Coherent oscillations and synchronous activity are suggested to play an important role in selective processing and dynamic routing of information across the primary visual cortical areas. In this contribution we show that local power spectral amplitudes and phase coherency between distant recording sites allow to distinguish almost perfectly between two attentional states in a behavioural task, thus giving strong quantitative support for a functional role of oscillatory neural dynamics. Macaque monkeys were trained to perform a delayed-match-to-sample task, in which the animals had to direct attention to one of two sequences of morphing shapes presented on a computer screen. The task was to signal the reoccurrence of the initial shape of the attended morphing sequence. Recordings of local field potentials (LFPs) were performed with an array of chronically implanted intracortical micro-electrodes in one animal, and epidural recording arrays in two animals. These arrays covered parts of areas V1 and V4. We employed different stimulus sizes and configurations, ranging from 1 to 4 degrees in visual angle for the shape's diameters, and from 1 to 4 degrees visual angle in shape separation.

The signals were split into their frequency components by applying a Morlet-wavelet transform. From the transformed data, we computed the phase coherency (i.e. a complex-valued scalar with amplitude <=1 and a phase difference) averaged over a time interval of 2500 ms, for every electrode pair. We then used a support vector machine (SVM) to classify the attended state (attention directed either to one or to the other sequence) from the power spectral amplitudes and mean phase differences between two recording sites. Strikingly, nearly perfect state identification (up to 99.9% correct) was possible from several pairs of electrodes in V4, mainly in the frequency bands of 48 Hz and 61 Hz. From V1-V4 electrode pairs, classification with up to 76% correct was possible. A similar performance was obtained using the spectral power of single electrodes in V4 in the Gamma frequency range. Our results show that power spectral amplitudes as well as phase differences between signals from V4 can accurately inform about the direction of attention to different locations in visual space in every single trial. This effect is robust against continuous changes of the shapes at the attended location. In addition, these findings are stable under the use of different recording techniques and various stimulus configurations, thus pointing to a key mechanism based on coherent oscillations for processing information under attention.