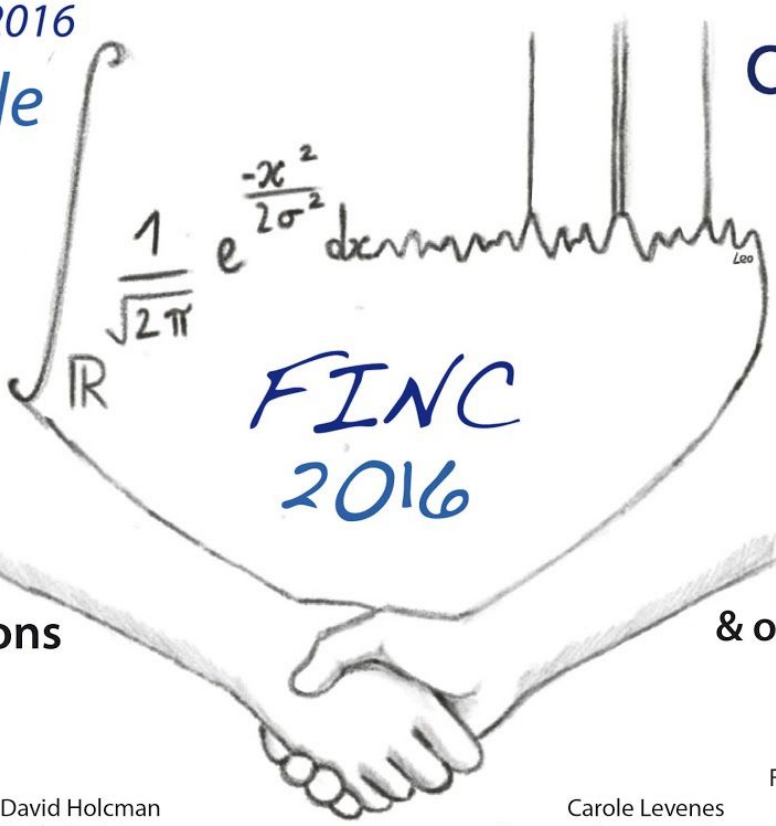
6th French-Israel Neuroscience Conference

« The Power of Mathematics in Contemporary Neuroscience »

July 10-15 2016

Marseille

CIRM



Speakers Chairpersons & organizers*

Cendra Agulhon
Paul Apicella
Amos Arieli
Demian Battaglia
Moshe Bar
Yehezkel Ben Ari
Thomas Boraud
Thomas Brochier
Yoram Burak
Frédéric Chavane *
Jenny Coull
Aline Desmedt *
David Holcman
Yadin Dudai
Jean-Marc Edeline
Valérie Ego
Olivier Faugeras
Jean-Marc Fellous
Tomer Fekete
Yves Frégnac
Jean-Marc Goaillard
Inbal Goshen
Yael Hanein
David Hansel *
Lydia Kerkerian le Goff
Bjørg Kilavik
Ilan Lampl
Arthur Leblois
Carole Levenes
Yonatan Loewenstein
Claude Meunier
Gianluigi Mongillo
Anna Montagnini
Genela Morris
Eli Nelken *
Laurent Perrinet
Serge Picaud
Bruno Poucet
Alexa Riehle
David Robbe
Francesca Sargolini
Menahem Segal
Maoz Shamir *
Oren Shriki
Daniel Shulz
Jonathan Touboul
Eilon Vaadia
Ivo Vanzetta
Carl van Vreeswijk
Shlomo Wagner

registration mandatory at http://scientific-events.weebly.com/1414.html contact: 2016finc@gmail.com

French-Israel Neurosciences Conference 2016

Marseille / CIRM - July 10-15 2016

Organizers

Frederic Chavane (CNRS, Marseille, co-chair of FINC2016)
Aline Desmedt (Bordeaux University)
David Hansel (CNRS, Paris, co-chair of FINC2016)
Israel Nelken (The Hebrew University)
Maoz Shamir (Ben Gurion University)

The goal

Over the past decade technological advances across several disciplines have dramatically expanded the frontiers of experimentally accessible questions in neuroscience. We believe that making sense of these data necessitates guidance through a parallel revolution in theoretical neuroscience. The goal of *FINC2016* is to contribute to this challenge by bringing together French and Israeli neuroscientists who will paint the current status of theoretical and experimental neuroscience and identify what is needed to move forward. Our hope is that the conference will contribute to a roadmap for a better synergy between theoretical and experimental neuroscience.

Location

The conference will take place at the CIRM (http://www.cirm-math.fr/) in the campus of Luminy, Marseille (France).

Format

The conference will last for 5 days divided into 8 half-day thematic sessions. Each session will be address a scientific question from the experimental and the theoretical standpoints by a “duo” or a “trio” of speakers (30’ each). Talks on each thematic will be followed by a discussion (30’) chaired by another experimentalist/theoretician duo.

Sunday, July 10

Reception

18:00 General introduction - **Frédéric Chavane** & **David Hansel**

18:15 Keynote presentation by **Olivier Faugeras** (INRIA, Sophia-Antipolis, FR)

Geometry, symmetries, and randomness in neuroscience

Cold-Buffet Dinner

Monday, July 11

Session 1: Computing across states

Chairs: **Eli Nelken** (HUJI, IL) & **Demian Battaglia** (CNRS, Marseille, FR)

09:00-10:30 ***Excitation/inhibition in strongly recurrent networks and computation***

09:00-09:30 **Ilan Lampl** (Weizmann I., IL)

Local and thalamic origins of ongoing and sensory evoked cortical correlations

09:30-10:00 **David Hansel** (CNRS, Paris, FR)

Balanced or not balanced, what is the question?

10:00-10:30 Discussion

Break

10:45-12:15 ***Diversity of states and computation***

10:45-11:15 **Jean-Marc Goaillard** (INSERM, Marseille, FR)

Diversity of biophysical solutions underlying electrical phenotype of neurons

11:15-11:45 **Maoz Shamir** (Ben Gurion U, IL)

In search for the neural code: neuronal diversity and noise correlations

11:45-12:15 Discussion

Lunch

Session 2: Dynamic computations at mesoscopic scale

Chairs: **Jonathan TOUBOUL** (Coll. de Fr, Paris, FR) & **Yves Frégnac** (UNIC-CNRS., Gif, FR)

14:00-15:30 ***Dynamic computations within visual maps***

14:00-14:30 **Frédéric Chavane** (CNRS-INT, Marseille, FR)

Canonical dynamic computations within visual cortical maps

14:30-15:00 **Tomer Fekete** (KU Leuven/Weizmann)

Spontaneously emerging cortical maps revisited

15:00-15:30 Discussion

Break

16:00-17:30 ***Dynamic representation in the motor system***

16:00-16:30 **Carl van Vreeswijk** (CNRS, Paris, FR)

Mechanism of transient muscle activation during movements

16:30-17:00 **Thomas Brochier** (CNRS-INT, Marseille, FR)

Cortical dynamics for hand movement control

17:00-17:30 Discussion

Early Dinner & evening hike in the calanques

Tuesday, July 12

Session 3: Perception - Action

Chairs: **Laurent Perrinet** (CNRS, Marseille, FR) & **Daniel Shulz** (CNRS, Gif, FR)

09:00-10:30 ***Brain-Machine interface for action***

09:00-09:30 **Eilon Vaadia** (HUJI, IL)

Learning In Brain Machine Interfaces

09:30-10:00 **Valérie Ego** (CNRS Gif, FR)

Neural Mechanisms of Brain-Machine Interfaces

10:00-10:30 Discussion

Break

10:45-12:15 ***Active sensing in visual processing***

10:45-11:15 **Amos Arieli** (Weizmann I, IL)

The role of active sensing in depth perception

11:15-11:45 **Anna Montagnini** (CNRS, Marseille, FR)

Eye movements and visual perception: the restless pas de deux

11:45-12:15 Discussion

Lunch

Session 4: Dynamic predictive representations

Chairs: **Alexa Riehle** (CNRS, MRS, FR) & **Claude Meunier** (CNRS, Paris, FR)

14:00-15:30 ***Complexity vs. predictiveness***

14:00-14:30 **Eli Nelken** (HUJI, IL)

Context-specificity of neuronal responses in primary auditory cortex: complexity or simplicity?

14:30-15:00 **Jean-Marc Edeline** (CNRS, Orsay, FR)

How well can we predict auditory cortex responses to natural stimuli?

15:00-15:30 Discussion

Break

16:00-17:30 ***The predictive brain***

16:00-16:30 **Jenny Coull** (CNRS, Marseille, FR)

Predicting time

16:30-17:00 **Moshe Bar** (Bar Ilan, IL)

The Lasting Primacy Hypothesis

17:00-17:30 Discussion

Dinner

Wednesday, July 13

Session 5: ***Memory: going beyond neuronal plasticity/engram***

Chairs: **Francesca Sargolini** (Aix-Mars U, FR) & **Menahem Segal** (WIS, IL)

09:00-10:30 ***New directions in spatial navigation?***

09:00-09:30 **Bruno Poucet** (CNRS, Marseille, FR)

Properties of hippocampal place cells during goal-directed spatial navigation

09:00-09:30 **Yoram Burak** (HUJI, IL)

What principles may determine the allocation of grid cells to modules in the entorhinal cortex?

10:00-10:30 Discussion

Break

10:45-12:15 ***Still searching the engram: should we?***

10:45-11:15 **Gianluigi Mongillo** (CNRS, Paris, FR)

Inhibitory connectivity defines the realm of excitatory plasticity

11:15-11:45 **Yadin Dudai** (WIS, IL)

The first seconds of episodic memories, and the years thereafter

11:45-12:15 Discussion

Lunch

SOCIAL: BOAT TOUR and PIC-NIC

16:00-20:00

Thursday, July 14

Session 6 *Neurons and non-neurons*

Chairs: **Bjorg Kilavik** (CNRS, MRS, FR) & **Ivo Vanzetta** (CNRS, MRS, FR)

09:00-10:30 ***Neurons and the nano-scale***

09:00-09:30 **David Holcman** (ENS, Paris, FR)

Diffusion and electrodiffusion regulated by glial cells and dendritic spines

09:00-09:30 **Yael Hanein** (Tel Aviv U., IL)

Glutamate Mediated Astrocytic Filtering of Neuronal Activity

10:00-10:30 Discussion

Break

10:45-12:15 ***Glia and Neuro-glia interactions***

10:45-11:15 **Cendra Agulhon** (CNRS, Paris, FR)

Inhibitory connectivity defines the realm of excitatory plasticity

11:15-11:45 **Inbal Goshen** (HUJI, IL)

Glial and neuronal contributions to long term memory and plasticity

11:45-12:15 Discussion

Lunch

Session 7 *Theoretical perspectives about the basal ganglia*

Chairs: **David Robbe** (INSERM, Marseille, FR) & **Arthur Leblois** (CNRS, FR)

14:00-15:30 ***Dynamics of the basal ganglia***

14:00-14:30 **Thomas Boraud** (CNRS, Bordeaux, FR)

Multiple striatal territories compete in order to select spatial navigation strategy

14:30-15:00 **Genela Morris** (HaifaU,IL)

Striatal mechanism of plasticity underlying multi-modal learning

15:00-15:30 Discussion

Break

16:00-17:30 ***New hints from the reward system***

16:00-16:30 **Paul Apicella** (CNRS, Marseille, FR)

Striatal dopamine and acetylcholine mechanisms involved in reward-related learning

16:30-17:00 **Yonatan Loewenstein** (HUJI, IL)

Modeling operant learning: from synaptic plasticity to behavior

17:00-17:30 Discussion

Dinner - “Bouillabaisse“

Friday, July 15

Session 8 *Theoretical challenges in animal models*

Chairs **Carole Levenes** (CNRS, Paris, FR) & **Oren Shriki** (Ben Gurion U., IL)

09:00-10:30 ***Animal models of neurodegeneration***

09:00-09:30 **Lydia Kerkerian le Goff** (CNRS, Marseille, FR)

Insights onto the pathophysiology of Parkinson's disease from optogenetics and disease progression modeling in rodents

09:30-10:00 **Serge Picaud** (INSERM, Paris, FR)

Why assessing visual restoration on non-human primates?

10:00-10:30 Discussion

Break

10:45-12:15 ***Animal models of Post-traumatic stress disorder***

11:00-11:30 **Aline Desmedt** (INSERM, Bordeaux, FR)

Distinguishing "pathological" from "normal" fear memory: a prerequisite for studying PTSD-related memory in animals

11:30-12:00 **Jean-Marc Fellous** (U. of Haifa, IL)

The role of neuromodulation in memory consolidation and PTSD: Dopamine and Oxytocin

11:45-12:15 Discussion

Lunch

14:00-15:30 ***Animal models of Social Behavior pathologies***

14:00-14:30 **Yehezkel Ben-Ari** (INSERM, Marseille, FR)

Treating autism beyond genes and psychiatry and/or is delivery a critical period for the pathogenesis of autism?

15:00-15:30 **Shlomo Wagner** (U. of Haifa, IL)

Neuromodulation, social arousal and social memory: implications for autism spectrum disorder

15:00-15:30 Discussion

Break

Conclusion *Improving synergy between theoretical and experimental neuroscience*

16:00-17:00 **General discussion**

17:00 **Departure**

ABSTRACTS

Paul Apicella CNRS & AMU, INT Marseille, France

Striatal dopamine and acetylcholine mechanisms involved in reward-related learning

The midbrain dopamine system has been identified as a major component of motivation and reward processing. One of its main targets is the striatum which plays an important role in motor control and learning functions. Other subcortical neurons work in parallel with dopamine neurons. In particular, striatal cholinergic interneurons participate in signaling the reward-related significance of stimuli and they may act in concert with dopamine to encode prediction error signals and control the learning of stimulus–response associations. Recent studies have revealed functional cooperativity between these two neuromodulatory systems of a complexity far greater than previously appreciated. In this talk I will review the difference and similarities between dopamine and acetylcholine reward-signaling systems, the possible nature of reward representation in each system, and discuss the involvement of striatal dopamine-acetylcholine interactions during leaning and behavior.

Cendra Agulhon CNRS FR3636, University Paris Descartes, Paris, France

What can we learn from precise control of astrocyte signaling

The morphology of astrocytes and the fact that they envelop synapses uniquely enables them to detect signals from and respond to individual synapses. Astrocytes express many GPCRs linked to Ca^{2+} mobilization from internal stores, most of them being G_q–coupled GPCRs. These receptors are activated by spillover of neurotransmitters released from presynaptic terminals and they appear to be the primary transducers of signals from neurons to astrocytes, with resultant elevations in astrocytic Ca^{2+}. Studies have demonstrated that pharmacologically-induced Ca^{2+} elevations in astrocytes trigger the release of transmitters from astrocytes, thus modulating pre- and post-synaptic receptors in neurons, and therefore modulating synaptic transmission and plasticity. The recognition of a possible bidirectional communication between neurons and astrocytes at the synapse led to the concept of gliotransmission, in which astrocytes can release neuroactive molecules (gliotransmitters) in a neuronally-induced G_q GPCR Ca^{2+}-dependent manner to reciprocally and acutely affect synaptic

transmission and plasticity. The implications of these findings are profound, with astrocytes representing a potential feedforward excitatory or inhibitory influence on synaptic transmission. Although this concept was a recent important shift in our view of synaptic transmission, it remains debated. I will introduce this concept and will discuss our work suggesting that this concept is more complex than previously thought and that further investigation of its validity is called for.

Amos Arieli Weizmann Institute of Science, Rehovot, Israel

The role of active sensing in depth perception

I will talk about visual depth perception as an emerging property of action-perception coupling. Specifically, we have studied the nature and function of vergence eye movements (VeyeM) in visual perception of three dimensional (3D) objects. Our results show that participants' performance is better during VeyeM towards the object. This result is in agreement with the view that VeyeM is part of a high-level object oriented processing of 3D shape, and it is not consistent with the common view of image oriented processing in which enhanced visual perception occurs when the eyes are stably fixed in the right distance from the object.

Moshe Bar Gonda Multidisciplinary Brain Research Center**,** Tel Aviv, Israel

The Lasting Primacy Hypothesis

It is proposed that the human brain is proactive in that it continuously generates predictions that approximate the relevant future. This proposal posits that coarse information is extracted rapidly from the input to derive analogies linking that input with representations in memory. The linked stored representations then activate the associations that are relevant in the specific context, which provides focused predictions. These predictions facilitate perception and cognition by pre-sensitizing relevant representations. In the talk I will concentrate on top-down predictions particularly in visual recognition and in the application of contextual knowledge in the human brain. This cognitive neuroscience framework provides a new hypothesis (The Lasting Primacy Hypothesis) with which to consider the purpose of memory, and can help explain a variety of phenomena, ranging from recognition to first impressions, from preferences to aesthetic evaluations, and from the brain's 'default mode' to a host of mental disorders.

Y Ben-Ari, Founder and honorary director of INMED –INSERM U 901, Director emeritus INSERM and CEO Neurochlore

Treating autism with a diruetic or why has the genocentric approach failed in the treament of brain disorders

The developing brain is not a small adult brain. Its ionic currents, network activities, and molecular processes have unique features and follow a developmental sequence adapting them to their adult functions. I have proposed with my colleague N Spitzer the checkpoint concept according to which genes and neuronal activity cooperate in series controlling together the adequacy of the program implemented. Subsequently, I have suggested the “neuroarcheology” concept according to which genetic or environmental insults alter these sequences producing pre-symptomatic architectural or electric signatures of disorders to come. In this perspective, neurons failing to implement their sequence and are misplaced or misconnected remain with immature features that are the factor impacting the operation of adjacent networks leading to the expression of the disorder subsequently. These concepts have now been confirmed in many early disorders (including infantile seizures, DCX mutations, TSC, nodular heterotopia etc). This also implies that future treatments will heavily rely on the use of selective drugs that antagonise specifically immature currents in the adult brain. I shall discuss these issues also in the frame of the delivery process and its links with Autism and Developmental Disorders (DDs). Indeed, Birth is one of the most complex biological processes, yet its impacts on neuronal activity have not been investigated. This is of particular importance in a clinical perspective considering the major life long deleterious neurological and psychiatric sequels associated with complicated or preterm deliveries. We have made recently seminal discoveries in this domain including i), the oxytocin mediated neuro-protective abrupt and dramatic reduction of (Cl-)I levels & GABA excitatory to inhibitory shift (1); ii) the failure of this shift in animal models of autism and the attenuation of the severity of the syndrome in offspring by maternal treatment with the diuretic bumetanide to restore low (Cl-)I levels and GABAergic inhibition (2); iii) the attenuation of autism in children treated with bumetanide in a double blind randomized study(3). I shall illustrate these issues notably with our recent clinical trials in autism and discuss the limitations of the genomic vision of brain development and disorders that fails to incorporate these issues that require a detail analysis of the detrimental physiological processes at early developmental stages.

1.Ben-Ari Y. Neuro-archaeology: pre-symptomatic architecture and signature of neurological disorders.Trends Neurosci. 2008 Dec;31(12):626-36

2.Lemonnier E, Degrez C, Phelep M, Tyzio R, Josse F, Grandgeorge M, Hadjikhani N, Ben-Ari Y. A randomised controlled trial of bumetanide in the treatment of autism in children. Transl Psychiatry. 2012 Dec 11;2:e202
3. Tyzio R, Nardou R, Ferrari DC, Tsintsadze T, Shahrokhi A, Eftekhari S, Khalilov I, Tsintsadze V, Brouchoud C, Chazal G, Lemonnier E, Lozovaya N, Burnashev N, Ben-Ari Y. Oxytocin-mediated GABA inhibition during delivery attenuates autism pathogenesis in rodent offspring. Science. 2014 Feb 7;343(6171):675-9.
4. Ben-Ari, Yehezkel, & Spitzer, N. C. (2010). Phenotypic checkpoints regulate neuronal development Trends in neurosciences, 33(11), 485-492.
5. Nouchine Hadjikhani, Nicole R Zürcher, Ophelie Rogier, Torsten Ruest, Loyse Hippolyte, Yehezkel Ben-Ari and Eric Lemonnier Improving emotional face perception in bautism with diuretic bumetanide: A proof-of-concept behavioral and functional brain imaging pilot studyAutism 2015, Vol. 19(2) 149–157
6. Eftekhari et al. Response to Comment on "Oxytocin-mediated GABA inhibition during delivery attenuates autism pathogenesis in rodent offspring Science 346, 176 (2014);

Thomas Brochier, Institut de Neurosciences de la Timone UMR 7289 CNRS, Aix-Marseille Université, Marseille, France.

Cortical dynamics for hand movement control

The dexterity of the hand in grasping and manipulating objects is one of the distinctive properties of human and non human primates. Grasping movements involve transforming the visual properties of the object into the coordinated activation of arm and hand muscles to move the upper limb in a coherent way. The cerebral cortex, with its descending outputs to the brainstem and the spinal cord is the major structure for the control of grasping movements. We will present our recent studies describing the spatio-temporal structure of motor cortex activity during complex reach-to-grasp tasks. In particular, we will focus on recent technical advances that allow investigating the dynamic of neuronal activity at the mesoscopic scale for upper limb control and discuss novel ideas about the functional organization of the motor cortex.

Yoram Burak Racah Institute of Physics, and Edmond and Lily Safra Center for Brain Sciences Hebrew University of Jerusalem

What principles may determine the allocation of grid cells to modules in the entorhinal cortex?

Grid cells in rodents and bats provide a glimpse into the coding, deep within the brain, of an internally computed quantity - an animal’s self estimate of its position in its environment. Recent experiments established that these cells are functionally organized in discrete modules, each

containing neurons with uniform grid spacing, whereas the spacings seen in successive modules approximately follow a geometric progression. Previous theoretical works proposed that the geometric progression can be explained by a hypothesis, that grid cells implement an efficient coding scheme for position. However, the experimental data suggests also that the number of cells decreases sharply with grid spacing, in marked disagreement with existing theories. I will introduce a hypothesis that the entorhinal cortex is adapted to represent a dynamic quantity (the trajectory of the animal in space), while taking into account the temporal statistics of this variable. We recently developed a theory for efficient coding of such a variable. A central prediction of the theory is that neuron population sizes should sharply decrease with the increase of grid spacing, in agreement with the trends seen in the experimental data. I will also discuss a simple, near optimal scheme for neural readout of the dynamic position from the grid cell code, in which model place cells linearly sum inputs from grid cells. Crucially, the summation involves a temporal kernel, whose characteristic decay time depends on the spacing of the presynaptic grid cell. The simple readout scheme requires mechanisms for persistence over time scales ranging from ~1 ms to ~1 s, suggesting that diverse biophysical mechanisms for persistence may be involved in readout of the grid cell code.

Jenny Coull CNRS & AMU, LNC Marseille, France

Predicting time

Being able to predict when relevant events are likely to occur improves how quickly and accurately they are processed. In a series of fMRI investigations we have found that the behavioral benefits of temporal predictability implicate left-lateralised parietal cortex, and that this is independent of the motor requirements of the task. In these studies, temporal cues allowed participants to predict the time of event onset a priori. Yet the very passage of time itself provides temporally predictive information that can be used to hone information processing in a more dynamic manner. The longer we wait for an event to occur, the higher is the conditional probability, and hence temporal predictability, of its occurrence (the “hazard function”). Temporal predictability can therefore be fixed in advance (prior probability) or else evolve dynamically as a function of the elapse of time (posterior probability). We have recently confirmed a key role for left inferior parietal cortex in instantiating the behavioural benefits of temporal predictability, whether predictions are fixed or dynamically evolving.

Yadin Dudai Weizmann Institute of Science, Rehovot, Israel

The first seconds of episodic memories, and the years thereafter

Most realistic experiences unfold on-line till they make sense, and frequently contain familiar elements. Brain mechanisms of episodic memory should therefore be able to account for binding of episodes on the fly, and for the integration of encoding and retrieval while the experience unfolds. We combine brief movie clips as memoranda with fMRI scanning in a subsequent memory protocol to tap into the aforementioned mechanisms in the human brain. We find that the hippocampus exhibits memory-predictive activity at the offset of unfamiliar events, and that this activity is attenuated by familiarity. Conversely, an onset response in the hippocampus emerges for familiar events, likely reflecting a retrieval-related process. Our findings suggest that the hippocampus shifts between encoding and retrieval modes during the course of a single experience, and that the encoding mode involves binding in a short-lived content-sensitive buffer before the information is relegated to become consolidated in longer-term memory. With the passage of time, however, the episodic representation semanticizes and the dependence on the hippocampus diminishes. Nevertheless, the hippocampus is still reactivated for those privileged representations that either retain or reconstruct vividness and contextual details. Items in episodic memory are hence the outcome of time-dependent amalgamation and transformation of elements of different history and mnemonic quality, which are reflected in signatures of hippocampal activity.

Jean-Marc Edeline Paris-Saclay Institute of Neurosciences (NeuroPSI) Orsay, France

How well can we predict auditory cortex responses to natural stimuli?

For decades, auditory physiologists have studied the responses of auditory cortex neurons to artificial stimuli with the implicit assumption that the functional properties revealed by these stimuli allows understanding how natural stimuli are processed and represented in the auditory cortex. After, many studies and sophisticated models we now know that predicting the response to communication sounds (speech, birdsong, vocalization) is far from been a trivial task and requires to build complex, non-linear, models of cortical responses. Still, it is not clear if these models help predicting how neuromodulators or changes in vigilance states modify the

responses to natural stimuli. At a much larger scale, how well can we predict the response of a particular group of neurons to electrical stimulation of a particular location in the cochlea? And, by the way, for what purposes do we want to predict neuronal responses? All these questions will be raised with the hope that some answers will emerge during the discussion.

Yael Hanein School of electrical Engineering, Tel Aviv University, Tel Aviv, Israel

Glutamate Mediated Astrocytic Filtering of Neuronal Activity

Healthy functionality of the central nervous system relies on intricate neuron-glia networks. Recent studies suggest that glial cells, including astrocytes, play a crucial role in information processing, coding and storage. In light of this, synapses should not be considered bipartite, but rather tripartite structures, comprised of the pre-synaptic terminal, the post-synaptic one and the surrounding astrocyte. Moreover, glial cells too form intricate cell networks that communicate with each other through the propagation of calcium waves. Therefore, neurons and astrocytes form intertwined neuron-glial networks supporting active partnership between the two cell populations. Currently a knowledge gap persists in understanding the nature of the neuron-glia interaction.

Using cultured dissociated networks, calcium imaging and electrical stimulation we mapped astrocytic Ca2+ wave propagation and explored how astrocyte signals develop, and dynamically affect synaptic information transfer, thus regulating neuronal network activity. Our results reveal a clear glial activation mechanism which is strongly dependent on neuronal activation. More interestingly, the data indicate that this activation process is frequency dependent revealing an exciting new neuro-glia communication pathway.

More recently we started studying the effect of norepinephrine (a main distinguishing factor between an awake and a sleep states) on the dynamics of neuron-glial networks. MEAs were used to deliver electrical stimulation to neurons. Immunostaining was used to map morphological changes in astrocytes in response to NE applications and Ca2+ imaging traces show marked changes in glial cells activity. These effects suggest a possible morphological effect on the chemically-controlled neuron glia pathway

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David Holcman CNRS, ENS, Paris, France

Diffusion and electrodiffusion regulated by glial cells and dendritic spines

Electrical activity in dendritic spines and in cellular microdomains in general remains unresolved because the electrical current is carried by moving ions and induces a local change in the voltage, which can modulate the opening of channels and contribute to the initiation of an action potential. The ionic flow in dendritic spines is driven by the coupled electric field to the charge densities that interact through the non-cylindrical spine geometry. Due to small nanometric scale and the charge-voltage interaction, the voltage-current (I-V) relation and its regulation by geometry remains difficult to investigate, as the classical cable equations do not apply and no direct recordings are possible.

I will present here our recent effort to deconvolve the response of the slow genetically encoded voltage sensor Arclight in hippocampal neurons in slices and to compute from the electro-diffusion theory, the electric field and the ionic flows in the spine head. We resolve here the I-V relation and extract the spine resistance, which is certainly insufficient to characterize the nonlinear I-V interaction.

Lydia Kerkerian-Le Goff CNRS & AMU, IBDM Marseille, France

Insights onto the pathophysiology of Parkinson's disease from optogenetics and disease progression modeling in rodents.

The massive and progressive degeneration of the nigral dopamine neurons innervating the striatum, the main input station of the basal ganglia, is a main neuropathological feature of Parkinson's disease (PD). The hypokinetic parkinsonian syndrome is viewed as the consequence of imbalanced activity of the direct and the indirect pathways by which the striatum controls the basal ganglia output structures (mainly the substantia nigra reticulata, SNr), reinforcing the inhibitory tone exerted by these structures via the thalamus onto the motor cortical outflow. I will illustrate two aspects of our work in rodent models of PD. First, I will present our recent data pointing to striatal cholinergic interneurons as important players in PD pathophysiology. Silencing cholinergic interneurons by optogenetics alleviated motor deficits in classical PD models in mice (collaboration with M Amalric), normalized the pathological bursting activity in the SNr, and increased the functional weight of the direct striatonigral pathway in cortical information processing while counteracting the enhanced excitability of neurons of the direct pathway. These data provide direct evidence for a causal role of striatal cholinergic

interneurons in PD symptomatology and raise questions as to the dichotomous view of striatal function/dysfunction and the relationship between neuronal excitability and outflow. Second, I will discuss the advantages and limitations of the current rodent models of PD and present a novel model we developed, based on dysfunction of excitatory aminoacid transporters, which recapitulates several PD pathogenic mechanisms and pathological hallmarks, in particular the progressive character of neurodegeneration. We are currently using this model to study PD pathophysiology in an evolving neurodegenerative context, to investigate the mechanisms that contribute to cell death progression and to evaluate potential disease-modifying strategies.

Eli Nelken The Alexander Silberman Institute of Life Sciences, Jerusalem, Israel

Context-specificity of neuronal responses in primary auditory cortex: complexity or simplicity?

One goal of sensory physiology is to identify neuronal 'integration functions': the transformation from sensory input to neuronal output. In the auditory system, such integration functions are reasonably well understood for neurons in early stations, but starting at least from the inferior colliculus, neuronal transformations are complex and in particular context-sensitive. In primary auditory cortex, responses of the same neuron to pure tones on the one hand, and to complex, naturalistic sounds on the other, are often hard to reconcile. Thus, spectro-temporal context, even almost instantaneous, may strongly affect the responses of a cortical neuron.

I will discuss two findings that illustrate this complexity. First, I will discuss the sensitivity of cortical neurons to interaural time differences (ITDs) in high-frequency auditory cortex. Such ITD sensitivity is based on processing sound envelopes, and we show that some cortical neurons show exquisite sensitivity to envelope ITD. However, the same neuron may or may not show ITD sensitivity depending on the parameters of the sound. Second, I will summarize our studies of the coding of bird songs in cat auditory cortex. These studies suggest that cortical neurons are sensitive to particular ethologically-relevant components of sounds, rather than to specific acoustic features. I will argue that these examples, as well as others, suggest that the complexity of processing in auditory cortex has to be understood in the framework of the overall function of the auditory system, that of performing auditory scene analysis.

Bruno Poucet CNRS & AMU, LNC Marseille, France

Properties of hippocampal place cells during goal-directed spatial navigation

In this talk, I will summarize some of our results on the properties of hippocampal place cells in rats that solve various spatial navigation tasks. Several of these properties are directly relevant to their role in navigation, including the phenomenon of local remapping, overdispersion (variability in firing), and goal-related firing, and thus emphasize the participation of place cells in the coding of spatial information and the computation of optimal paths.

Maoz Shamir Department of Physiology and cell biology & Department of Physics, Ben-Gurion University of the Negev.

In search for the neural code: neuronal diversity and noise correlations

One of the central open questions in neuroscience is: What is the neural code? How information about certain external stimuli or planned motor commands is represented by the responses of large nerve cell populations? And how this information is communicated from one brain region to another?

In my talk I will review the approach for addressing these questions. I will describe the basic concepts of signal and noise as they emerge from empirical findings on the neuronal representation of external stimuli and planned motor commands. I will explain the theoretical methodology, tools and the theoretical approaches for addressing this problem. Specifically, I will illustrate these ideas using the example of linear readout mechanisms such as the population vector and optimal linear readout. I will then elaborate on the effects of neuronal noise correlations on the accuracy of the code and highlight the role of neuronal heterogeneity and response variability as potential primary sources of information in the central nervous system. Then I will discuss how we investigate the structure of neuronal noise-correlations and our findings. I will relate to recently introduced concepts to the field. Finally, I will point out future directions in the field of neuronal coding.