2018-2019

CIMeC Doctoral Program Colloquia

LIST:

08/11/2018: **Monica Gori** - Istituto Italiano di Tecnologia, Italy.

TITLE: From science to technology: the interaction between senses during the development and the creation of new rehabilitation devices.

10/01/2019: **Rufin Van Rullen** - Centre de Recherche Cerveau et Cognition (CerCo), CNRS, Toulose, France.

TITLE: Alpha oscillations, travelling waves and predictive coding.

07/02/2019: **Christian Doeller** - Director, Max Planck Institute for Human Cognitive and Brain Sciences, Department of Psychology, Leipzig, Germany AND Professor of Medicine (Neuroscience), Kavli Institute for Systems Neuroscience, NTNU - Norwegian University of Science and Technology, Trondheim, Norway.

TITLE: Structuring experience in cognitive spaces.

07/03/2019: **John van Opstal** - Professor Biophysics Donders Institute for Brain, Cognition and Behaviour and at Faculty of Medical Sciences at Radboud University.

TITLE: Sound localisation is ill-posed. What to do?

04/04/2019: **Antje Nuthmann** - Full Professor (W3) for Perception and Cognition, Institute of Psychology, University of Kiel (Germany).

TITLE: Perception, Attention and Eye Guidance in Real-world Scenes: Experiments and Modelling.

09/05/2019: **Simon Thorpe** - DRCE CNRS Centre de Recherche Cerveau & Cognition UMR 5549 Hôpital de Purpan Toulouse.

TITLE: Finding repeating patterns: A key to intelligence in man and machine?

06/06/2019: **Matteo Carandini** - Professor – University College London.

TITLE: Local and global neural correlates of vision and action.

04/07/2019: **Joachim Gross** - Professor (W3) and Director of Institute for Biomagnetism and Biosignalanalysis, University of Muenster.

TITLE: Using MEG to study the dynamics of information processing in the human brain.

DETAIL:

08/11/2018: **Monica Gori** - Istituto Italiano di Tecnologia, Italy.

TITLE: From science to technology: the interaction between senses during the development and the creation of new rehabilitation devices.

"It is evident that the brain is capable of large-scale reorganization following sensory deprivation but the extent of such reorganization is not clear to date. Many works show that the visual modality is crucial to develop spatial representations and the auditory modality is crucial to develop temporal representations. Blindness and deafness are ideal clinical conditions to study the reorganization of spatial and temporal representations when the visual or audio signals are not available. I will present our data on the development of cross-sensory spatial and temporal skills in typical, blind and deaf children and adults. Results show that blind and low vision children and adults are impaired in some audio and tactile spatial skills and deaf are impaired on visual temporal processing. These results support the importance of these modalities on the cross-sensory development of spatial and temporal representations. I will also present EEG results in blind and deaf individuals to support this idea showing that the sensory cortices have a pivotal role in building a high resolution and flexible spatial and temporal representations within the audio and visual modality and that these mechanisms are experience dependent. Finally, I will show that it possible to improve spatial representation skills in blind individuals with specific rehabilitation training. Previous works have shown that in sighted children the development of spatial representation is strictly related to the link between body movements and visual feedback. By 5 months of age, sighted infants start to watch movements of their own hands and reach out towards interesting objects. The onset of this successful sensory-motor association likely mediates the effects of visual experience on spatial representations in the sighted infant (Bremner et al., 2008). When the visual information is unavailable, the natural visual sensory feedback associated with body movement, and crucial for the development of space-representation, is missing. We investigated whether a new sensory-motor training based on audio-tactile-motor feedback associated with body movement can be used to improve spatial representation in blind and low vision children. 42 children between 3 and 15 years of age participated in 3 months of rehabilitation training with the new device. Results suggest that it possible to use audio feedbacks associated with arm movement (e.g. small audio speakers positioned on the child's wrist) to rehabilitate space representation in blind children."

10/01/2019: **Rufin Van Rullen** - Centre de Recherche Cerveau et Cognition (CerCo), CNRS, Toulose, France.

TITLE: Alpha oscillations, travelling waves and predictive coding.

“Alpha oscillations are not strictly spontaneous, like an idling rhythm, but can also respond to visual stimulation, giving rise to perceptual "echoes" of the stimulation sequence. These echoes propagate across the visual and cortical space with specific and robust phase relations. In other words, the alpha perceptual cycles are actually travelling waves. The direction of these waves depends on the state of the system: feed-forward during visual processing, top-down in the absence of inputs. I will tentatively relate these alpha-band echoes and waves to back-and-forth communication signals within a predictive coding system.”

07/02/2019: **Christian Doeller** - Director, Max Planck Institute for Human Cognitive and Brain Sciences, Department of Psychology, Leipzig, Germany AND Professor of Medicine (Neuroscience), Kavli Institute for Systems Neuroscience, NTNU - Norwegian University of Science and Technology, Trondheim, Norway.

TITLE: Structuring experience in cognitive spaces.

“The fundamental question in cognitive neuroscience—what are the key coding principles of the brain enabling human thinking—still remains largely unanswered. Evidence from neurophysiology suggests that place and grid cells in the hippocampal-entorhinal system provide an internal spatial map, the brain’s SatNav—the most intriguing neuronal coding scheme outside the sensory system. Our framework is concerned with the key idea that this navigation system in the brain—potentially as a result of evolution—provides the blueprint for a neural metric underlying human cognition. Specifically, we propose that the brain maps experience in so-called ‘cognitive spaces’. In this talk, I will give an overview of our theoretical framework and experimental approach and will present show-case examples from our fMRI, MEG and virtual reality experiments identifying cognitive coding mechanisms in the hippocampal-entorhinal system and beyond.”

07/03/2019: **John van Opstal** - Professor Biophysics Donders Institute for Brain, Cognition and Behaviour and at Faculty of Medical Sciences at Radboud University.

TITLE: Sound localisation is ill-posed. What to do?

“The brain estimates the two-dimensional direction of sounds from the pressure-induced linear displacements of the eardrums. Accurate sound localisation along the horizontal plane (azimuth angle) is enabled by binaural difference cues in timing and intensity. Localisation along the vertical plane (elevation angle) relies on complex spectral-shape cues made possible by elevation-dependent filtering in the pinna. However, the problem of extracting elevation from the sensory input is ill-posed, since the spectrum results from a convolution between source spectrum and the particular head-related spectral filter (HRTF) associated with the source elevation, which are both a-priori unknown to the system. As a result, sound localization should be impossible, as infinitely many sound-wave patterns can give rise to identical inputs at the eardrums. Yet, humans can localise sounds in unknown environments with considerable accuracy and precision. I will argue that the auditory system relies on several non-acoustic assumptions (priors) to cope with the ill-posed nature of the localisation problem, and will describe results from experiments in our lab that probe these priors.

These considerations have also implications for restorative therapies and device-encoding strategies of the hearing impaired."

04/04/2019: **Antje Nuthmann** - Full Professor (W3) for Perception and Cognition, Institute of Psychology, University of Kiel (Germany).

TITLE: Perception, Attention and Eye Guidance in Real-world Scenes: Experiments and Modelling.

"How do we gather real-world visual information for perception and action? Our approach is to record observers' eye movements to indicate where attention is being allocated in static and dynamic images of real-world scenes. In the first part of this talk, I will summarize recent research on the spatial (Where?) and temporal (When?) decisions involved in eye-movement control during scene perception. Our research on the decision where next to fixate challenges the conventional view that visually salient regions of scenes attract attention and gaze. Our research on when decisions has led to the CRISP computational model of fixation durations. In the second part of this talk, I will present research on visuomotor and higher-level aspects of scene perception. One line of research concerns the conditions under which incongruent objects in the scene (e.g., a Nutella jar in a bathroom) attract eye fixations. Another series of studies has revealed that neither foveal nor central vision is necessary for locating a target object in a scene. These results demonstrate that findings from studies using highly artificial displays do not necessarily generalize to more realistic situations, and they challenge researchers to address the understanding of real-world scene perception."

09/05/2019: **Simon Thorpe** - DRCE CNRS Centre de Recherche Cerveau & Cognition UMR 5549 Hôpital de Purpan Toulouse.

TITLE: Finding repeating patterns: A key to intelligence in man and machine?

"Humans are incredibly good at spotting repeating patterns. For example, when presented with a stream of novel images at rates of up to 120 frames a second, an image repeated between 2 and 5 times can subsequently be picked out of a set of four images - where the other 3 have all been seen just once (Thunell & Thorpe, in press). Similarly impressive levels of performance have been seen with auditory snippets presented at rates of 20 per second - again, a few repeats are enough to make the sound easy to pick out. This suggests that this ability to detect patterns that repeat is a general feature of the brain. Parallel modelling work has shown that a modified Spike-Time Dependent Plasticity Rule using binary synapses can allow neurons to learn to detect repeating patterns, again with only a few repeats, and these ideas have been been validated using artificial systems with thousands of neurones. We would like to suggest that this sort of unsupervised learning could be a key to biological intelligence, and could provide a radical alternative to the supervised deep learning techniques that currently dominate the field."

06/06/2019: **Matteo Carandini** - Professor – University College London.

TITLE: Local and global neural correlates of vision and action.

“Behavior arises from neuronal activity patterns, but it is not known whether the relevant neurons are concentrated in a few brain regions or distributed across many regions. We trained mice to report perceptual decisions about visual stimuli, and used high-density Neuropixels arrays to record from >30,000 individual neurons across 42 brain regions in the cerebral cortex, basal ganglia, hippocampus, thalamus, and midbrain. Task-relevant visual and auditory signals propagated through a wide set of brain regions, much wider than expected from passive sensory stimulation. Furthermore, neurons in nearly all brain regions responded around the time of action. Neurons encoding choice prior to action were observed in few regions, with the earliest signals seen in midbrain. These results demonstrate that task-related signals related to sensory processing and motor actions are widely distributed in the brain, and suggest a simple model for how the brain decides between alternatives.”

04/07/2019: **Joachim Gross** - Professor (W3) and Director of Institute for Biomagnetism and Biosignalanalysis, University of Muenster.

TITLE: Using MEG to study the dynamics of information processing in the human brain.

“Invasive and noninvasive studies in humans under physiological and pathological conditions converged on the suggestion that brain oscillations are related to cognitive processes such as sensory representations, attentional selection, and dynamical routing/gating of information. First, I will discuss the role of MEG for studying the dynamics of information processing. Second, I will present recent studies that aim to further our understanding of the computational role of brain oscillations. Specifically, I will characterise spectral fingerprints of human brain activity during rest and behavioural tasks.”