



The human subcortex remains terra incognita, a largely uncharted territory. Long-term efforts and advances in neuroanatomy, ultra-high field MRI, deep brain recording, and cognitive modeling are painting a rich and varied picture, which has very direct implication in fundamental and clinical neuroscience. This workshop aims to bring together some of the world's experts in the subcortex to discuss recent results from multiple techniques and foster interactions within this often disregarded region of the brain.

### ***Full Program***

*Monday March 1st, 2021*

#### **Workshop introduction**

<i>time</i>	<i>timezone</i>	
6:00 - 6:45	San Francisco	Opening remarks by Pilou Bazin & Birte Forstmann
9:00 - 9:45	Montreal	"Terra Incognita: diving into the subcortex"
14:00 - 14:45	London	
15:00 - 15:45	Amsterdam	
01:00 - 01:45*	Melbourne	

#### **Session 1: Charting the terra incognita**

<i>time</i>	<i>timezone</i>	
6:45 - 9:00	San Francisco	<u>Juan Eugenio Iglesias</u> - "Histological atlases of the human brain and their application to MRI segmentation with machine learning."
9:45 - 12:00	Montreal	
14:45 - 17:00	London	<u>Mallar Chakravarty</u> - "Mapping the subcortex along other biological dimensions: the influence of microstructure and genetics."
15:45 - 18:00	Amsterdam	
01:45 - 04:00*	Melbourne	<u>Jonathan Lau</u> - "The space between structures: in vivo visualization of the zona incerta region using 7T MRI"

## Session 2: Probing the deep brain

time	timezone	introduction by Bernadette van Wijk
9:45 - 13:00	San Francisco	
12:45 - 16:00	Montreal	<u>Martijn Beudel</u> - "Finally Probing the Deep Brain in Vivo: First results of longer LPF recordings in a cohort of patients with DBS."
17:45 - 21:00	London	
18:45 - 22:00	Amsterdam	<u>Dagmar Timmann</u> - "Imaging of the cerebellar nuclei in humans."
04:45 - 08:00*	Melbourne	<u>Lea Grinberg</u> - "It all starts in the brainstem: Rewriting the initial stages of Alzheimer's disease."  <u>James Rowe</u> - TBA

Tuesday March 2nd, 2021

## Session 3 : Bridging MRI and microscopy

time	timezone	introduction by Anneke Alkemade
6:30 - 9:00	San Francisco	
9:30 - 12:00	Montreal	<u>Evgeniya Kirilina</u> - "Imaging subdivisions in Substantia Nigra: could we map dopaminergic neurons in vivo?"
14:30 - 17:00	London	
15:30 - 18:00	Amsterdam	<u>Karla Miller</u> - "Linking MRI with Microscopy for Multi-scale Neuroscience."
01:30 - 04:00*	Melbourne	<u>Matthan Caan</u> - "Deep Learning for Accelerating Quantitative MRI."

## Session 4: Tracing the subcortex's networks

time	timezone	introduction by Max Keuken
10:00 - 12:30	San Francisco	
13:00 - 15:30	Montreal	<u>Andreas Horn</u> - "Connectomic Brain Stimulation."
18:00 - 20:30	London	<u>Suzanne Haber</u> - TBA
19:00 - 21:30	Amsterdam	
05:00 - 07:30*	Melbourne	<u>Ye Tian</u> - "Functional organisation of the human subcortex: Smooth gradients, discrete regions or a bit of both?"

Wednesday March 3rd, 2021

### Session 5: Uncovering subcortical behavior

time	timezone	introduction by Steven Miletić
6:30 - 9:00	San Francisco	
9:30 - 12:00	Montreal	<u>Rafal Bogacz</u> - "Dopamine role in learning and action inference."
14:30 - 17:00	London	
15:30 - 18:00	Amsterdam	<u>Michael Frank</u> - "Striatal dopamine computations for learning about agency."
01:30 - 04:00*	Melbourne	
		<u>Paul Cisek</u> - "The neural control of decision urgency and movement vigor."

### Session 6: General Discussion

time	timezone	Questions and discussion across all themes of the workshop with speakers and attendees.
10:00 - 12:00	San Francisco	
13:00 - 15:00	Montreal	
18:00 - 20:00	London	moderated by Pilou Bazin
19:00 - 21:00	Amsterdam	
05:00 - 07:00*	Melbourne	

\* Melbourne times are +1 day

### Speaker biographies

*in order of appearance*

#### Juan Eugenio Iglesias

University College London, UK, and Martinos Center for Biomedical Imaging, Boston, USA.

*Juan Eugenio Iglesias holds M.Sc. degrees in Telecom and Electrical Engineering from the University of Seville (Spain) and the Royal Institute of Technology (KTH, Stockholm, Sweden), respectively. He did a Ph.D. in Biomedical Engineering at UCLA sponsored by a Fulbright grant. He now holds appointments at University College London (UK) and the Martinos Center for Biomedical Imaging (Massachusetts General Hospital & Harvard Medical School). His main research interest, which is funded by the European Research Council, is the construction of computational atlases of the human brain using ex vivo samples, as well as their application to automated segmentation of in vivo brain MRI.*

#### Mallar Chakravarty

McGill University, Montreal, Canada.

*Mallar Chakravarty is a Computational Neuroscientist in the Cerebral Imaging Centre at Douglas Mental Health University Institute. He is also an Assistant Professor in the Department of Psychiatry and an Associate Member of the Department of Biomedical Engineering at McGill University. Dr. Chakravarty received his Bachelor's Degree in Electrical Engineering from the*

*University of Waterloo and his PhD in Biomedical Engineering from McGill University. He went on to do postdoctoral fellowships in Aarhus, Denmark and jointly at the Rotman Research Institute and at the Mouse Imaging Centre (MICE) and the Hospital Sick Children in Toronto, Canada. Between fellowships, Dr. Chakravarty worked at the Allen Institute for Brain Science (Seattle, WA, USA). He is interested in the anatomy of the brain. His group focuses on how anatomy changes through development, aging, and in illness and how the dynamics of brain anatomy are influenced by genetics and environment.*

Jonathan Lau

Emory University, Atlanta, USA.

*Jonathan Lau is a Canadian-trained neurosurgeon and researcher with an interest in image-guided interventions for neurosurgery. His doctoral thesis focussed on investigating the utility of ultra-high field magnetic resonance imaging for stereotactic procedures. He is currently completing a functional and epilepsy neurosurgery fellowship at Emory University.*

Martijn Beudel

Amsterdam University Medical Centers, the Netherlands.

*Dr. Martijn Beudel is a neurologist working in the Amsterdam University Medical Centers. His key interest is neuromodulation for movement disorders. In his work he combines clinical neurology with research on deep brain stimulation (DBS). After obtaining his PhD in functional neuroimaging (2009), he combined his clinical training in neurology (University Medical Center Groningen) with neurophysiological research on deep brain stimulation (DBS). In 2014 and 2015 he did a post-doc on this subject at the University of Oxford in the group of prof. Peter Brown and worked on the development of a new adaptive form of DBS (aDBS) in Parkinson's disease. After finishing his training in neurology (2016) he was awarded with a fellowship of the Dutch Brain Council. This enabled him to continue to work on aDBS in Groningen. In 2018 he moved to Amsterdam to work as a consultant neurologist in the DBS team of the Amsterdam University Medical Centers. His current research focusses on the actual clinical application of aDBS, the development of neuro-physiological 'physiomarkers' that can be used for the application of aDBS and on the application of machine learning for optimising DBS treatment in movement disorders.*

Dagmar Timmann

University Hospital Essen, University of Duisburg-Essen, Germany.

*Dr. Timmann received her medical degree from the University of Tübingen, Germany. She is a board-certified neurologist. She was a postdoctoral researcher at the R.S. Dow Neurological Sciences Institute (Dr. F.B. Horak), Portland, USA, at the Arizona State University, Tempe and Barrow Neurological Institute (Dr. J. Bloedel), Phoenix, USA, and at the Dept. of Physiology (Dr. J. Hore), University of Western Ontario, London, Canada. She was a visiting scholar at the Human Sensorimotor Control Laboratory (Dr. J. Konczak), University of Minnesota, Minneapolis, MN, USA. Dr. Timmann's research areas are the physiology and pathophysiology of the human cerebellum with a focus on human cerebellar lesion studies, lesion-behavior ("symptom")-mapping, ataxias, structural and functional MRI of the cerebellum and cerebellar nuclei. She is an Associate Professor of Experimental Neurology at the Department of Neurology, University Hospital Essen, University of Duisburg-Essen. Dr. Timmann is head of the Ataxia Clinic, Department of Neurology, University Hospital Essen. She is currently vice speaker of the Collaborative Research Center SFB 1280 "Extinction learning".*

### Lea Grinberg

University of California San Francisco, USA.

*Dr. Lea Tenenholz Grinberg is a neuropathologist specializing in brain aging and associated disorders, most notably, Alzheimer's. Currently, she is an Associate Professor and a John Douglas French Alzheimer's Foundation Endowed Professor at the UCSF Memory and Aging Center, part of the leadership of the Global Brain Health Institute and member of the Medical Scientific Advisory Group for the Alzheimer Association. Dr. Grinberg received her MD from the Santa Casa Medical School in São Paulo – Brazil and residency and Ph.D. degrees from the University of São Paulo, where her doctorate work focused on the neuropathology of frontotemporal lobar degeneration. In 2003, Dr. Grinberg was among the founders of a brain bank in São Paulo, focusing on brain aging. This brain bank which she had since developed into an extremely prolific and highly-regarded institution, helped Dr. Grinberg to prove that, contrary to what has been accepted previously, the brainstem and not the cortex, harbors the first detectable neurodegeneration in Alzheimer's disease. Between 2007 and 2009, during her post-doc at the University of Würzburg, Germany, Dr. Grinberg acquired expertise in neuroanatomy and in the use of visual computing for digital reconstruction of brains for enabling high-scale computer-based analysis. This knowledge has been continuously utilized in multiple projects, primarily focusing on improving the interpretation of neuroimaging results based on histological validation. In 2009, she was the recipient of the UNESCO-L'Oréal Award "For Women in Science," and in 2010 she received the John Douglas French Alzheimer Foundation "Distinguished Research Scholar Award." Currently, Dr. Grinberg is the Co-Leader of the UCSF/Neurodegenerative Disease Brain Bank, where she conducts neuropathological diagnosis of neurodegenerative diseases. She also directs the Human Biology Validation Core for the NIH/U54 Tau Centers Without Walls, is a principal investigator from the Tau Consortium and co-lead the Neuropathology Core for the LEADS project.*

### James Rowe

Cambridge University, UK.

*Professor James B. Rowe is both a neuroscientist and a cognitive neurologist. His early training in Medical Sciences and Experimental Psychology (1st class hon.) began at Downing College at the University of Cambridge (1988-1991), followed by Magdalen College at the University of Oxford (1991-1994) and a PhD at the Functional Imaging Laboratory of the Wellcome Department of Cognitive Neurology (1998-2001), supervised by Professor Richard Frackowiak and Professor Dick Passingham. His PhD focused on the neural mechanisms of response selection and attention to action, in health and Parkinson's disease, using human neuroimaging techniques, such as positron emission tomography, functional magnetic resonance imaging (fMRI), and repetitive transcranial magnetic stimulation (TMS). After completing his PhD he undertook full time clinical specialist training in neurology, for four years. During his clinical training he continued research, including UK and international collaborations on the interactions within cortical and subcortical neural networks. His Wellcome Trust Intermediate Research Fellowship (2005-2009) enabled him to develop further research methodologies (including magnetoencephalography), clinical experience with Frontotemporal dementia, and the theoretical foundations of his later research program. In 2009, he became a Wellcome Trust Senior Research Fellow in Clinical Science. In 2015, he was appointed as the Professor of Cognitive Neurology at the University of Cambridge and an affiliated Professor of Clinical Neuroscience at the University of Copenhagen in Denmark. His scientific work has been published in more than 200 high-ranking peer-reviewed articles including Science, Brain, Nature Communications, and Neurology. He is an active consultant neurologist, leading regional specialist clinics for patients with early dementia, frontotemporal dementia, Progressive Supranuclear Palsy, and other 'tauopathies', and he is a consultant in the Cambridge Memory Clinic.*

Evgeniya Kirilina

Max Planck Institute for Human Cognitive and Brain Science, Leipzig, Germany.

*I studied physics and received my PhD at the Novosibirsk State University in Russia investigating basic mechanisms of spin relaxation. In 2005 I moved to Germany for PosDocs at the Free University Berlin and Physikalisch-Technische Bundesanstalt where I applied my physical knowledge to study brain anatomy and function with MRI. Since 2009 I am a leading physicist at the MRI Lab of the Center for Cognitive Neuroscience Berlin at Free University Berlin. Since 2015 I complement this position with research position at MPI CBS where I am developing advanced methods for anatomical brain imaging specifically investigating the iron-induced contrast in the human brain.*

Karla Miller

Oxford University, UK.

*Karla Miller is a biomedical engineer at the Wellcome Centre for Integrative Neuroimaging in Oxford. She is interested in developing novel MRI techniques, understanding their relationship to neurobiology, and deploying these techniques to enable novel neuroscience investigations. Current themes in her work include big data, integrated acquisition and analysis, and relating MRI to microscopy. She co-leads the brain imaging in UK Biobank, the largest imaging study ever conducted.*

Matthan Caan

Amsterdam University Medical Centers, the Netherlands.

*Matthan Caan is assistant professor at the Biomedical Engineering & Physics department at Amsterdam UMC, location AMC. His research focuses on Artificial Intelligence in Medical Imaging, in particular on rapid and comprehensive MRI in the human brain. Machine learning methods find their application in different brain disease studies. He earned his PhD in Physics in 2010 from Delft University of Technology, on Quantifying pathology in Diffusion weighted MRI. His teaching activities are with the AMC and the University of Amsterdam on medical imaging and AI.*

Andreas Horn

Charité Hospital, Berlin, Germany.

*Andreas Horn is a clinician scientist with interests in neuroimaging, neuromodulation, clinical neuroscience and software development. He is group leader of the network stimulation laboratory at the movement disorders and neuromodulation unit in Berlin ([www.netstim.org](http://www.netstim.org)). The goal of his research is to analyze how modulation of distributed brain networks leads to specific symptom improvements of brain diseases, predominantly in the movement disorders spectrum. In order to do so, his laboratory analyzes structural imaging data (MRI/CT) and noninvasive connectivity measures derived from functional and diffusion weighted MRI. Andreas has spent the last seven years including a PhD focused on developing and improving methods to reconstruct brain stimulation sites and to analyze how their whole brain effects are mediated via distributed structural and functional brain networks. Here, focus resides on reconstructing electrode placements following deep brain stimulation surgery based on pre- and postoperative neuroimaging data. Andreas is leading the development effort of a scientific software package that facilitates these analyses ([www.lead-dbs.org](http://www.lead-dbs.org)).*

Suzanne Haber

University of Rochester, USA.

*Dr. Haber's laboratory investigates the neural network that underlies incentive-based learning and decision-making leading to the development of action plans. The cortico-basal ganglia system is at the center of this circuit and comprises a diverse group of structures involved in reward and motivation, cognition, and motor control. The consequence of basal ganglia dysfunction is emphasized in the range of diseases that involve it, including mental health disorders such as obsessive-compulsive disorder, drug abuse and addiction, and schizophrenia, and motor control disorders including Parkinson's disease. One set of experiments in Dr. Haber's laboratory address the hypothesis that the cortico-basal ganglia network processes information through both parallel and integrative circuits. A second set of studies focus on the pathway trajectories from different prefrontal areas to their targets. A third set of experiments focus on which pathways and terminal fields are likely to be involved in the therapeutic effects of during deep brain stimulation (DBS). A fourth set of studies address the changes in terminal fields and white matter tracts during postnatal development.*

Andrew Zalesky

University of Melbourne, Australia.

*Dr Zalesky is internationally recognized for his work in network neuroscience, particularly in its application to neuropsychiatry. He developed the network-based statistic, a tool that is widely used to localize brain network pathology. His tool has been used in hundreds of published research studies. Dr Zalesky co-authored the textbook Fundamentals of Brain Network Analysis and co-founded the Australian Connectomics School. Dr Zalesky received his PhD in 2006 from the Department of Electrical and Electronic Engineering at the University of Melbourne for research on mathematical modeling of all-optical telecommunication networks. After completing postdoctoral research in Hong Kong, he returned to Australia in 2007 and began applying his expertise in engineered networks to investigate brain networks in neuropsychiatric disorders. He identified novel links between disease progression in brain networks and cascading failures in engineered networks, which led to the development of innovative and widely used tools for brain network analysis. He has been with the Department of Psychiatry since 2007 and commenced a joint appointment with the Department of Biomedical Engineering at its inception in 2015.*

Ye Tian

University of Melbourne, Australia.

*Dr Ye Tian is a postdoc researcher at Melbourne Neuropsychiatry Centre, The University of Melbourne, Australia. She graduated with a Bachelor's in medicine in 2013 from Sichuan University and then completed specialist training in psychiatry at Peking University. She completed her PhD at The University of Melbourne in 2020 and commenced postdoctoral research with Associate Professor Andrew Zalesky and Dr Vanessa Cropley thereafter. She establishes the Melbourne Subcortex Atlas, one of the most comprehensive functional atlases of the human subcortex, using 3 and 7 Tesla functional MRI in more than 1000 healthy adults. She is broadly interested in understanding brain organisation and using brain imaging techniques to unveil neuropathology underpinning neuropsychiatric disorders.*

Rafal Bogacz

Oxford University, UK.

*Rafal Bogacz graduated in computer science at Wroclaw University of Technology in Poland. Then he did a PhD in computational neuroscience at the University of Bristol, and next he worked as a postdoctoral researcher at Princeton University, USA, jointly in the Departments of Applied Mathematics and Psychology. In 2004 he came back to Bristol where he worked as a Lecturer and then a Reader. He moved to the University of Oxford in 2013.*

Michael Frank

Brown University, Providence, USA.

*Michael J. Frank, PhD is Edgar L Marston Professor of Cognitive, Linguistic & Psychological Sciences at Brown University. He directs the Center for Computational Brain Science within the Carney Institute for Brain Science. He received his PhD in Neuroscience and Psychology in 2004 at the University of Colorado, following undergraduate and master's degrees in electrical engineering and biomedicine (Queen's University (Canada) and University of Colorado). Dr. Frank's work focuses primarily on theoretical models of frontostriatal circuits and their modulation by dopamine, especially in terms of their cognitive functions and implications for neurological and psychiatric disorders. The models are tested and refined with experiments involving pharmacological manipulation, deep brain stimulation, EEG, fMRI and genetics. Honors include the Troland Research Award from the National Academy of Sciences (2021), Kavli Fellow (2016), the Cognitive Neuroscience Society Young Investigator Award (2011), the Janet T Spence Award for early career transformative contributions (Association for Psychological Science, 2010) and the DG Marquis award for best paper published in Behavioral Neuroscience (2006). Dr Frank is a senior editor for eLife.*

Paul Cisek

University of Montreal, Canada.

*Paul Cisek was born in Poland and emigrated to the US as a child. While he was originally trained in computer science and artificial intelligence, he became more interested in natural intelligence and enrolled in graduate studies under the supervision of Stephen Grossberg and Daniel Bullock and Boston University, obtaining a PhD in computational neuroscience. He then became interested in empirical neuroscience, and joined the laboratories of Stephen Scott and John Kalaska to study the processes of selection, planning, and control of actions by recording neural activity in the cerebral cortex during voluntary behavior. Since then, he has established his own laboratory at the University of Montreal, in which he combines all of these techniques to investigate the cortical and subcortical mechanisms controlling our interactions with the world.*