IDG/McGOVERN INSTITUTE
FOR BRAIN RESEARCH AT PKU

IDG/McGovern Institute for Brain Research at Peking University

10TH Anniversary International Symposium on Brain Science

November 6-7, 2021 Youcai Deng Lecture Hall, Peking University

SPONSORS: OLYMPUS Nikon

The IDG McGovern Institute for Brain Research at PKU consists of neural and cognitive scientists at Peking University, who focus on understanding fundamental processes underlying brain function and uncovering mechanisms of brain disorders.

We emphasize on interdisciplinary interactions and approaches, and include faculty members from biology, cognitive sciences, psychology and psychiatry, employing technologies ranging from traditional psychophysics, genetics and molecular biology to modern imaging, spatial-temporal manipulation of molecules and neurons, visualization of functioning human brains, and genomics analysis of diseases and cognitive traits.

The institute was established in 2011 with contributions from Patrick J. McGovern and Lore Harp McGovern, who are committed to improving human welfare, communication and understanding, through their support for neuroscience research.

Lui Che Woo Building

Wang Kezhen Building

SCHEDULE

	November 6 - Molecules, Diseases and Circuits		Talk Title	Session Chair
Morning	8:00-8:30	*Zoom link testing for speakers*		
	8:30-9:00	Opening Remarks: Robert Desimone (McGovern, MIT) & Yi Rao		
	9:00-9:40	Josh Sanes	What transcriptomics can tell us about retinal development, disease and evolution	Yi Rao
	9:40-10:20	Liqun Luo	Wiring specificity of neural circuits	
	10:20-11:00	Yang Dan	Motor and sleep control: a tale of two circuits	
	11:00-11:40	Bing Liu	Searching for dysconnectivity-based neuroimaging biomarkers in schizophrenia	
	11:40-11:50	Group Photo		
Lunch Break				
Afternoon	12:30-13:00	*Zoom link testing for speakers*		
	13:00-13:40	Yan Song	Ready, go! Timely and robust cell fate commitment in neural stem cell lineages	Yun Wang
	13:40-14:20	Eunjoon Kim	Early and late corrections in mouse models of autism	
	14:20-15:00	Minmin Luo	Role of the anterior cingulate cortex in reward devaluation	
	15:00-15:20	Tea Break	*Zoom link testing for speakers*	
	15:20-16:00	Masashi Yanagisawa	Deciphering the mystery of sleep: toward the molecular substrate for sleepiness	Weihua Yue
	16:00-16:40	Tobias Bonhoeffer	Stability and plasticity of cortical circuits	
	16:40-17:20	Moritz Helmstaedter	CONNECTOMICS	
Dinner Break				
Evening	19:30-20:00	*Zoom link testing for speakers*		
	20:00-20:40	Richard Tsien	Homeostatic tuning of synaptic strength uses LTP-like mechanisms	Xiang Yu
	20:40-21:20	Dayu Lin	Neural circuit of aggression: innate yet flexible	
	21:20-22:00	Yulong Li	Spying on neuromodulation by constructing a toolbox of genetically encoded fluorescent sensors	

SCHEDULE

	November 7 -Circuits, Systems and Psychology		Talk Title	Session Chair
Morning	8:30-9:00	*Zoom link testing for speakers*		
	9:00-9:40	Eve Marder	Perturbations reveal that degenerate circuits hide cryptic individual variability	Fang Fang
	9:40-10:20	Sabine Kastner	Neural dynamics of the primate attention network	
	10:20-11:00	Alice Ting	Optogenetic and chemogenetic technologies for probing molecular and cellular interactions	
	11:00-11:40	Doris Tsao	Faces: a neural Rosetta Stone	
	11:40-11:50	Group Photo		
Lunch Break				
Afternoon	12:30-13:00	*Zoom link testing for speakers*		
	13:00-13:40	Yanchao Bi	Dual coding of knowledge in the human brain	Jian Li
	13:40-14:20	Huan Luo	Probing and manipulating sequence working memory in human brains	
	14:20-15:00	Liping Wang	Sequence representations in humans and monkeys	
	15:00-15:20	Tea Break	*Zoom link testing for speakers*	
	15:20-16:00	Winfried Denk	Signals and wires, how do they compute?	Si Wu
	16:00-16:40	Liangyi Chen	The next-generation of live-cell super-resolution microscopy: new mechanisms and new applications	
	16:40-17:20	Shiming Tang	Studying macaque visual cortex with a large set of natural images	
Dinner Break				
Evening	19:30-20:00	*Zoom link testing for speakers*		
	20:00-20:40	Michael Hausser	Forging causal connections between neural circuit activity and behaviour	Donggen Luo
	20:40-21:20	Timothy Behrens	Representing the structure of problems in the frontal hippocampal circuitry	
	21:20-22:00	Elizabeth Phelps	Mechanism of threat control and translation challenges	

INVITED SPEAKERS

Name: Tim Behrens

Affiliation: Oxford and UCL

Talk title: Representing the structure of problems in the frontal hippocampal circuitry

BRIEF SELF-INTRODUCTION

Tim Behrens is a neuroscientist at Oxford and UCL. He is interested in how our brains learn and represent knowledge in service of flexible behaviour. He builds computational models of this process and tests these models across a range of mammalian species.

ABSTRACT

The cellular representations and computations that allow rodents to navigate in space have been described with beautiful precision. In this talk, I will show that some of these same computations can be found in humans doing tasks that appear very different from spatial navigation. I will describe some theory that allows us to think about spatial and non-spatial problems in the same framework, and I will try to use this theory to give a new perspective on the beautiful spatial computations that inspired it. The overall goal of this work is to find a framework where we can talk about complicated non-spatial inference problems with the same precision that is only currently available in space.

INVITED SPEAKERS

Name: Yanchao Bi

Affiliation: Beijing Normal University

Talk title: Dual coding of knowledge in the human brain

BRIEF SELF-INTRODUCTION

Yanchao Bi is a ChangJiang professor in IDG/McGovern Institute for Brain Research and the State Key Laboratory of Cognitive Neuroscience and Learning, at Beijing Normal University. She received her PhD from the Department of Psychology, Harvard University in 2006. Her work focuses on the study of functional and neural architecture associated with knowledge, semantic memory and language, using cognitive, neuropsychological, neuroimaging, and computational methods. She serves on the board of "Society of Neurobiology of Language", the editorial board of Journals Elife, Cognition, Cognitive Neuropsychology, and Neurobiology of Language. She has won various awards, scholarships or recognitions such as“The National Science Fund for Distinguished Young Scholars”, “The National Science Fund for Excellent Young Scholars”, Sackler scholar of psychophysiology, Fulbright scholar, and “rising star” by the American psychological association.

ABSTRACT

Human brain stores tremendous amount of knowledge about this world, which is the foundation of language, thought, and reasoning. What’s the neural codes of semantic knowledge representation? Is the knowledge “roses are red” simply the memory trace of perceiving the color of roses, stored in the brain circuits within color-sensitive neurons? What about knowledge that is not directly perceived by senses, such as “freedom” or “rationality”? I will present some work from my lab that addresses this issue using cognitive, neuroimaging, and neuropsychological methods with healthy subjects, individuals with sensory deprivation (blind and deaf) or with brain damage. The findings point to a highly distributed system incorporating two different types of information coding – one based on distributed sensory experiences (embodied) and one based on language (symbolic).

INVITED SPEAKERS

Name: Tobias Bonhoeffer

Affiliation: Max Planck Institute of Neurobiology

Talk title: Stability and plasticity of cortical circuits

BRIEF SELF-INTRODUCTION

Tobias Bonhoeffer is a neuroscientist who is known for his work on synaptic plasticity and the functional organization of the developing neocortex. He has made a number of important discoveries, such as the pinwheel-like organization of the visual cortex in higher mammals, the growth of new dendritic spines after the induction of synaptic plasticity, and the observation that such structural changes help store information and facilitate later re-learning.

Tobias Bonhoeffer studied physics at the University of Tübingen, Germany, where he also conducted his PhD work at the Max Planck Institute (MPI) for Biological Cybernetics. After postdocs at the Rockefeller University in New York and the MPI for Brain Research in Frankfurt, Germany, he moved to the MPI of Neurobiology in Munich, where he initially was leader of a research group and later became director. He is also professor at the Ludwig-Maximilians-University, Munich. Furthermore, he is member of the German Academy of Sciences Leopoldina, the Academia Europaea, and the US National Academy of Sciences. Bonhoeffer held a number of leadership positions in the Max Planck Society in Germany and he has been Governor of the Wellcome Trust in the UK.

ABSTRACT

The lecture is going to describe recent experiments on the plasticity and stability of neural connections in the visual cortex and how these processes are affected by exposure to the visual environment. It will furthermore describe a different set of experiments, in which it has been possible to show that mice are able to form perceptual categories. This has enabled the investigation of neuronal processes underlying categorization in the mouse brain. The results are helping to understand the role that cells in mouse medial prefrontal cortex play in this cognitive task and what happens during the acquisition such a complicated task.

INVITED SPEAKERS

Name: Liangyi Chen

Affiliation: IDG/McGovern Institute for Brain Research at Peking University
Institute of Molecular Medicine, School of Future Technology, Peking University

Talk title: The next-generation of live-cell super-resolution microscopy: new mechanisms and new applications

BRIEF SELF-INTRODUCTION

Liangyi Chen is Boya Professor of Peking University. He obtained his undergraduate degrees Biomedical engineering in Xi'an JiaoTong University, then majored in Biomedical engineering in pursuing PhD degree in Huazhong University of Science and Technology. His lab focused on two interweaved aspects: the development of new imaging and quantitative image analysis algorithms, and the application of these technology to study how glucose-stimulated insulin secretion is regulated in the health and disease at multiple levels (single cells, islets and in vivo) in the health and disease animal models. The techniques developed included ultrasensitive Hessian structured illumination microscopy (Hessian SIM) for live cell super-resolution imaging, the Sparse deconvolution algorithm for extending spatial resolution of fluorescence microscopes limited by the optics, Super-resolution fluorescence-assisted diffraction computational tomography (SR-FACT) for revealing the three-dimensional landscape of the cellular organelle interactome, two-photon three-axis digital scanned lightsheet microscopy (2P3A-DSLM) for tissue and small organism imaging, and fast High-resolution Miniature Two-photon Microscopy (FHIRM-TPM) for Brain Imaging in Freely-behaving Mice. He is also recipient of the National Distinguish Scholar Fund project from National Natural Science Foundation of China.

ABSTRACT

Here we will present three pieces of high-resolution fluorescence microscopy methods we invented for live sample imaging. The first one is for live-cell long-term super-resolution (SR) imaging. We have developed a deconvolution algorithm for structured illumination microscopy based on Hessian matrixes (Hessian-SIM). It uses the continuity of biological structures in multiple dimensions as a priori knowledge to guide image reconstruction and attains artifact-minimized SR images with less than 10% of the photon dose used by conventional SIM while substantially outperforming current algorithms at low signal intensities. Its high sensitivity allows the use of sub-millisecond excitation pulses followed by dark recovery times to reduce photobleaching of fluorescent proteins, enabling hour-long time-lapse SR imaging in live cells.

After the first work, we realized that the spatial resolutions of live-cell super-resolution microscopes are limited by the maximum collected photon flux.. Taking advantage of a priori knowledge of the sparsity and continuity of biological structures, we develop a deconvolution algorithm that further extends the resolution of super-resolution microscopes under the same photon budgets by nearly twofold. As a result, sparse structured illumination microscopy (Sparse-SIM) achieves ~60 nm resolution at a 564 Hz frame rate, allowing it to resolve intricate structural intermediates, including small vesicular fusion pores, ring-shaped nuclear pores formed by different nucleoporins, and relative movements between the inner and outer membranes of mitochondria in live cells. Likewise, sparse deconvolution can be used to increase the three-dimensional resolution and contrast of spinning-disc confocal-based SIM (SD-SIM), and operates under conditions with the insufficient signal-to-noise ratio, all of which allows routine four-color, three-dimensional, ~90 nm resolution live-cell super-resolution imaging. Overall, we argue that sparse deconvolution may be a general tool to push the spatiotemporal resolution limits of live-cell fluorescence microscopy.

The third technology is a dual-mode SR microscopy for highlighting molecules as well as a holistic view of related interacting organelles in live cells. It is a combination of two-dimensional Hessian-SIM with label-free three-dimensional optical diffraction tomography (ODT), term SR fluorescence-assisted diffraction computational tomography (SR-FACT). The ODT module is capable of resolving mitochondria, lipid droplets, the nuclear membrane, chromosomes, the tubular endoplasmic reticulum, and lysosomes. These works demonstrate the unique capabilities of SR-FACT, which suggest its wide applicability in cell biology in general.

INVITED SPEAKERS

Name: Yang Dan

Affiliation: University of California, Berkeley

Talk title: Motor and sleep control: a tale of two circuits

BRIEF SELF-INTRODUCTION

Yang Dan is Nan Fung Life Sciences Chancellor's Chair Professor in the Department of Molecular and Cell Biology and an investigator of the Howard Hughes Medical Institute at the University of California, Berkeley. She studied physics as an undergraduate student at Peking University and received her Ph.D. training in Biological Sciences at Columbia University, where she worked on cellular mechanisms of neurotransmitter secretion and synaptic plasticity. She did her postdoctoral research on information coding in the visual system at Rockefeller University and Harvard Medical School. Dan's recent interest is to understand the neural circuits controlling sleep, a fundamental biological process with strong impact on human health. Using novel techniques to target genetically defined cell types for recording and manipulation, her team has identified key neuronal circuits for the generation of both rapid-eye-movement (REM) and non-REM sleep. The identification of sleep neurons allows them to induce or terminate sleep on command, which provides a powerful tool for understanding the functional roles of sleep.

ABSTRACT

To identify neurons involved in sleep generation, we have performed whole-brain screening for sleep active and sleep promoting neurons. Sleep is controlled by a highly distributed network spanning the forebrain, midbrain, and hindbrain, and most sleep neurons are part of the central somatic and autonomic motor circuits. The intimate association between the sleep and the two motor control networks suggests that a primary function of sleep is to promote biological processes incompatible with movement.

INVITED SPEAKERS

Name: Winfried Denk

Affiliation: Deputy managing director at the Max Planck Institute of Neurobiology

Talk title: Signals and wires, how do they compute?

BRIEF SELF-INTRODUCTION

I studied physics at Ludwig Maximilian University in Munich and the Swiss Federal Institute of Technology (ETH) in Zurich. For my doctoral thesis, I moved to Cornell University in Ithaca (USA). Subsequently, I conducted research at the IBM Research Lab in Rüschlikon (Switzerland) and Bell Laboratories in Murray Hill (USA). In 1999, I was appointed Director at the Max Planck Institute for Medical Research in Heidelberg. Since September 2011, I have been director at the Max Planck Institute of Neurobiology in Martinsried.

I am involved in the new and further development of microscopes to visualize neuronal activity and connectivity in the intact nervous system.

Biological processes are generally based on processes and changes at the molecular and cellular level. To understand such processes in their details, they cannot be considered independently of their environment - the surrounding tissue. They must be studied where they take place. This is possible with the aid of optical microscopy. Hand in hand with the development of fluorescent dyes, microscopy is now one of the most important technologies in biological research: Thanks to these dyes, individual cells, their components or specific cell processes become visible to the observer through the microscope.

Together with my team we develop new and better microscopy methods for biological and medical research. One of our successes is the co-development of the multiquantum microscope. With its help, the strong light scattering that occurs especially in brain tissue and causes problems in normal light microscopy is significantly reduced. Another success is the development of the three-dimensional scanning electron microscope. In this automated process, an electron microscope scans the surface of a piece of tissue slice by slice. These are later reassembled on the computer to form the original three-dimensional structure - with the aim of decoding the brain's circuitry.

ABSTRACT

Signals carry the information around the brain but the wires and their connections store memory and implement algorithms. The circuit diagram also is what guides information flow in the brain. The circuit structure is the code that implements the computational algorithms. The algorithms are in all likelihood embedded in the circuit structure. Any hypothesis about how the brain functions makes explicit or implicit assumptions of information flow between neural subsystems. Knowing where information can or cannot flow directly between subsystems thus has the potential of a powerful tool to distinguish between such hypotheses.

The study of mesoscopic brain structure at scale has taken off in the last two decades during which my lab has changed its focus from the development of tools for the recording of brain signals to mapping its structure at high resolution and at a large scope. We are now at a point where the mapping of an entire mouse brain seems feasible.

INVITED SPEAKERS

Name: Michael Hausser

Affiliation: University College London

Talk title: Forging causal connections between neural circuit activity and behaviour

BRIEF SELF-INTRODUCTION

Michael Häusser is Professor of Neuroscience at University College London and a Principal Research Fellow of the Wellcome Trust. He did his PhD work at Oxford University under the supervision of Julian Jack. He then worked with Bert Sakmann at the Max-Planck-Institute for Medical Research in Heidelberg and with Philippe Ascher at the Ecole Normale Superieure in Paris. He established his own lab at UCL in 1997, where his group aims to understand the cellular basis of neural computation in the mammalian brain using a combination of experiments and theory, with a special focus on the role of dendrites. He is also the Facilitator of the International Brain Laboratory (www.internationalbrainlab.com), a new global open-science collaboration which aims to understand how the brain makes decisions.

ABSTRACT

Understanding the causal relationship between activity patterns in neural circuits and behavior requires the ability to perform rapid and targeted interventions in ongoing neuronal activity. I will describe results of experiments using an "all-optical" strategy for interrogating neural circuits, combining simultaneous two-photon imaging and two-photon optogenetics at cellular resolution. We have used this approach to identify the lower bound for perception of cortical activity, probe how brain state influences the role of cortex in perception, and provide causal tests of the role of hippocampal place cells in spatial navigation.

INVITED SPEAKERS

Name: Moritz Helmstaedter

Affiliation: Max Planck Institute for Brain Research, Frankfurt am Main, Germany

Talk title: CONNECTOMICS

BRIEF SELF-INTRODUCTION

Moritz Helmstaedter is Director at the Max Planck Institute for Brain Research in Frankfurt, Germany. His work aims at pushing the frontiers of Connectomics, an emerging research field occupied with mapping neuronal networks in the brain at unprecedented scale and resolution. Before joining the Max Planck Institute for Brain Research in 2014, he was a group leader at the Max Planck Institute of Neurobiology in Munich (2011-2014).

Born in Berlin in 1978, Moritz studied medicine and physics in Heidelberg, where he also completed his doctoral thesis with Nobel laureate Bert Sakmann at the Max Planck Institute in Heidelberg, Germany, followed by post-doctoral work with Winfried Denk.

Additional appointments include professor by special appointment at Radboud University, Nijmegen, Netherlands (since 2016), Perspective Committee of the Biomedical Section of the Max Planck Society (since 2017), Scientific Advisory Board of the Biomedical Big Data initiative, Chinese Academy of Sciences, Shanghai (since 2018).

ABSTRACT

Brains are highly interconnected networks of millions to billions of neurons. For a century, we have not been able to map these connectivity networks at synaptic resolution. Only recently, using novel electron microscopy techniques and machine-learning based data analysis, the mapping of neuronal networks has become possible at a larger scale. This new field of connectomics is still limited by technology and requires efficient AI-based analysis of peta-to-exascale datasets, but it is already starting to provide exciting insights into how neuronal circuits operate in the brain. We are turning connectomics into a high-throughput screening technique for neuroscience, for discovering brain-implemented algorithms, which may inspire novel machine learning, to map the imprints of sensory experience onto neuronal networks in the brain, and to investigate connectome alterations in models of psychiatric disease.

INVITED SPEAKERS

Name: Sabine Kastner

Affiliation: Princeton Neuroscience Institute & Department of Psychology, Princeton University

Talk title: Neural dynamics of the primate attention network

BRIEF SELF-INTRODUCTION

Sabine Kastner is a Professor of Neuroscience and Psychology in the Princeton Neuroscience Institute and Department of Psychology and serves as the Scientific Director of Princeton's neuroimaging facility. Kastner joined the faculty at Princeton University in 2000 after earning MD and PhD degrees and receiving postdoctoral training at the National Institute of Mental Health. Kastner studies the neural basis of visual perception, attention, and awareness in the healthy, adult primate brain as well as in patients with brain lesions and during development. Kastner has made substantial contributions to her field publishing more than 150 journal articles and editing the *Handbook of Attention* (together with A.C. Nobre). She is known for her pioneering work on the neural basis of visual attention, her comparative studies in the human and monkey brain, and her groundbreaking studies on the role of the thalamus in perception and cognition. Kastner is a Fellow of the American Psychological Society, the Society for Experimental Psychology and a Member of the German National Academy of Sciences (Leopoldina). Kastner serves on several advisory and editorial boards and is the Editor-in-Chief of *Progress in Neurobiology.* Kastner is passionate about public outreach such as fostering the careers of young women in science, promoting neuroscience in schools and public education (as chief editor of *Frontiers for Young Minds – Understanding neuroscience*) and exploring the intersection of visual neuroscience and art.

ABSTRACT

The selection of information from our cluttered sensory environments is one of the most fundamental cognitive operations performed by the primate brain. In the visual domain, the selection process is thought to be mediated by a static spatial mechanism – a 'spotlight' that can be flexibly shifted around the visual scene. This spatial search mechanism has been associated with a large-scale network that consists of multiple nodes distributed across all major cortical lobes and includes also subcortical regions. To identify the specific functions of each network node and their functional interactions is a major goal for the field of cognitive neuroscience. In my lecture, I will give an overview on the neural basis of this fundamental cognitive function and discuss recently discovered rhythmic properties that set up alternating attention states.

INVITED SPEAKERS

Name: Eunjoon Kim

Affiliation: Center for Synaptic Brain Dysfunctions, Institute for Basic Science (IBS) and Department of Biological Sciences, Korea Advanced Institute of Science and Technology (KAIST)

Talk title: Early and late corrections in mouse models of autism

BRIEF SELF-INTRODUCTION

Dr. Eunjoon Kim is the director of the Center for Synaptic Brain Dysfunctions at the Institute for Basic Science (IBS), and a professor in the Department of Biological Sciences at Korea Advanced Institute of Science and Technology (KAIST). His research has focused on unveiling molecular mechanisms underlying the development and plasticity of excitatory synapses, and how defects in synaptic proteins lead to diverse neuropsychiatric disorders, including autism spectrum disorders. Dr. Kim has published more than 150 papers on these topics and is currently serving as a member of the editorial board for journals including eLife and PLoS Biology. Dr. Kim has been an assistant, associate, and full professor at KAIST since 2000 and directing the IBS Center for Synaptic Brain Dysfunctions at KAIST since 2012. Dr. Kim received postdoctoral training at Harvard University during 1995-1997, and earned PhD from Michigan State University in 1994.

ABSTRACT

Autism spectrum disorders (ASD) are neurodevelopmental disorders characterized by social and repetitive symptoms. A key feature of ASD is early-life manifestations of symptoms, indicative of early pathophysiological mechanisms. In mouse models of ASD, increasing evidence indicates that there are early pathophysiological mechanisms that can be corrected early to prevent phenotypic defects in adults, overcoming the disadvantage of the short-lasting effects of adult-stage treatments. In addition, the results from gene re-expression studies indicate that ASD-related phenotypes can be rescued in some cases even after the brain has fully matured. These results suggest that we need to consider both temporal and mechanistic aspects in studying mouse models of ASD. In my presentation, I will discuss early and late corrections in mouse models of ASD, and discuss how to better integrate these aspects to promote efficient and long-lasting corrections in animal models for eventual clinical translation.

INVITED SPEAKERS

Name: Yulong Li

Affiliation: IDG/McGovern Institute for Brain Research at Peking University School of Life Sciences, Peking University

Talk title: Spying on neuromodulation by constructing a toolbox of genetically encoded fluorescent sensors

BRIEF SELF-INTRODUCTION

Dr. Yulong Li is a tenured Professor of School of Life Sciences, a Principal Investigator of PKU-THU Center for Life Sciences and IDG/McGovern Institute for Brain Research, Peking University. He got his bachelor degree at Peking University (2000) and PhD degree with Dr. George Augustine at Duke University (2006). After finishing his postdoc training with Dr. Richard Tsien at Stanford University, he set up his own lab at Peking University since 2012. His group is carrying two layers of research: first, they are developing cutting edge research tools, namely advanced imaging probes, to untangle the complexity of nervous system in space and in time; second, capitalizing on the advancement of research toolkits, they are studying the regulation of synaptic transmission, focusing on the modulation of presynaptic transmitter release in health and in disease condition. Dr. Li is awarded the 2019 National Science Fund for Distinguished Young Scholars.

ABSTRACT

Diverse neuromodulators in the brain, such as acetylcholine, monoamines, lipids and neuropeptides, play important roles in a plethora of physiological processes including reward, movement, attention, sleep, learning and memory. Dysfunction of the neuromodulatory system is associated with a range of diseases, such as epilepsy, addition, neurodegenerative and psychiatric diseases. A longstanding yet largely unmet goal is to measure the dynamics of different neuromodulators reliably and specifically with high spatiotemporal resolution, particularly in behaving animals. To achieve this goal, we develop a series of genetically encoded GPCR-activation-based (GRAB) sensors for the detection of acetylcholine, dopamine, norepinephrine, adenosine, ATP, serotonin, histamine, endocannabinoids and neuropeptides, and validate the performance of these sensors in multiple preparations in vitro and in vivo. The GRAB sensor toolbox provides new insights into the dynamics and mechanism of neuromodulatory signaling both in health and disease.

INVITED SPEAKERS

Name: Dayu Lin

Affiliation: Neuroscience Institute, New York University Langone Medical Center

Talk title: Neural circuit of aggression: innate yet flexible

BRIEF SELF-INTRODUCTION

In 2001, Dayu Lin received a B.S. in biological sciences from Fudan University in China. In 2006, she received her Ph.D. in Neurobiology from Duke University, working with late Dr. Larry Katz to investigate the neural representation of natural olfactory cues in the main olfactory bulb. She then joined Dr. David Anderson's group at California Institute of Technology as a postdoctoral fellow, investigating the neural substrates essential for the generation of aggression. In 2010, she began work as an assistant professor in Simlow Neuroscience Program at New York University Langone Medical Center, which was later merged into the newly established Neuroscience Institute. In 2018, she was promoted as an associate professor with tenure. Her lab focuses on understanding the neural circuits of innate social behaviors, such as aggression, parental behaviors and sexual behaviors using mice as an animal model.

ABSTRACT

Aggression is an innate behavior across animal species. It is essential for competing for food, defending territory, securing mates, and protecting families and oneself. Since initiating an attack requires no explicit learning, the neural circuit underlying aggression is believed to be genetically and developmentally hardwired. Despite being innate, aggression is highly plastic. It is influenced by a wide variety of experiences, particularly winning and losing previous encounters. Numerous studies in insects, reptiles, birds and mammals, have shown that winning and losing lead to heightened and depressed aggressiveness, respectively, a phenomenon referred to as the winner and loser effect. In the talk, I will present our recent findings regarding the neural mechanisms underlying the plasticity of aggressive behaviors.

INVITED SPEAKERS

Name: Bing Liu

Affiliation: State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, China

Talk title: Searching for dysconnectivity-based neuroimaging biomarkers in schizophrenia

BRIEF SELF-INTRODUCTION

Prof. Bing Liu is a Principal Investigator in State Key Laboratory of Cognitive Neuroscience and Learning of Beijing Normal University (since 2021) and a co-PI in Chinese Institute for Brain Research (since 2020). She completed her doctoral degree in Pattern Recognition and Intelligent Systems from the Institute of Automation in 2007. Since June 2007, Dr. LIU worked in the institute as an assistant professor (2007-2010), associate professor (2010-2015), a full professor (2015-2020) and a co-PI in the Center for Excellence in Brain Science and Intelligence Technology (2016-2021) respectively. Since Febuary 2021, her lab moved to Beijing Normal University. The research interests of her lab mainly focus on the precision medicine of psychiatric disorders by integrating multimodal brain imaging and other omics techniques. They aim to advance the understanding of the biological mechanisms of psychiatric disorders, and to develop personalized biomarkers and strategies for diagnosis and treatments of psychiatric disorders. She has published over 70 research papers in peer-reviewed journals, including *Nature Medicine, Journal of Neuroscience, Schizophrenia Bulletin, Neuropsychopharmacology, NeuroImage* etc.

ABSTRACT

The current diagnosis and treatment of schizophrenia are mainly based on the intuitive experience of psychiatrists based on symptoms. The establishment of a biomarker-based precise diagnosis and treatment framework is one of the most critical issues in the field of Precision Psychiatry. In view of the current dilemma of lack of effective, reliable, and biological plausible biomarkers for schizophrenia, we have jointly developed a multi-level research framework by integrating multi-omics data and artificial intelligence techniques, and further developed a new biomarker to index striatal dysconnectivity and established its utility in predicting antipsychotic treatment response, clinical stratification and elucidating striatal dysfunction in neuropsychiatric disorders. This new hypothesis-driven neuroimaging biomarker has been validated for schizophrenia identification, prognosis and subtyping based on functional striatal abnormalities (FSA), which provide a personalized index of striatal dysfunction, ranging from normal to highly pathological. Loci of striatal hyperactivity also recapitulated the spatial distribution of dopaminergic function and the expression profiles of polygenic risk for schizophrenia. In order to reveal the molecular bases of dysconnectivity-based neuroimaging biomarkers for schizophrenia, we advance cross-modal approaches to identify cell types and gene transcripts associated with schizophrenia-related brain dysconnectivity. Across multiple datasets and ex vivo patient cortical tissue, excitatory neuron and oligodendrocytes emerge as replicable cell-level correlates of cortical dysconnectivity in schizophrenia. These findings help advance the understanding of pathological mechanisms of schizophrenia by integrating in vivo clinical imaging with genetic and postmortem single-cell transcriptional data.

INVITED SPEAKERS

Name: Huan Luo

Affiliation: IDG/McGovern Institute for Brain Research at Peking University
School of Psychological and Cognitive Sciences, Peking University

Talk title: Probing and manipulating sequence working memory in human brains

BRIEF SELF-INTRODUCTION

Dr. Huan Luo is a tenured associate professor at the School of Psychological and Cognitive Sciences and a PI of IDG/McGovern Institute for Brain Research, Peking University. Her research primarily focuses on the brain mechanisms of perception, attention, and working memory in humans, particularly from a dynamic perspective, using combination of time-resolved behavioral, neuroimaging (e.g., EEG, MEG, etc.) and computational modelling methods, and has revealed crucial role of time-based information integration, segregation, and organization in various cognitive processes. She is Chang Jiang Young Scholar and supported by NSFC Key Program and Excellence Young Scientists Funds. Dr. Luo received her Ph.D. from the University of Maryland College Park, first worked at Chinese Academy of Sciences and joined Peking University since 2015. Dr. Luo currently serves as the associate editor for *Progress in Neurobiology*, reviewing editor for *eLife*, and consulting editor for *Journal of Cognitive Neuroscience.* As one of six labs in the world, her lab recently participated in a high-impact international collaborative project COGITATE supported by Templeton World Charity Foundation to test two theories for the neural correlates of consciousness.

ABSTRACT

Working memory (WM) is a core ability in human cognition from perception, attention, to decision making. Although psychological and neural mechanism for WM has been widely studied, how multiple items as well as their relationship are retained and organized in WM remain elusive. Our recent work, using an impulse-response approach to transiently perturb the WM system, demonstrate that WM items in a sequence are stored in distinct 'activity-silent' states and that content and ordinal structure are maintained in dissociated manner. We have newly developed a "dynamic perturbation" behavioral approach, by shifting the network from 'activity-silent' to active state, to manipulate the relative memory strength of a sequence of WM item, providing causal evidence for the key role of temporal dynamics in multi-item WM. A continuous attractor neural network model incorporating short-term neural plasticity (STP) further reproduces this manipulation. Taken together, multiple items are retained in distinct latent states of WM network according to their ordinal relationship in sequence, which could be efficiently manipulated via STP-based "dynamic perturbation" at a fine temporal scale.

INVITED SPEAKERS

Name: Liqun Luo

Affiliation: Stanford University

Talk title: Wiring specificity of neural circuits

BRIEF SELF-INTRODUCTION

Dr. Luo grew up in Shanghai, China, and earned his bachelor's degree in molecular biology from the University of Science and Technology of China. After obtaining his PhD in Brandeis University, and postdoctoral training at the University of California, San Francisco, Dr. Luo started his own lab in the Department of Biology, Stanford University in December 1996. Together with his postdoctoral fellows and graduate students, Dr. Luo studies how neural circuits are organized to perform specific functions in adults, and how they are assembled during development. Dr. Luo is currently the Ann and Bill Swindells Professor in the School of Humanities and Sciences, Professor of Biology, and Professor of Neurobiology by courtesy at Stanford University, and a Howard Hughes Medical Institute Investigator. He teaches neurobiology to Stanford undergraduate and graduate students. His single-author textbook “Principles of Neurobiology” (1st edition 2015; 2nd edition 2020) is widely used for undergraduate and graduate courses across the world.

Dr. Luo has served on the editorial boards of several scientific journals, including Neuron, eLife, and Annual Review of Neuroscience, Cell, and PNAS. He has also served on the Pew Scholar National Committee and Scientific Advisory Committee of Damon Runyon Cancer Research Foundation. He is recipient of the McKnight Technological Innovation in Neuroscience Award, the Society for Neuroscience Young Investigator Award, the Jacob Javits Award from National Institute of Neurological Disorders and Stroke, HW Mossman Award from American Association of Anatomists, the Lawrence Katz Prize, and the Pradel Award of National Academy of Sciences. Dr. Luo is a Member of the National Academy of Sciences and a Fellow of the American Academy of Arts and Sciences.

ABSTRACT

Developing brains utilize a limited number of molecules to specify connection specificity of a much larger number of neurons and synapses. How is this feat achieved? In this talk, I will first discuss our work using the *Drosophila* olfactory circuit as a model to address this question. I will then discuss studies of mammalian homologs of some of the wiring molecules we identified in the fly, focusing on the mouse hippocampal network.

INVITED SPEAKERS

Name: Minmin Luo

Affiliation: Chinese Institute for Brain Research, Beijing; National Institute of Biological Sciences, Beijing; Tsinghua University

Talk title: Role of the anterior cingulate cortex in reward devaluation

BRIEF SELF-INTRODUCTION

Dr. Minmin Luo is currently the Co-Director of Chinese Institute for Brain Research, Beijing, an Investigator at the National Institute of Biological Sciences, Beijing, and a professor at Tsinghua University. He received BS in psychology from Peking University (1995), MS in in computer science and PhD in neuroscience from the University of Pennsylvania (1997 & 2000). He completed postdoctoral training at the Howard Hughes Institute/Duke University (2004). His research interests focus on the neural circuits underlying reward-related behaviors, the relationship between circuit malfunctions and mental disorders, and the potential drug drugs for clinical interventions. His research group recently discovered that dorsal raphe serotonin neurons encode beneficialness signals and represent a reward modulatory system in parallel of the midbrain dopamine system.

ABSTRACT

Anhedonia is a core clinical criterion of major depression, which indicates a loss of interest or pleasure to reward. However, the neural circuit mechanism of anhedonia is not well understood. Here, I will present our recent results showing that the anterior cingulate cortex (ACC) plays a key role in encoding reward devaluation and depression. We observed that depressed mice were hypersensitive to reward devaluation which contributed to the feature of anhedonia. Ketamine, a rapid antidepressant, rescued this hypersensitivity. The activities of ACC principal neurons were negatively correlated with reward value and encoded the reward devaluation by the blunting of reward inhibition. In addition, ablation or inhibition of ACC principal neurons in healthy mice alleviated the reward devaluation and consequently resulted in over-consumption of food and obesity, while inhibition of these ACC neurons in depressed mice rescued their hypersensitive reward devaluation. Moreover, we identified that the basolateral amygdala (BLA)-projecting ACC neurons were functional subpopulations that bidirectionally modulated reward devaluation and consequently modulated reward intake and depressive behaviors. These results reveal a role and its underlying mechanism of ACC circuits in etiology and treatment of depression.

INVITED SPEAKERS

Name: Eve Marder

Affiliation: Brandeis University

Talk title: Perturbations reveal that degenerate circuits hide cryptic individual variability

BRIEF SELF-INTRODUCTION

Eve Marder is the Victor and Gwendolyn Beinfield University Professor at Brandeis University. She obtained a B.A degree from Brandeis University in 1969, a Ph.D. from the University of California, San Diego in 1974, and did postdoctoral research at the University of Oregon and the Ecole Normale Superieure in Paris, France before assuming her faculty position in 1978. Marder was President of the Society for Neuroscience (2008), and is a member of the National Academy of Sciences and the American Academy of Arts and Sciences. She has served on numerous grant and advisory panels and editorial boards. She has received numerous awards including the Gruber and Kavli Prizes. She received honorary doctorates from Bowdoin College and Tel Aviv University, and her life was highlighted in a recent book by Charlotte Nassim, MIT Press, 2018 *Lessons from the Lobster, Eve Marder's Work in Neuroscience.* Marder studies the dynamics of small neuronal networks, and was instrumental in demonstrating that neuronal circuits are not "hard-wired" but can be reconfigured by neuromodulatory neurons and substances to produce a variety of outputs. She combines experimental work with insights from modeling and theoretical studies. With Larry Abbott, her lab developed the programmable dynamic clamp and together they pioneered studies of homeostatic regulation of intrinsic membrane properties, and stimulated work on the mechanisms by which brains remain stable while allowing for change during development and learning. Marder now studies how similar network performance can arise from different sets of underlying network parameters, with its relevance for differential resilience in the population.

ABSTRACT

Both computational and experimental results in single neurons and small networks demonstrate that very similar network function can result from quite disparate sets of neuronal and network parameters. Using the crustacean stomatogastric nervous system, we now study the influence of these differences in underlying structure on differential resilience of individuals to a variety of environmental perturbations, including changes in temperature, pH, potassium concentration and neuromodulation. We show that neurons with many different kinds of ion channels can smoothly move through different mechanisms in generating their activity patterns, thus extending their dynamic range.

INVITED SPEAKERS

Name: Elizabeth Phelps

Affiliation: Harvard University

Talk title: Mechanism of threat control and translation challenges

BRIEF SELF-INTRODUCTION

Elizabeth A. Phelps is the Pershing Square Professor of Human Neuroscience. She received her PhD from Princeton University and served on the faculty of Yale University and New York University. Her laboratory has earned widespread acclaim for its groundbreaking research on how the human brain processes emotion, particularly as it relates to learning, memory and decision making. Dr. Phelps is the recipient of the 21st Century Scientist Award from the James S. McDonnell Foundation, the Distinguished Scholar Award from the Social and Affective Neuroscience Society, the William James Award from the Association for Psychological Science and the George Miller Award from the Cognitive Neuroscience Society. She is a fellow of the American Association for the Advancement of Science, the Society for Experimental Psychology and the American Academy of Arts and Sciences. She has served on the Board of Directors of the Association for Psychological Science, the Society for Neuroeconomics and was a founding board member of the Society for Neuroethics. She has previously served as the President of the Society for Neuroeconomics, the Association for Psychological Science and the Social and Affective Neuroscience Society.

ABSTRACT

Animal models of associative threat learning provide a basis for understanding human fears and anxiety. This talk will explore how the neural mechanisms identified in animal models are consistent with human brain function and extend this research to the complex learning situations more typical of human experience. Building on research from animal models of associative threat learning, we explore a range of means maladaptive defensive responses can be diminished in humans. I outline how extinction and emotion regulation, techniques adapted in cognitive behavioral therapy, can be used to control learned defensive responses via inhibitory signals from the ventromedial prefrontal cortex to the amygdala. One drawback of these techniques is that these responses are only inhibited and can return, with one factor being stress. I will then describe novel behavioral techniques that might result in a more lasting fear reduction. Finally, I will discuss issues related to the translating these techniques to novel treatments for clinical disorders.

INVITED SPEAKERS

Name: Joshua R. Sanes

Affiliation: Harvard University

Talk title: What transcriptomics can tell us about retinal development, disease and evolution

BRIEF SELF-INTRODUCTION

Joshua R. Sanes and his colleagues study how specific connections form in the mammalian nervous system to generate the complex circuits that underlie the processing of information. Most of their work has used the motor system (neuromuscular junction) and visual system (retina) as models; investigations have involved molecular, histological, physiological and genetic methods. They have also pioneered new ways to mark and manipulate neurons and the synapses they form. Their results have been published in over 400 papers. Their current work focuses on comprehensive classification and characterization on neurons in the mammalian retina, and the use of this atlas to address issues in development, disease and evolution.

Sanes received a PhD from Harvard and served on the faculty of Washington University before returning to Harvard in 2004 as Founding Director of the Center for Brain Science and Professor of Molecular and Cellular Biology. He has served on editorial boards of scientific journals including Cell and Neuron; on planning committees for the NIH BRAIN Initiative and the NEI Audacious Goals Initiative; and on advisory boards for multiple organizations including NINDS (NIH), the Institute of Neuroscience (Shanghai) Max-Planck Institutes (Martinsreid and Frankfort), Wellcome Trust, and Howard Hughes Medical Institute. He is a member of the National Academy of Sciences and the American Academy of Arts and Sciences. He has delivered Grass and Harvey Lectures, and has been awarded the Schuetze, Gruber, UNC-Perl, Cowan and Scolnick prizes in neuroscience.

ABSTRACT

Classification of neurons, long viewed as a fairly boring enterprise, has emerged as a major bottleneck in analysis of neural circuits. High throughput single/single nucleus RNA-seq has provided a new way to improve the situation. We initially applied this method to mouse retina, showing that its five neuronal classes (photoreceptors, three groups of interneurons, and retinal ganglion cells) can be divided into approximately 130 discrete types. We are now using this atlas as a foundation to ask several questions. For example, how do the many cell types within a class diversify as development proceeds? How do neurons respond to injury and are alterations similar or different among closely related cell types? Can genes selectively expressed by resilient or susceptible cells serve as starting points for devising interventions that promote neuronal survival or regeneration? We also used lessons learned from the mouse atlas to generate atlases from human retina and subsequently whole human eyes, allowing us to determine the cell types that express genes implicated in blinding diseases. Finally, we have generated retinal atlases from several other vertebrate species including macaque, marmoset, ferret, squirrel, pig, zebrafish and chick, in order to learn about how neuronal classes and types evolve.

INVITED SPEAKERS

Name: Yan Song

Affiliation: School of Life Sciences, PKU-THU Joint Center for Life Sciences, Peking University, Beijing, China

Talk title: Ready, go! Timely and robust cell fate commitment in neural stem cell lineages

BRIEF SELF-INTRODUCTION

Yan Song is currently Associate Professor with Tenure at the School of Life Sciences and Principal Investigator at the Peking-Tsinghua Joint Center for Life Sciences at Peking University, Beijing, China. She received her BS from Peking University, her PhD in Molecular Genetics from Duke University and completed her postdoctoral training at Stanford University. She then joined the faculty of Peking University to start her independent research group. Combining powerful fly and mouse genetics, state-of-the-art imaging with cell biology and biochemical approaches, her research group has been focused on understanding the fundamental mechanisms underlying cell fate decision in neural stem cell lineages, both in development and disease (https://www.yansonglab.org). Although much is known about the molecular mechanisms underlying spatial control of cell fate determination, how the fourth dimension, time, governs neural cell fate specification remains enigmatic. Her group has been very interested in deciphering the mysteries of the temporal control of neural cell fate determination: (a) how timely cell fate commitment is achieved; (b) how temporal signals are decoded and translated into cell fate decisions; and (c) how temporal and spatial cues are integrated to dictate cell fate or identity. She currently serves as Associate Editor at *PLoS Genetics,* Early Career Advisory Board member at *Journal of Cell Biology* and Guest Editor at *Developmental Biology.*

ABSTRACT

Although much is known about the molecular mechanisms underlying spatial control of cell fate determination, how the fourth dimension, time, governs neural cell fate specification remains enigmatic. In particular, it is unclear how timely and robust cell fate commitment is achieved during neural stem cell lineage progression. By performing in vivo time-lapse live imaging of dividing Drosophila neural stem cells (NSCs), we revealed the existence of a tightly-regulated yet previously-overlooked transition phase between the initial cell fate decision and the ultimate cell fate commitment. We identified the Super Elongation Complex (SEC), best known for transcription elongation checkpoint control, as an **intrinsic amplifier** that accelerates this transition stage and thereby drives timely NSC fate commitment. To understand how timely neuronal differentiation is secured, we unexpectedly discovered that, in dividing fly neural precursors, the transcription factor Prospero is retained at the pericentromeric regions of mitotic chromosomes via liquid-liquid phase separation (LLPS). At mitotic exit, Prospero droplets recruit and concentrate heterochromatin protein 1 (HP1) into phase-separated condensates and drive heterochromatin compaction. This establishes a transcriptionally repressive chromatin environment that guarantees timely cell-cycle exit and terminal neuronal differentiation. Our ongoing work suggest that mammalian Prospero homolog Prox1 uses a similar **mitotic retention** strategy to ensure timely neural fate specification. Together, new paradigms including positive feedback-base intrinsic amplifier strategy and LLPS-based mitotic retention strategy are utilized in distinct cell fate determination steps to drive timely cell fate commitment and ensure correct neural stem cell lineage progression.

INVITED SPEAKERS

Name: Shiming Tang

Affiliation: IDG/McGovern Institute for Brain Research at Peking University School of Life Sciences, Peking University

Talk title: Studying macaque visual cortex with a large set of natural images

BRIEF SELF-INTRODUCTION

Dr. Shiming Tang is an associate Professor of Biology at Peking University and an Investigator of Peking and Tsinghua Center for Life Sciences. He studied aerospace engineering at Beihang University and received his doctorate in mechanical and electronic engineering in 1998, under the guidance of Qixian Zhang. His lab focuses on the neural mechanism of object recognition in macaque visual cortex. He has received National Outstanding Youth Grant and the 9th Chinese Young Scientist Award.

ABSTRACT

Studies of the macaque visual cortex have been hampered by neurophysiological recording techniques that are limited in the number of neurons that can be recorded and the duration in which they can be studied. As a result, researchers typically have to resort to a hypothesis-driven approach, testing neurons with a small set of preselected artificial or natural scene stimuli. The bias in the stimulus sets might have created biases in our understanding of the neural codes and functional organization of the visual cortex. As an example, our early studies have demonstrated that classically defined orientation–tuned cells in V1 can act as higher-order shape detectors when examined with extended stimulus sets. Whereas in IT, a face neuron could be reported as a face component selective neuron when checked with the feature-reduction technique. At the population level, varying functional maps were found in the same cortical area depending on the stimulus sets used. A new research paradigm is required to obtain a complete and unbiased picture of the neural code and functional organization of the visual cortex.

We have developed long-term stable two-photon imaging and large-field single-photon imaging techniques in awake monkeys. By testing macaque visual neurons responding to tens of thousands of natural stimuli, we can shift our research paradigm to a big-data-driven approach to study neural codes and functional organization. The randomly selected natural images, containing a great variety of features in a great variety of combinations, could be more effective in discovering the critical features encoded by visual neurons without prior hypothesis and bias. Using the deep learning networks trained on these big–data sets, we can visualize the critical features for each recorded neuron or cortical pixel. We found that single neurons in V1 and V4 sparsely encode specific visual features, which we confirmed using loose-patch single-cell recordings. We further revealed macaque area V4 contains a topological functional map with modules coding distinct clusters of natural image features far richer and diverse than suggested by earlier studies. These discoveries demonstrate the power of the technology-enabled big-data-driven approach in bringing new insights into the neural mechanism of visual information processing.

INVITED SPEAKERS

Name: Alice Y. Ting

Affiliation: Stanford University

Talk title: Optogenetic and chemogenetic technologies for probing molecular and cellular interactions

BRIEF SELF-INTRODUCTION

Alice Ting is Professor of Genetics, Biology, and by courtesy, Chemistry at Stanford University. She was born in Taiwan, raised in Texas, and received her degrees from Harvard (AB) and UC Berkeley (PhD), training with EJ Corey, Peter Schultz, and Roger Tsien. Alice started her independent laboratory at MIT in 2002, and relocated as Full Professor to Stanford in 2016. Alice's work straddles the interface of chemistry and biology and the molecular technologies she has invented have transformed cell biology and neuroscience. She has received the NIH Pioneer Award, the Arthur Cope Scholar Award, and the McKnight Technological Innovations in Neuroscience Award. Alice has been a Chan Zuckerberg Biohub investigator since 2017.

ABSTRACT

Molecular recorders are scalable, single cell technologies that fulfill a longstanding need in biology by creating stable records of past cellular events, simultaneously applicable across thousands of cells. The "records" can be read out by RNA sequencing, FACS, imaging, or if desired, altered cellular properties and physiology. I will describe our efforts to develop and apply molecular recorders for calcium, protein localization, and cell-cell contacts in living systems.

In the second part of the talk, I will describe recent improvements to and extensions of technologies for proximity labeling. Proximity labeling is catalyzed by engineered promiscuous enzymes in living cells and used for the discovery of local proteomes and transcriptomes with nanometer spatial resolution and minute temporal resolution.

INVITED SPEAKERS

Name: Doris Tsao

Affiliation: University of California, Berkeley

Talk title: Faces: a neural Rosetta Stone

BRIEF SELF-INTRODUCTION

Dr. Doris Y. Tsao is a Professor of Biology at the University of California Berkeley and Investigator of the Howard Hughes Medical Institute. She studied biology and mathematics at Caltech as an undergraduate and then received her Ph.D. in neuroscience from Harvard in 2002, under the guidance of Margaret Livingstone.

The central question that guides her lab is: how does the brain represent the visual world? Her interests span all levels of the visual brain, from early/mid-level retinotopic areas, to high-level areas in the parietal and temporal lobes, to prefrontal cortex. She is especially interested in visual object representation, and has done extensive work both on object recognition (for a recent review, see Hesse & Tsao, Nature Reviews Neuroscience 2020) and object segmentation & tracking (see Tsao & Tsao Arxiv 2021). Dr.Tsao has received multiple honors including the Sofia Kovalevskaya Award, the Eppendorf and Science International Prize in Neurobiology, and a MacArthur Fellowship. She is a member of the US National Academy of Science.

ABSTRACT

Objects constitute the fundamental currency of the brain: they are things that we perceive, remember, and think about. One of the most important objects for a primate is a face. Research on the macaque face patch system in recent years has given us a remarkable window into the detailed processes underlying object recognition. I will discuss findings from our lab elucidating the code for facial identity used by cells in face patches. I will then discuss how this system provides a general template for understanding high-level object recognition. Finally, I will discuss recent work exploring dynamic interactions between face patches during visual inference.

INVITED SPEAKERS

Name: Richard W. Tsien

Affiliation: Neuroscience Institute, NYU Grossman School of Medicine, New York University

Talk title: Homeostatic tuning of synaptic strength uses LTP-like mechanisms

BRIEF SELF-INTRODUCTION

Starting with a background in electrical engineering, I entered the field of membrane biophysics through the backdoor and learned about the workings of the heartbeat and the brain while earning my D.Phil. at Oxford with Denis Noble and Julian Jack. I transitioned from heart to brain at Yale, and went on to start new departments/institutes at Stanford and NYU, focusing first on Molecular Physiology and later on Neuroscience. Over the decades, I have investigated ion channels and synaptic transmission, dating back to the discovery that central synapses use a previously unrecognized set of calcium channels, exemplified by the N-type channel, to drive exocytosis. Studies of the diversity of Ca^{2+} channels led to work on long-term plasticity and then to more general studies on synaptic physiology. I have been fascinated by how the properties of individual synapses contribute to the dynamics of neuronal networks and by the possibility that translocation of synaptic resources (vesicles, postsynaptic receptors) supports heterosynaptic plasticity. What role do diverse excitatory and inhibitory synapses play in shaping the flow of information in CNS circuits? How might neural circuitry containing such synapses become dysfunctional in disorders such as autism and epilepsy and be modified by oxytocin and cannabidiol? Ensembles of recurrently connected neurons generate healthy activity like sharp wave discharges but also epileptic discharges --what determines the watershed between these forms of activity? We use electrical, molecular, genetic and optical approaches to address such fundamental questions, capitalizing on genetic discoveries of highly penetrant disorders such as Timothy Syndrome (TiS), that display aspects of both autism and epilepsy. Monogenic disorders like TiS are rare, but provide valuable tests of more general approaches to bridge the divide between genetics and pathophysiological understanding, with the ultimate goal of finding useful therapeutic interventions.

ABSTRACT

Homeostasis is a fundamental property of biological systems that uses negative feedback to maintain functional stability. In the nervous system, this is seen in homeostatic plasticity wherein neurons adjust their synaptic or firing properties over hours-to-days in response to prolonged changes in activity levels (e.g. stroke or sensory deprivation). Homeostatic synaptic plasticity is often framed as complementary to and distinct from Hebbian plasticity such as LTP, which requires positive (destabilizing) feedback. Still, it remains mysterious because several questions remain unanswered. What is the time course of the homeostatic adaptation? Is its expression purely postsynaptic? Does it share mechanisms in common with LTP? We present evidence that spike blockade causes a damped oscillatory response in the properties of unitary postsynaptic currents, not a monotonic relaxation. The oscillatory response depends on familiar signaling components, including L-type calcium channels, Ca-permeable AMPARs, CaMKII and calcineurin, already implicated in Hebbian forms of plasticity. Experiments and modeling describe an interplay between two feedback loops involving cytoplasmic calcium: negative feedback initiated by shutting off the phosphatase calcineurin, and positive feedback elicited by spine depolarization and recruitment of CaMKII, which speeds restoration of basal conditions. Synaptic adaptation in turn drives homeostatic changes in neuronal spikes mediated by changes in alternative splicing of the large-conductance, Ca^{2+}-activated BK potassium channel. Players in these pathways are genetically implicated in autism, schizophrenia, major depression and bipolar disorder.

INVITED SPEAKERS

Name: Liping Wang

Affiliation: Institute of Neuroscience, Center for Excellence in Brain Science and Intelligence Technology, Chinese Academy of Sciences

Talk title: Sequence representations in humans and monkeys

BRIEF SELF-INTRODUCTION

Dr. Liping Wang received his B.S. in Biology from East China Normal University (ECNU) Shanghai in 2003. From 2003 to 2009, he was in a joint PhD program between Johns Hopkins University and ECNU and received his Ph.D. in Cognitive Neuroscience from ECNU in 2009. He studied the tactile working memory in non-human primates under the supervision of Prof. Yong-Di Zhou. He then did his first postdoctoral work with Prof. Yasushi Miyashita at the University of Tokyo in Japan, and got his second postdoc training by Prof. Stanislas Dehaene at INSERM NeuroSpin brain imaging center in France. In Paris, Wang focused on neural representations of language syntax in both humans and non-human primates. In 2016, Wang joined the Institute of Neuroscience in Chinese Academy of Sciences full time as Investigator and Head of the Laboratory of Comparative Psychobiology. His main interests are the neural mechanisms underlying sequence learning, working memory and bodily self-consciousness.

ABSTRACT

A sequence of images, sounds, or words can be stored at several levels of detail, from specific items and their timing to abstract structure. We do not know how the brain encodes temporal sequences of items, such that this knowledge can be used to retrieve a sequence from memory, recognize it, anticipate on forthcoming items, and generalize this knowledge to novel sequences with a similar structure. In this talk, I will present several studies to investigate the neural code underlying spatial sequence and working memory, using two-photon calcium imaging to record thousands of neurons in the prefrontal cortex of macaque monkeys. We discovered a regular geometrical organization: the high-dimensional neural state space during the delay could be decomposed into a sum of low-dimensional subspaces, each storing the spatial location at a given ordinal rank, generalizing to new sequences and explaining monkey behavior. The rank subspaces were distributed across large overlapping neural groups, and the integration of ordinal and spatial information occurred at the collective level, not within single neurons. Thus, a simple representational geometry underlies sequence working memory. I will also talk about how macaque monkeys learn sequences with supra-regular grammars, and how we could translate the knowledge of sequence structures in neuroscience to the clinic to assessing residual consciousness in unresponsive patients.

INVITED SPEAKERS

Name: Masashi Yanagisawa

Affiliation: International Institute for Integrative Sleep Medicine (WPI-IIIS) , The University of Tsukuba

Talk title: Deciphering the mystery of sleep: toward the molecular substrate for sleepiness

BRIEF SELF-INTRODUCTION

In 1988, as a graduate student at University of Tsukuba, Yanagisawa discovered endothelin, a potent vasoconstrictor peptide from vascular endothelial cells, which sparked an intense research activity in the field. In the subsequent year, his group identified a G protein-coupled receptor for endothelin, which would become an important drug target; the endothelin receptor antagonist bosentan was approved in 2001 for the treatment of pulmonary hypertension. After moving to University of Texas Southwestern Medical Center at Dallas in 1991 as a young HHMI investigator, he identified the endothelin-converting enzyme, a metalloprotease that generate the active, mature endothelin peptides. Through gene-targeting experiments in mice, he also discovered in 1994 that the endothelin pathway is essential for embryonic development of certain neural crest derived tissues, and that endothelin-B receptor deficiency causes Hirschsprung disease in mice and humans. In 1996, he initiated a systematic search for endogenous ligands of “orphan” G protein-coupled receptors, which resulted in his 1998 discovery of orexin, a hypothalamic neuropeptide. He then discovered in 1999 that orexin deficiency causes the sleep disorder narcolepsy. This opened up a new avenue in sleep research, and led to a better understanding of sleep/wake switching mechanisms in the brain. The notion that orexin is an important endogenous waking agent led to the development of orexin receptor antagonists as sleep-inducing drug, first of which, suvorexant, was approved in 2014. Recognizing, however, that the fundamental mechanism for sleep homeostasis still remains a mystery, in 2010 he embarked upon a highly ambitious project of polysomnography (EEG/EMG)-based forward genetic screen for sleep/wake abnormalities in chemically mutagenized mouse cohort. This large-scale project is now continuing in Tsukuba, Japan, and has recently led to identification of several new genes that are importantly involved in the regulation of sleep amounts and the level of sleep need.

ABSTRACT

Although sleep is a ubiquitous behavior in animal species with central nervous systems, the neurobiology of sleep remain mysterious. Our discovery of orexin, a hypothalamic neuropeptide involved in the maintenance of wakefulness, has helped reveal neural pathways in the regulation of sleep/wakefulness. Orexin receptor antagonists, which specifically block the endogenous waking system, have been approved as a new drug to treat insomnia. Also, since the sleep disorder narcolepsy-cataplexy is caused by orexin deficiency, orexin receptor agonists are expected to provide mechanistic therapy for narcolepsy; they will likely be also useful for treating excessive sleepiness due to other etiologies.

Despite the fact that the executive neurocircuitry and neurochemistry for sleep/wake switching has been increasingly revealed in recent years, the mechanism for homeostatic regulation of sleep, as well as the neural substrate for "sleepiness" (sleep need), remains unknown. To crack open this black box, we have initiated a large-scale forward genetic screen of sleep/wake phenotype in mice based on true somnographic (EEG/EMG) measurements. We have so far screened >10,000 heterozygous ENU-mutagenized founders and established a number of pedigrees exhibiting heritable and specific sleep/wake abnormalities. By combining linkage analysis and the next-generation whole exome sequencing, we have molecularly identified and verified the causal mutations in several of these pedigrees. Biochemical and neurophysiological analyses of these mutations are underway. Indeed, through a systematic cross-comparison of the Sleepy mutants (with a gain-of-function change in a serine/threonine kinase pathway) and sleep-deprived mice, we have found that the cumulative phosphorylation state of a specific set of mostly synaptic proteins may be the molecular substrate of sleep need.

OLYMPUS

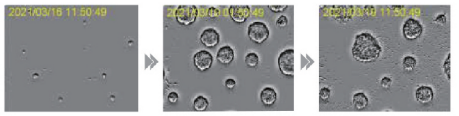
奥林巴斯神经科学解决方案

1 样本制备

CM20 细胞培养监控系统

适用于仪器设备的高品质光学组件

- 精确控制接种细胞数量
- 培养过程中实时观察3D培养细胞形态的变化
- 优化培养条件，精确的质量控制
- 评估实验流程节点



NSC sphere Conditions Vessel: 12 well Interval time: 1 H Measurement period: 6 Days

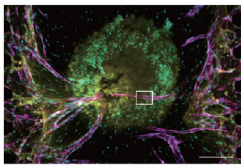
NSC sphere 视频

CM20 应用资料

2 成像

完美平衡 **FV3000** 激光扫描共聚焦显微镜

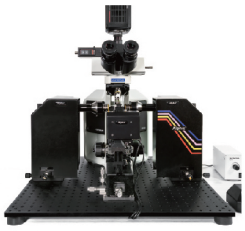
- TruSpectral全真光谱检测
- GaAsP高灵敏检测器
- Resonant Scanner高速成像



The tumor spheroid and its vascular network.

FV3000 应用资料

高速度 **Alpha^3** 光片显微成像系统



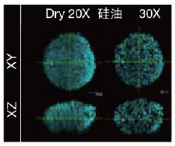
深层成像 **FVMPE-RS** 双光子显微成像系统

- 成像深度可达8mm
- Resonant Scanner 高速成像
- 双IR激光+4通道双光子检测

超分辨 **IXplore SpinSR** 转盘共聚焦高分辨成像系统

- 110nm超分辨
- 200fps高速成像
- 低光毒性活细胞成像
- 活细胞长时程成像

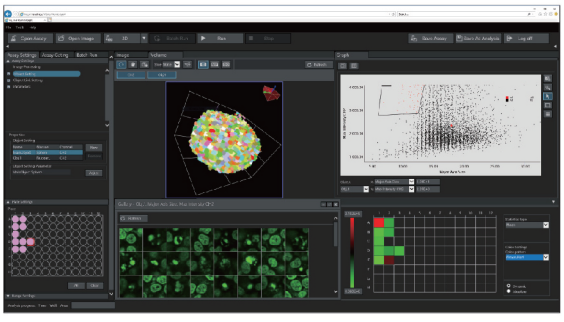
硅油物镜 准确的细胞识别

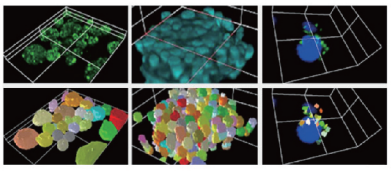


NoviSight / 硅油物镜 应用资料

3 分析

NoviSight_ 专门为神经科学研究开发的 3D 分析软件





3D细胞分析软件，可对z序列图像进行统计分析，包括自动细胞识别、分割与计数。并对标本的体积、表面积、长度等形态学参数及荧光强度进行定量统计分析。

OLYMPUS
www.olympus-lifescience.com.cn/zh/

奥林巴斯（北京）销售服务有限公司
上海市徐汇区淮海中路1010号嘉华中心10楼
电话：400 969 0458

北京中晟天成科技有限公司
（奥林巴斯生命科学 一级代理商）
电话：13466669357

如需咨询或联系，请登录：
www.olympus-lifescience.com.cn/zh/

NIKON公司提供多种模式的神经生物学成像产品

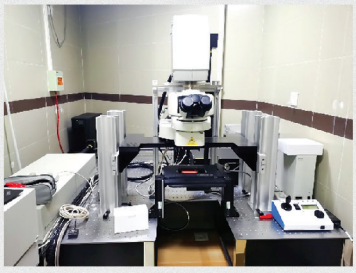
产品联系人：徐经理 13811854863

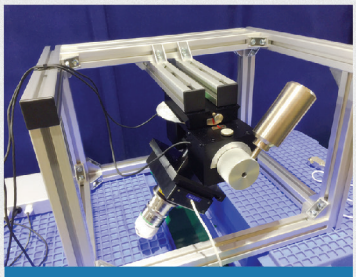
产品咨询

1.常规正置小鼠脑部观察双光子显微镜

2.正置高速转盘共聚焦：--高速动态成像

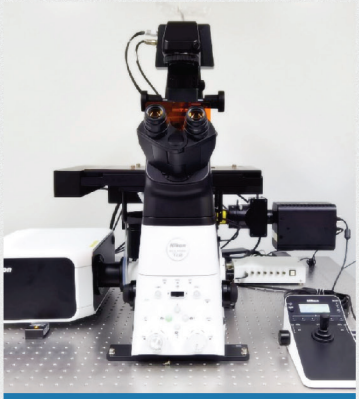
3.全自动多电极显微微操作系统；支持1-8个微操作器





4.大空间双光子-可做猕猴、乳猪等大型动物；兼容小鼠、大鼠；兼容物镜旋转系统

5.正置转盘共聚焦改造系统—边切边扫； 用于鼠脑、猴脑、狗等大样品切片扫描成像



6.最新型高速高分辨扫描共聚焦AXR—具有大视场FOV25mm；高速高分辨：15帧/秒@1024x1024；720帧/秒@2048x16

北大脑科学

北京大学IDG麦戈文
脑科学研究所
（Bilibili）

医大时代教育
直播平台