The neural architecture of visual awareness

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Many previous studies have examined various aspects of the neural architecture of visual consciousness using MRI, e.g. studies of grey matter volume, white matter integrity, or GABA, but often in samples that are smaller than power analyses would suggest to be sufficient. Here, I present the framework of our large-scale experimentation in COST Action 18106 where each study relates a range of MRI-based indices of neural architecture to behavioural consciousness data in samples of typically minimum 200 participants. I present preliminary data from the Action as well as already published findings from precursors of the Action1,2, and I discuss the relevance to theories of consciousness.

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Electrophysiological correlates of first and second-order consciousness
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Perceptual consciousness encompasses two interrelated phenomena: the subjective experience associated with a sensory event, and the reflexive monitoring of the corresponding percept which involves a second-order representation of a stimulus. The study of first and second-order consciousness is now based on empirical yet mostly distinct grounds. A way to simultaneously characterize first and second-order consciousness is to ask volunteers to detect stimuli presented around the threshold for detectability, and to provide subsequent confidence ratings about the likelihood that they correctly detected the stimulus. Based on this paradigm, I will present a series of behavioral, electrophysiological, and modeling results documenting the commonalities and specificities of the mechanisms involved in first and second-order conscious processes.

What constitutes an optimal brain architecture? The role of sensory processing versus sleep
Chen Song
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Structure shapes function. Understanding what kinds of brain structure are optimal for cognitive function is fundamental to neuroscience research as well as to the design of artificial intelligence. Traditionally, large brain volumes, large number of neurons and strong neural connections are considered beneficial. In this talk, I will present our experimental and theoretical work that challenges the conventional wisdom. We show that a functionally optimal visual cortex is constituted of a large cortical surface area, but a small cortical thickness and weak lateral connections. This architecture enables neurons in visual cortex to have high selectivity, short latency, and human participants to excel in visual tasks. To achieve the optimal brain structure, we show that sleep plays an essential role. Sleep facilitates the overnight improvement in cognitive function through homeostatic weakening of neural connections and thinning of cortex, at both a cellular and a system level. The overnight brain structural changes in turn enhance the cost-efficacy of brain activity. I will conclude by discussing how a balanced view of brain structure and function requires the consideration of sleep-wake cycle, and how the contrast between awake and sleeping brain activity may be key to our intelligence.

Modulation of auditory steady-state responses by the fluctuations in the state of consciousness

Marek Binder
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Auditory-steady state responses (ASSRs) are defined as the frequency-domain EEG activity elicited by the periodic acoustic stimulation. These oscillations reflect not only the integrity of the auditory system within the cortex and the subcortical regions, but they also appear to be sensitive to the fluctuations in the state of consciousness. During this talk I will present the results of our recent research on sleep and disorders of consciousness and how they influence the ASSR, and describe our experiments aimed to identify the mechanisms underlying this sensitivity.