Contribution ID: **61** Type: **Keynote Lecture**

From Group Averages to Precision Neuroimaging: Brain Function and Anatomy at the Individual Level

Tuesday 28 October 2025 09:45 (1 hour)

Most neuroimaging studies rely on group averages, yet individuals differ substantially in brain anatomy, function, and behavior. In clinical populations, where single-subject diagnostics and biologically informed stratification are essential, this variability cannot be ignored. My talk will highlight efforts in my lab to develop and apply individualized neuroimaging methods.

In the first part, I will focus on modeling fMRI signals and effective connectivity between brain regions. Physiologically informed generative models, such as dynamic causal modeling (P-DCM), enable inference of neuronal states and connectivity from BOLD signals. In Major Depressive Disorder, we found that connectivity-based features outperform conventional activation measures, distinguishing patients from controls and revealing biologically meaningful subgroups. I will also discuss high-resolution 7T fMRI for probing depth-specific responses across cortical layers and demonstrate how ultra-high-resolution datasets such as BigBrain can guide the development of region-specific microcircuit models.

In the second part, I will present anatomical studies with clinical applications. I will show how 7T MRI improves visualization of subcortical structures, evaluate MRI contrasts for thalamic segmentation (and relate them to the BigBrain), and introduce a framework that combines electrode segmentation with 3D inpainting to correct metal artifacts in post-operative DBS scans. Achieving ~98% segmentation accuracy, this approach restores artifact-affected regions with high fidelity, enhancing electrode localization and the reliability of outcome assessments.

Together, these advances demonstrate how precision neuroimaging can move beyond group-level findings to provide individualized biomarkers that improve diagnosis, guide neurosurgical interventions, and ultimately transform patient care.

Short Bio:

Kâmil Uludağ studied Physics at the Technical University of Berlin, completed his Ph.D. in Medical Physics in 2003 on Near-Infrared Optical Spectroscopy (Charité, Humboldt University, Berlin) and moved for a postdoc position to the Center for Functional MRI (UCSD, San Diego, USA) to work on the physiological and physical basis of functional MRI. In 2004, he was appointed Head of Human Brain Imaging group at the Max-Planck-Institute for Biological Cybernetics, Tübingen, Germany. In June 2010, he became Associate Professor in the Faculty of Psychology & Neuroscience and Head of the Department of Cognitive Neuroscience continuing his work on the basis of fMRI utilizing the new Ultra-High Field human MRI scanners (7 and 9.4 Tesla). Since 2019, he is Senior Scientist at the University Health Network, Toronto, and Full Professor at the Department of Medical Biophysics, University of Toronto. Since 2024, he was appointed the Scientific Director of human 7T MRI scanner at the Sunnybrook Research Institute. Dr. Uludağ has been recently appointed Senior Fellow of the International Society for Magnetic Resonance Imaging in Medicine (ISMRM) and Canada Research Chair Tier 1.

Dr Uludağ will present the Sievers Lecture in Computational Neuroscience.

Presenter: ULUDAĞ, Kâmil

Session Classification: Kâmil Uludağ