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Stan Gielen is full professor in Biophysics at the Radboud University Nijmegen with an appointment both in the Faculty of Science and in the Medical Faculty. He holds a PhD in physics. His main interest is in information processing in the brain, focusing on perception and action and on adaptive learning. His work includes both experimental studies, using electrophysiology and neuroimaging techniques, and theoretical approaches. The results of his work have been used in many applications and he was co-founder of several spin-off companies. He was director of the Donders Institute for Brain, Cognition and Behaviour at the Radboud University Nijmegen until September 2010, when he was appointed as Dean of the Faculty of Science.

He is a member of the Royal Dutch Academy of Arts and Sciences since 2010.

Abstract

Complexity in the brain: Emergent behaviour from complex interactions within and between neurons.

The brain is the most complex organ of the human body with unprecedented flexibility. This flexibility is attributed to the adaptive and flexible task-dependent reorganization of the brain in neuronal assemblies that operate in parallel.

Understanding brain function requires a detailed insight into the properties of single neurons and the consequences of adaptive interactions between neurons at different scales of space and time. I will explain that neurons are complex nonlinear systems with multi-stability and hysteresis. These properties provide the key for the distributed parallel processing of the brain. Because of the property of multi-stability, several identical neurons with identical input can be in different states. This explains how groups of neurons form assemblies in a task-dependent way and why different assemblies of neurons may be active in parallel in different tasks. The generation of neuronal assemblies is due to bottom-up sensory input and high-level top-down input, related to attention and cognition. It is one of the most challenging problems to understand how top-down cognitive processes steer low-level neuronal processing as this is the ultimate example of a complex self-organizing system.