HBP SCIENCE MARKET

SYSTEMS AND COGNITVE NEUROSCIENCE

SP3

What we do

Our goal is to uncover neural mechanisms underlying cognitive processes such as learning, multisensory integration, perception, sleep, consciousness, and associated systems phenomena.
Our results constrain computational models of cognitive and systems-level processes that will be implemented in robots and neuromorphic computing systems. SP3 unifies different disciplines by addressing these issues at multiple study levels (cells, groups, networks, brain systems).
One of the deepest problems in science is the nature of consciousness. How is consciousness generated by the brain? Novel ways to measure consciousness will make us less dependent on behavioural measures, which will benefit minimally conscious patients. Similarly, how can disparate phenomena such as sleep and wakefulness emerge from the same cortico-thalamic systems? We will investigate slow-wave activity and simulations of large populations of firing neurons in mice and humans.
We also investigate brain mechanisms of memory. Episodic memory is the memory of our personal, conscious experiences set within space and time. We will identify the neuronal mechanisms behind episodic memory, and validate them by computational models and robotic systems.
In relation to this, how does the brain create a representation of an object from multisensory input? Representations form the building blocks for higher cognitive processes. One goal is to develop a "deep learning" artificial neuronal network that learns to recognize objects and functions similar to real neurobiological systems.
Finally, we engage in Co-Design projects which facilitate interactions between scientific groups and platforms. We focus on models of learning in large-scale systems and on how visual signals are transferred into motor commands.
By its cross-disciplinary approach to multiple levels of neural and brain organization, SP3 will elucidate mind–brain relationships that have eluded explanation for centuries.

How we are organised

WP3.1 CONTEXT-SENSITIVE MULTISENSORY OBJECT RECOGNITION. Aims to develop an understanding of neural interactions and models incorporating information processing in a realistic theory of how we recognise objects within certain contexts.
WP3.2 WAVE SCALING EXPERIMENTS AND SIMULATIONS. Focuses on slow wave activity (SWA), and asks such questions as how SWA changes when the brain state changes.
WP3.3 EPISODIC MEMORY AS MULTISENSORY RECONSTRUCTION. Conducts experiments to identify the neuronal mechanisms behind episodic memory, validate them using computational models and robotic systems, and test how they fail in old age and dementia.
WP3.4 EXPERIMENTAL AND COMPUTATIONAL EXPLORATION OF CONSCIOUSNESS MECHANISMS AND METHODS IN MICE AND HUMANS. Aims to: a) test and improve physiological methods for assessing consciousness; and b) contribute to understanding the nature of consciousness by testing theories. This will be done using experiments to test principles in mice, and then using the insights from these and from computational modelling to develop better non-invasive methods in humans.
WP3.5 SCIENTIFIC COORDINATION, PROJECT MANAGEMENT AND COMMUNICATION. Coordinates inter-WP work within SP3 and its links with other SPs, the entire HBP and the larger neuroscience community. Its project management and communication brief covers quality assurance, ethics reporting, innovation, outreach, and public engagement.
WP3.6 SP3 CONTRIBUTIONS TO CO-DESIGN PROJECTS AND INFRASTRUCTURE. Supports the HBP Co-Design Projects and Infrastructure coordination beyond that of WP3.5.

SP LEADER Cyriel PENNARTZ
DEPUTY SP LEADERS Lars MUCKLI
Pier Stanislao PAOLUCCI
WORK PACKAGE LEADERS

- WP3.1 Context-sensitive Multisensory Object Recognition: Lars MUCKLI
- WP3.2 Wave Scaling Experiments and Simulations: Pier Stanislao PAOLUCCI
- WP3.3 Episodic memory as multisensory reconstruction: Cyriel PENNARTZ
- WP3.4 Experimental and computational exploration of consciousness mechanisms and methods in mice and humans: Johan Frederik STORM
- WP3.5 Scientific Coordination, Project Management and Communication: Cyriel PENNARTZ
- WP3.6 SP3 contributions to Co-Design Projects and Infrastructure: Cyriel PENNARTZ

SP MANAGER Ingar SEEMANN

Publication highlights

Bodart O, Gosseries O, Wannez S, Thibaut A, Annen J, Boly M, *et al.* ***Measures of metabolism and complexity in the brain of patients with disorders of consciousness.*** NeuroImage: Clinical, 2017;14(Supplement C):354–362. DOI: 10.1016/j.nicl.2017.02.002.

Bos JJ, Vinck M, van Mourik-Donga LA, Jackson JC, Witter MP *et al.* ***Perirhinal firing patterns are sustained across large spatial segments of the task environment.*** Nat Commun 2017;8:15602. DOI: 10.1038/ncomms15602.

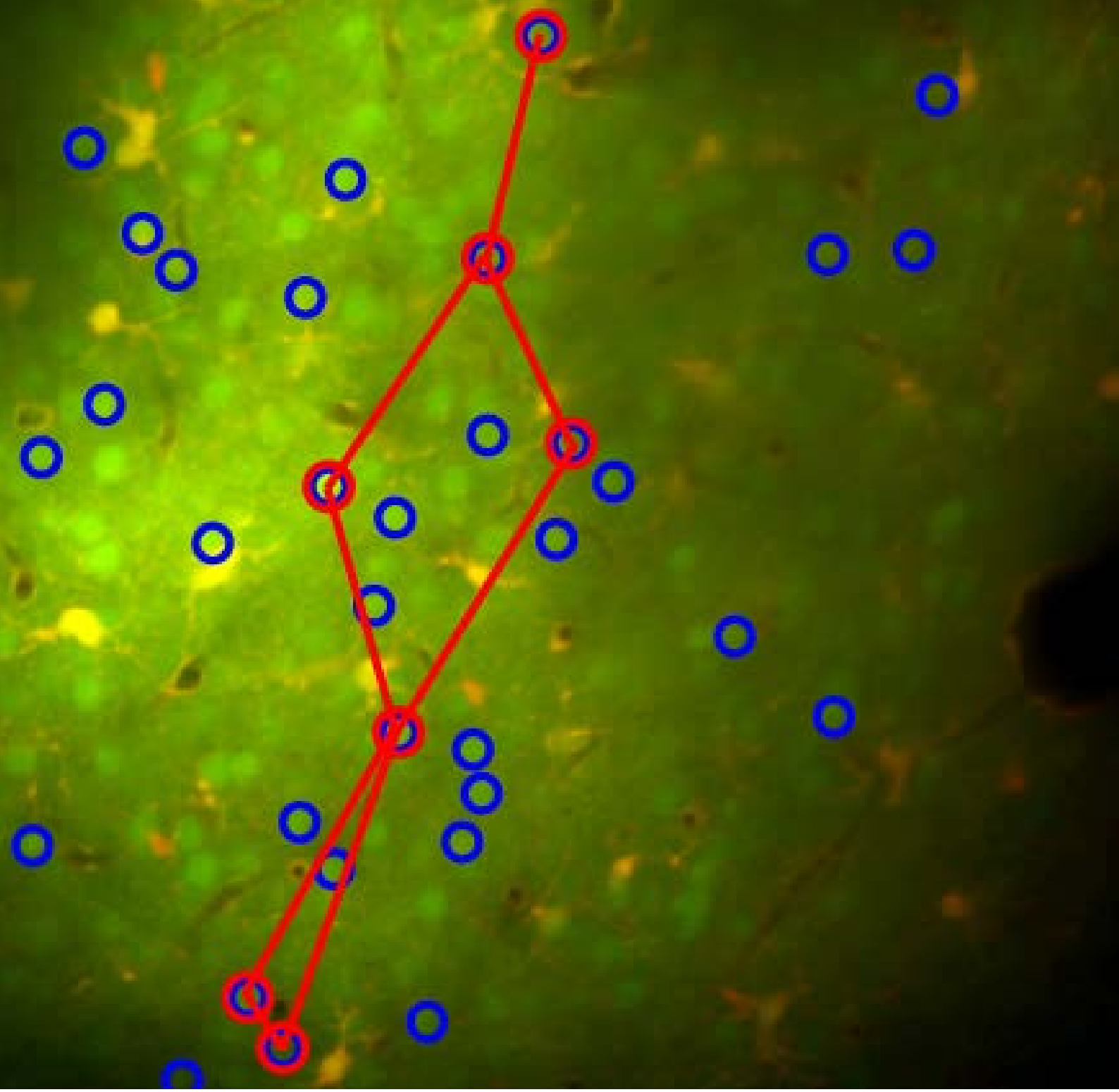
Sanchez-Vives MV, Massimini M, Mattia M. ***Shaping the default activity pattern of the cortical network.*** Neuron 2017;94:993–1001. DOI: 10.1016/j.neuron.2017.05.015.

Suzuki M, Larkum ME. ***Dendritic calcium spikes are clearly detectable at the cortical surface.*** Nature Commun. 2017;8:276. DOI: 10.1038/s41467-017-00282-4.

Contact

Ingar SEEMANN i.seemann@uva.nl

https://www.humanbrainproject.eu/en/about/project-structure/subprojects/



Human Brain Project

Co-funded by
the European Union