suggest that rhythmic population activity is important for controlling eye movements. Here we investigate the role of such neuronal oscillations for saccade planning and execution in the set of human homologues of the eye movement related areas.

We recorded the magnetoencephalogram (MEG) and eye movements while subjects performed a centrally cued delayed saccade task to peripheral targets in different directions and distances. The MEG signal around the time of saccades is heavily confounded by eye movement artefacts. Here we present a method to account for these artefacts by a combination of linear regression with the electrooculogram and analysis in source space using linear beamforming.

In general, our data reveals modulations of spatially specific spectral signatures that relate to the dynamics of saccade planning and execution: We found sustained high gamma band synchronization (70-90 Hz) independent of the saccade direction in medial frontal areas during the whole planning and execution phase of a saccade. Sustained signals reflecting saccade metrics were located in posterior parietal cortex and comprised desynchronization at low frequencies (10-20 Hz) and synchronization in the high gamma band (70-90 Hz). With saccade onset we found a transient synchronization in the gamma band (50-100 Hz) in parietal cortex. Furthermore, we identified sustained alpha band synchronization (6-12 Hz) in occipital areas that was constrained to the planning phase. It was followed by a transient synchronization in the beta band (10-30 Hz).

In summary, our data suggests that rhythmic population activity is crucial for planning and execution of saccades.

Keywords:
FEF, IPS, EEG, frontal eye fields, intraparietal sulcus