



LEVERHULME
TRUST



Perception and Consciousness: From Biological to Computational Approaches

Leverhulme Doctoral Scholarship Programme, 2nd Annual Conference

Online, 7th October - 8th October 2021

Schedule (BST) - Thursday 7th October 2021

- 12:50 - 13:00 Opening Remarks
- 13:00 - 13:30 **Theories of consciousness: background, predictions, and empirical testing**
Prof. Liad Mudrik (Tel Aviv University, Israel)
- 13:30 - 14:00 **Cellular mechanisms of conscious processing**
Assoc. Prof. Jaan Aru (University of Tartu, Estonia)
- 14:00 - 14:30 **How does our brain use the past to predict the future in visual perception?**
Prof. Floris de Lange (Radboud University of Nijmegen, Netherlands)
- 14:30 - 15:00 Panel Discussion and Q&A
- 15:00 - 15:30 Break
- 15:30 - 16:00 **Distinguishing the neural mechanisms of conscious access from sensory processing and decision making**
Prof. Claire Sergent (Université de Paris, France)
- 16:00 - 16:30 **Probing conscious and unconscious perception in the microsecond range**
Prof. Axel Cleeremans (Université libre de Bruxelles, Belgium)
- 16:30 - 17:00 Panel Discussion and Q&A
- 17:00 - 17:10 Closing Remarks



LEVERHULME
TRUST



Perception and Consciousness: From Biological to Computational Approaches

Leverhulme Doctoral Scholarship Programme, 2nd Annual Conference

Online, 7th October - 8th October 2021

Schedule (BST) - Friday 8th October 2021

12:50 - 13:00 Opening Remarks

13:00 - 13:30 **Beyond Seeing and Hearing: The Power of Olfaction in Multisensory Human-Computer Interaction**

Dr. Emanuela Maggioni (University College London, UK)

13:30 - 14:00 **Finding the Corporeal: design principles for interoception-based digital therapeutics**

Dr. David Plans (University of Exeter, UK)

14:00 - 14:40 Break

14:10 - 14:40 **A View of the Future for BMI Basic Research and Clinical Application**

Prof. Miguel Nicolelis (Duke University, USA) Unable to attend due to internet issues

14:40 - 15:10 **Sensory Feedback in Assistive Robotics: Embodiment, Agency, and Self-Trust**

Dr. Timothy Brown (University of Washington, USA)

15:10 - 15:40 Panel Discussion and Q&A

15:40 - 16:10 Break

16:10 - 17:00 **PhD Student Presentations (8 minutes talk, 2 minutes Q&A)**

Itay Yaron, Karl Kristjan Kaup, Carla Dance and Giulia Cabbai.

17:00 – 17:10 Closing Remarks

Abstracts – 7th October

Theories of consciousness: background, predictions, and empirical testing

Prof. Liad Mudrik (Tel Aviv University, Israel)

For centuries, consciousness was considered to be outside the reach of scientific investigation. Yet in recent decades, more and more studies have tried to probe the neural correlates of conscious experience, and several neuronally-inspired theories for consciousness have emerged. In this talk, I will focus on four leading theories of consciousness: Global Neuronal Workspace (GNW), integrated Information Theory (IIT), Recurrent Processing Theory (RPT) and Higher Order Theory (HOT). I will first shortly present the guiding principles of these theories, and compare them. Then, I will provide a bird's-eye view of the field, using the results of a large-scale quantitative and analytic review we conducted, examining all studies that either empirically tested these theories or interpreted their findings with respect to at least one of them. I will then ask what would be the best way to empirically test the theories, while taking into account some of the biases and trends we found.

Cellular mechanisms of conscious processing

Assoc. Prof. Jaan Aru (University of Tartu, Estonia)

Recent breakthroughs in neurobiology indicate that time is ripe to understand the cellular-level mechanisms of conscious experience. Accordingly, we have recently proposed that conscious processing depends on the integration between top-down and bottom-up information streams and that there exists a specific cellular mechanism that gates this integration.

I will first describe this cellular mechanism and demonstrate how it controls signal propagation within the thalamocortical system. Then I will show how this cellular-level mechanism provides a natural explanation for why conscious experience is modulated by top-down processing. Besides shining new light on the neural basis of consciousness, this perspective unravels the mechanisms of internally generated perception, such as dreams, imagery, and hallucinations.

How does our brain use the past to predict the future in visual perception?

Prof. Floris de Lange (Radboud University of Nijmegen, Netherlands)

Visual perception is strongly influenced by what we have been exposed to in the recent past. Examples of this include repulsive biases like the waterfall illusion and attractive biases like perceptual priming. In my talk, I will discuss how the brain may integrate past perception into current sensory and decision-making processes, to optimize processing of the present and anticipation of the future.

Distinguishing the neural mechanisms of conscious access from sensory processing and decision making

Prof. Claire Sergent (Université de Paris, France)

When contrasting how the brain processes the same external stimulation according to whether we report it as perceived or not, we observe a whole series of neural events that do correlate with conscious report. Our challenge now is to identify, among these correlates, the ones that correspond to the core mechanisms of conscious access, and distinguish them from upstream events, such as early sensory processing, that influence the future conscious or unconscious fate of an information, and from downstream events that reflect a mere consequence of conscious access,

such as the possibility to engage in an explicit decision-making task or report. Here I will present the results of two approaches that we are currently using in my team to try and perform this experimental dissection, and I will discuss their potential for identifying neural signatures of conscious access independent of report.

Probing conscious and unconscious perception in the microsecond range

Prof. Axel Cleeremans (Université libre de Bruxelles, Belgium)

Unconscious perception remains controversial. Its study involves substantial conceptual and methodological challenges. Here, I report on four ongoing lines of research that leverage a custom-built modern tachistoscope that enables the presentation of visual stimuli at very short durations (i.e., a few μsec). This in turn makes it possible to achieve invisibility with unmasked stimuli. We explored (1) unconscious priming, (2) emotion processing, (3) discrimination of complex images, and (4) 2-IFC discrimination of Vernier stimuli. Thus far, while we have found some evidence for unconscious discrimination, we have had no success achieving priming or emotional processing in the absence of awareness. These results are discussed in light of current debates about the extent of unconscious perception.

Abstracts - 8th October

Beyond Seeing and Hearing: The Power of Olfaction in Multisensory Human-Computer Interaction

Dr. Emanuela Maggioni (University College London, UK)

Despite living in a multisensory world, the way we interact with our technology is predominantly limited to a sub-set of our sensory modalities. New technological advances like novel multisensory devices and interfaces are transforming our interaction with technology, particularly the field of Human-Computer Interaction (HCI). Such multisensory technologies not only account for vision and audition, but also stimulate and enhance our sense of touch, smell, and taste. In between our senses, the potential of exploiting the power of olfaction as an interaction modality is opening new novel applications in a variety of contexts, from digital health, accessibility, rehabilitation to entertainment, automotive and many more.

Within this talk, I share an overview of our latest research on multisensory applications and development of an innovative smell-based technology solution (OWidgets), discussing the opportunities and challenges for future research within and beyond the field of HCI.

Finding the Corporeal: design principles for interoception-based digital therapeutics

Dr. David Plans (University of Exeter, UK)

Interoception, perception of one's bodily state, has been associated with mental health and socio-emotional processes. However, several interoception tasks are of questionable validity, meaning associations between interoception and other variables require confirmation with new measures. In this talk, I will show how a new smartphone-based task was designed, and what we learned about interaction design principles from its validation and testing that could inform future digital therapeutic efforts that look to build a better sense of corporeal signal as part of therapeutic efforts.

A View of the Future for BMI Basic Research and Clinical Application

Prof. Miguel Nicolelis (Duke University, USA)

In this talk I will initially discuss how BMI experiments will continue to play a major role in basic research by showing how they have already allowed us to demonstrate the existence of a variety of neurophysiological functions, such as space coding and social interaction mapping, not commonly associated with the motor cortex of non-human primates. I will also describe a combination of approaches that will allow BMI to fulfill its long-anticipated mission of providing new therapies for patients suffering from severe spinal cord injuries. In this context, I will describe the clinical advantages of a protocol that combines multiple non-invasive techniques into a single neurorehabilitation approach for such patients.

Sensory Feedback in Assistive Robotics: Embodiment, Agency, and Self-Trust

Dr. Timothy Brown (University of Washington, USA)

*Somatosensory stimulation is a promising means of providing biomimetic feedback to people with motor disabilities using robotic systems: prostheses, orthoses, and external robotic limbs. Such feedback, so the justification goes, would make control of these systems more intuitive, natural, *embodied*. On the contrary, It is possible that these systems will disrupt their ability to trust their senses—natural or artificial. In this talk, I will argue that biomimetic feedback has the power to erode self-trust in ways that complicate or limit user agency.*

PhD Student Presentation Titles - 8th October

The Consciousness Theories Studies (ConTraSt) database: analyzing and comparing empirical studies of consciousness theories

Itay Yaron (Tel Aviv University, Israel)

Insights in virtual reality

Karl Kristjan Kaup (University of Tartu, Estonia)

What is the link between mental imagery and sensory sensitivity? Insights from Aphantasia

Carla Dance (University of Sussex, UK)

Is goal-directed attention impacted by our ability to imagine?

Giulia Cabbai (University of Sussex, UK)