Neural Dynamics for Cognitive Control in Vision

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The computational Theory of Vision was proposed by David Marr in his book [1] as an early work for the elucidation of neural representation and computation in seeing. The early stage of visual processing has been remarkably clarified in these decades, while the level of conceptual representation and its neuronal operation in a part of cognitive control is still an open question. We proposed that synchronization of neural networks in visual system can provide flexible top-down control of visual processing in an visual environment as a scene. The phase coding in neuronal oscillations enables the figure-ground separation. We recently elucidated brain dynamics of cognitive controls in visual working memory and social tasks by using EEG and MRI. Our results demonstrate the central execution system and sensory areas are dynamically linked through synchronization in theta and alpha ranges according to task demands. The EEG synchronization in multiple frequencies indicates that multiple processes of cognitive functions are dynamically controlled independently and cooperatively through concurrent synchronizations to give network emergence in the brain.

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