OSCILLATIONS

Networking improves performance

Different brain areas, each specialized for a particular function, interact with each other during a cognitive operation, thus temporarily forming a functional cortical network. Using a new method of analysis, Hipp and colleagues now reveal that during sensory stimulation, two networks emerge, and that synchronized activity in these networks influences perception.

Previous studies have suggested that communication between brain areas may be promoted by synchronization of oscillatory activity in these areas, but direct evidence for this has been difficult to obtain owing to methodological constraints. In this study, Hipp and colleagues analysed electroencephalography (EEG) recordings from across the brain using a novel method based on cluster permutation statistics, to establish whether the activity of a local neuronal population is synchronized with that of other populations during sensory stimulation. This method enabled them to identify synchronized networks without having to make any *a priori* assumptions regarding the spatial structure or the frequency band of the networks.

Study participants underwent EEG recording while they watched two parallel bars moving towards each other on a screen. At the moment at which the bars overlapped — which in some trials was accompanied by a 'click' sound — the subjects perceived the bars either as bouncing off each other (bounce trials) or as passing each other (pass trials). Playing the sound increased the likelihood of the bars being perceived as bouncing, reflecting integration of auditory and visual inputs. The subjects indicated after each trial, with a button press, whether they had perceived a bounce or a pass.

Contrasting neuronal activity during stimulation and at baseline, the authors found synchronization of oscillatory activity in the beta frequency in a highly structured, bilateral cortical network consisting of frontal, parietal and extrastriate areas. The strength of the beta coherence was greater during bounce trials than during pass trials. Moreover, the difference in coherence between bounce and pass trials was apparent before the moment at which the bars overlapped, indicating that beta coherence in this network might actually cause the subjects to perceive the stimulus as a bounce rather than a pass.

When the authors contrasted neuronal activity during bounce and pass trials, they found a network in the left hemisphere consisting of central and temporal regions that showed greater synchronization of oscillations in the gamma frequency during bounce trials than during pass trials. This coherence was greatest in subjects whose percept of the bar overlap was not influenced by the addition of the sound, and was absent in participants for whom the click sound strongly influenced the way they perceived the moment of bar overlap. The authors interpreted this as meaning that in some participants gamma coherence in this network may be needed to integrate the auditory and visual input.

The unbiased analysis of EEG data used in this study has revealed two large-scale, frequency-specific functional neural networks that emerge during a perceptual task, and synchronization in these networks influences performance on the task. The factors that regulate the emergence and coordination of such functional networks remain an important topic for future research.

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ORIGINAL RESEARCH PAPER Hipp, J. F., Engel, A. K. & Siegel, M. Oscillatory synchronization in large-scale cortical networks predicts perception. *Neuron* **69**, 387–396 (2011)
FURTHER READING Fell, J. & Axmacher, N. The role of phase synchronization in memory processes. *Nature Rev. Neurosci.* **12**, 105–118 (2011)