COSYNE
Computational and Systems Neuroscience
2008
Workshops

March 3-4, 2008
Snow Bird, Utah

Red text is changed from printed workshop booklet.

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Food included with registration:

Monday 3/3 Hot Breakfast Buffet, Morning Beverage Break, Afternoon Beverage Break
Tuesday 3/4 Hot Breakfast Buffet, Morning Beverage Break, Afternoon Beverage Break, Dinner Buffet (with cash bar)

Lift tickets:

Discounted lift tickets $53 for chair lift only, $63 for tram and chair lifts.

Transportation to/from Snowbird:

Marriott Downtown to Snowbird:

- Free shuttle provided for registered attendees (leaves at 5pm on Sunday, 2-Mar).

Snowbird to Salt Lake City Airport:

- Lewis Tours shuttle available for individual reservations at $34 (877-658-3999, or see Cosyne website).
- Shuttle can also be arranged through Snowbird (in person, or call 800-232-9542 - 48 hours notice required for all cancellations)
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Organization: Fritz Sommer and Jascha Sohl-Dickstein (UC Berkeley)
Organizational support: Beth Heberger and the University of Rochester Conference and Events Office

Characterizing and decoding distributed brain representations

Nikolaus Kriegeskorte (National Institutes of Health), Dirk B. Walther (University of Illinois at Urbana-Champaign)*, Gabriel Kreiman (Harvard Medical School), Roozbeh Kiani (University of Washington), Geoffrey K. Aguirre (University of Pennsylvania)*
** These two organizers contributed equally*

Abstract

The characterization of neural codes in terms of their representational content and the reading out of that content (decoding) from brain-activity data constitute challenges fundamental to neuroscience. Neural representations are inherently a parallel, multi-unit phenomenon. In order to exploit the increasingly rich spatiotemporal brain-activity data provided by multi-channel electrophysiology and functional imaging, we need to develop analytic methods that handle the multivariate complexity of neural activity patterns and relate them to their representational content.

This workshop will explore two related approaches to analyzing distributed neural representations and their application in electrophysiology and functional imaging. The first approach is that of decoding, where the aim is to read out the content of the representation by means of pattern-classification algorithms. These techniques have allowed the decoding of the orientation of visually presented gratings, the category and identity of visually perceived objects, and even subjects' intended choice of future action. The second approach is that of representational similarity analysis, which characterizes the neural code by means of a representational similarity matrix. For each pair of experimental conditions (e.g. each pair of stimuli), the representational similarity matrix contains an entry reflecting the similarity of the activity patterns associated with the two conditions. This approach has shown, for example, that inferotemporal response patterns to natural object images form clusters corresponding to conventional object categories.

So far methods for characterization and decoding of distributed neuronal codes have been developed in relative isolation in electrophysiology and functional imaging. In this workshop, we intend to foster interaction and transfer of knowledge between these still largely separate fields. We aim to cover novel neuroscientific insights from these approaches as well as data analytical and algorithmic challenges inherent to the multivariate analysis of multi-channel data.

The workshop will be framed by introductory remarks highlighting common themes and overarching challenges and a concluding discussion. In the concluding discussion, we hope to envision a more integrated systems neuroscience, where different multi-channel measures of neural activity are quantitatively related to each other and to computational theory by means of a common multivariate framework for characterizing and decoding distributed neuronal representations.

Schedule (Monday, March 3, Wasatch A)

Morning Session: Decoding Multivariate Signals
Chairs: Dirk B. Walther, Gabriel Kreiman

8:00 - 8:30	***James Haxby***	Introductory talk Multivoxel pattern analysis of fMRI: What can it reveal about the neural representation of faces and objects
8:30 - 8:50	***Gabriel Kreiman***	What can the brain do with one or a few spikes per neuron?
8:50 - 9:10	***Hans Op de Beeck***	Cracking the code of visual objects in the ventral visual pathway with pattern-based fMRI: The role of perceived shape
9:10 - 9:40		Informal discussion over coffee
9:40 - 10:00	***David Cox***	Untangling transformation-invariant object representations
10:00 - 10:20	***Dirk B. Walther***	Predicting perceived natural scene categories from distributed patterns of fMRI activity

10:20 - 10:40	***Kendrick Kay***	Using voxel receptive eld models to identify natural images seen by an observer
10:40 - 11:00		Discussion

Afternoon Session: Representational Similarity Analysis
Chairs: Nikolaus Kriegeskorte, Geoffrey Aguirre, Roozbeh Kiani

4:30 - 4:50	**Geoffrey K. Aguirre**	*Continuous carry-over fMRI for measurement of focal and distributed neural similarity*
4:50 - 5:10	**Matthew Botvinick**	*Representational similarity structure and the neural basis of decision making*
5:10 - 5:40		*Informal discussion over coffee*
5:40 - 6:00	**Roozbeh Kiani**	*Object category structure in response patterns of neuronal population in monkey inferior temporal cortex*
6:00 - 6:20	**Nikolaus Kriegeskorte**	*Categorical and continuous IT representations relating monkey single-cell recordings and human fMRI with representational similarity analysis*
6:20 - 6:40	**Rajeev Raizada**	*Predicting individual differences in speech perception using pattern-based fMRI analysis of phonemic representations*
6:40 - 7:30		*General discussion*

The cortical microcircuit and cognitive function

Marc Sommer (University of Pittsburgh), John Reynolds (Salk Institute)

Abstract

The rhesus macaque has proven to be a remarkably successful model system for studying the neural mechanisms underlying a range of cognitive functions, including perception, attention, memory and decision making. Decades of research have identified the key brain areas that subserve these functions. Within the visual system alone, more than thirty distinct brain areas have been identified and characterized using a variety of techniques including lesions, microstimulation, reversible inactivation and extracellular recording. The capacity of the macaque to learn to perform complex behavioral tasks has enabled neurobiologists to examine the functions of different brain areas under tight experimental control. Sophisticated computational methods have been developed to quantify task-dependent changes in neuronal response properties and to characterize the relationship between neural responses and behavior.

Despite these considerable successes, research in the macaque has shed comparatively little light on the local microcircuits that mediate the computations that give rise to the changes in neuronal responses that occur with changes in cognitive state. Some notable successes in this direction have been made by developing computational models to account for neurophysiological data, but, almost without exception, neurophysiological studies of the neocortex in the behaving macaque have not sought to distinguish different types of neurons from one another, or to localize neurons according to their position in the laminar circuit. This is a serious shortcoming because cortical neurons differ from one another in critical ways, including their neurochemical properties, patterns of connectivity, laminar distribution, gene expression patterns and developmental origin. Significant progress in understanding the microcircuit-level mechanisms that subserve cognitive functions will come from making these distinctions.

The purpose of this workshop is to bring neurophysiologists who study cognitive functions in the macaque into contact with researchers working in anesthetized animals and cortical slices, where neuronal identity and laminar position can readily be established. A general aim of the session is to facilitate an exchange of perspectives on how best to advance our understanding of the biological underpinnings of cognitive function. Several specific topics could be the subject for debate and discussion, such as the utility of analyzing action potential waveform shape as a clue to neuron type (excitatory vs. inhibitory classes) and other approaches to distinguishing among cell classes in the awake primate. This exchange of ideas and data will prove very useful to computational neuroscientists who are interested in constructing realistic computational models of cognitive function. The workshop should also be of interest to those who work on cognitive function in the macaque and those who work on microcircuitry in anesthetized animals and in the slice, two communities who have not, to date, interacted sufficiently.

Schedule (Monday, March 3, Wasatch B)

8:00 - 8:10	**Sommer/Reynolds**	*Opening Remarks*
8:10 - 8:40	**John Reynolds**	*Mapping the microcircuitry of attention: differential attentional modulation across narrow and broad spiking neurons in macaque Area V4*
8:45 - 9:15	**Harvey Swadlow**	*Antidromic activation, spike duration, and spike-triggered averaging of axonal, synaptic, and dendritic events: Multiple tools for in vivo identification of diverse neocortical cell classes*
9:20 - 9:50 -	**Max Snodderley**	*Parallel and serial operations in primary visual cortex (V1) of alert primates*
9:55 - 10:25	**Ed Callaway**	*Fine Scale and Cell Type Specificity of Cortical Circuits*
10:30 - 11:00	**Jose-Manuel Alonso**	*Task Difficulty Modulates the Activity of Specific Populations of Neurons in Primary Visual Cortex*

4:30 - 5:00	**Dan Simons**	*Fast-spike units, feedforward inhibition and thalamocortical response transformations in the somatosensory system*
5:05 - 5:35	**Gyorgy Buzsaki**	*Physiological identification of cortical interneurons and principal cells in large-scale extracellular recordings*
5:40 - 6:10	**Elizabeth Torres**	*Distinct classes of Parietal Reach Region neurons have complementary responses in the planning of automatic vs. novel voluntary reaches*
6:15 - 6:45	**David McCormick**	*Recurrent cortical networks and the control of neuronal responsiveness*
6:50 - 7:20	**Marc Sommer**	*Division of labor between frontal eye field neurons during spatial visual processing*
7:20 - 7:30	**Sommer/Reynolds**	*Conclusions/Discussion*

Data sharing and modeling challenges in neuroscience - a first step towards predictive neuron models?

Arnd Roth (UCL), Wulfram Gerstner (EPFL), Fritz Sommer (UC Berkeley)

Abstract

Data sharing in neuroscience is currently pushed by modelers, experimentalists, and public agencies, for achieving various -not always compatible- goals:

- to test the predictions of models
- to help with parameter settings in large-scale simulations
- to overcome the limitations of the traditional "single lab" approach
- to expose experimental data to the full spectrum of available analysis methods
- to make the results of publicly funded science available to everybody

To achieve these goals, the sharing of raw data as such seems not sufficient. Rather, data sharing in neuroscience requires additional efforts to organize the raw data. For example, it is typically required to link raw data to detailed protocol descriptions, to stimuli or behavioral responses.

A discussion of questions of how to organize neuroscience data for sharing and what to expect from such activities seems timely since public support for data sharing activities has been recently brought into place, for example, a new NSF program for funding efforts in experimental labs to make data publicly available.

One specific topic of this workshop is to discuss recent experiences to organize neuroscience data by defining "modeling challenges". A modeling challenge puts data sets in the context of particular questions to be addressed, for instance by specifying a task that a model for the data should be able to achieve. First steps in this direction have been taken by the Berkeley "Neural Prediction Challenge" or by the Lausanne "Competition: Predicting Single-Neuron Behavior".

This discussion-oriented workshop aims to bring three different groups of people together: theoreticians interested in quantitatively predictive models; experimentalists interested in data sharing; and proponents of data sharing initiatives and challenges.

General questions to be addressed:

- How can we quantify the predictive power of current neuron models?
- How can we make use of publicly available data?
- What type of data would modelers like to see publicly available?
- What type of data would experimentalists like to see publicly available?

Format: Relatively short talks (15 minutes) with enough time for discussion after talks and in one or two general discussion sessions.

Schedule (Monday, March 3, Magpie A)

8:00 - 8:10		*Introduction*
8:10 - 8:35	**Walter Senn (University of Bern)**	*Nonlinear response properties of prefrontal pyramidal neurons: is the classical integrate-and-fire model appropriate?*
8:35 - 9:00	**Shaul Druckmann (Hebrew University)**	*The predictive power of conductance-based neuron models constrained by experimental responses to different input types*

9:00 - 9:25	**Quentin Huys (Gatsby, UCL)**	*Fitting biophysically detailed models to noisy data*
9:25 - 9:50	**Jonathan Pillow (Gatsby, UCL)**	*The effects of correlated population activity on single-neuron spike prediction*
9:50 - 10:00		*Coffee break*
10:00 - 10:25	**Pablo Achard (Brandeis)**	*Neurofitter: A parameter tuning package for electrophysiological neuron models*
10:25 - 10:50	**Erik De Schutter (Okinawa Institute of Science and Technology)**	*Using Neurofitter for automated parameter fitting to electrophysiological data*
10:50 - 10:55	**Wulfram Gerstner (EPFL)**	*Why public data needs a modeling challenge - The Lausanne single-neuron modeling competition, challenges A and B*
10:55 - 11:05	**Arnd Roth (Gatsby, UCL)**	*The Lausanne single-neuron modeling competition, challenges C and D*
11:05 - 11:10		*Competition winners present their results*
11:10 - 11:20		*General discussion*
4:30 - 4:55	**Konrad Koerding (Northwestern U.)**	*Priors for inferring functional connectivity*
4:55 - 5:20	**Ken Harris (Rutgers)**	*Fitting and evaluating models of cortical dynamics*
5:20 - 5:45	**Laurent Itti (USC)**	*Eye movements during free-viewing of natural videos*
5:45 - 5:55		*Coffee break*
5:55 - 6:05	**Fritz Sommer (UC Berkeley)**	*Data sharing for Computational Neuroscience Challenges to build a repository for electrophysiology data*
6:05 - 6:15	**Tom Jackson (York U.)**	*CARMEN: e-Science for Neurophysiology*
6:15 - 6:25	**Jan Bjaalie (INCF Stockholm)**	*Global infrastructure for data sharing*
6:25 - 7:30		*General discussion*

Dynamic faces: From experiments to novel computational neural theories

Cristbal Curio (Max Planck Institute for Biological Cybernetics), Heinrich H. Buelthoff (Max Planck Institute for Biological Cybernetics), Martin A. Giese (University of Bangor & University Clinic Tuebingen)

Abstract

Research on the neural encoding of faces in visual cortex, so far, has predominantly focused on the recognition of static faces. In spite of their high relevance of emotional and social interaction, only few results on the neural mechanisms of the processing of temporally changing dynamic faces exist. Specifically, almost no physiologically plausible neural theories of the recognition of dynamically changing faces have been developed. The workshop aims at presenting an overview of the state of art in multiple relevant fields that might serve as starting point for the development of neural theories for the processing of dynamic faces.

The workshop will combine contributions from multiple fields, aiming at establishing a dialogue between different research areas that can contribute to the development of physiologically founded neural theories of dynamic face processing, including:

- Electrophysiology
- Psychophysics
- Computational modeling and Computer Vision

Goal of the workshop is to initiate a new direction in theoretical neuroscience aiming at the development of physiologically-founded neural theories of the processing of facial movements and expressions. Such theories should quantitatively relate empirical data, e.g. from behavioral and physiological studies, and should inspire new experimental research.

Almost no physiologically inspired models on the neural mechanisms of the recognition of dynamic faces exist. At the same time, present research in different experimental disciplines has started to investigate the recognition of dynamic faces. This makes the development of neural models in this area a timely topic, which should be specifically of interest for theoretical neuroscientists working on higher cognitive functions and for scientists working on neural models of visual cortex.

Schedule (Monday, March 3, Superior A)

8:00 - 8:10		*Introduction*
8:10 - 8:40	**H. Hill (School of Psychology, Univ. of Wollongong, Australia)**	*Dynamic faces: behavioural studies and key questions*
8:40 - 9:10	**C. Curio (Max Planck Inst. for Biol. Cybernetics, Germany)**	*Exploring dynamic facial expression recognition using facial animation*
9:10 - 9:40	**A. Ghazanfar (Princeton Univ., NJ)**	*Engaging neocortical networks with dynamic faces*
9:40 - 10:00		*Pause*
10:00 - 10:30	**T. Serre (CBCL M.I.T., US)**	*A Biologically Inspired System for Action Recognition*
10:30 - 11:00	**M. Bartlett (Institute for Neural Computation, UCSD)**	*Determining spontaneous facial behavior with automatic expression coding*
4:30 - 5:00	**B. Heisele (Honda Research Institute, Cambridge, US)**	*A Vision System for Recognizing Played and Natural Expressions*

5:00 - 5:30	**S. Boker (Dept. of Psychology, Univ. of Virginia, VA)**	*Dissociating facial appearance and dynamics in real time during natural conversation*
5:30 - 6:00		*Pause*
6:00 - 6:30	**M. Turk (Dept. of Computerscience, UCSB)**	*Facial expression analysis on manifolds*
6:30 - 7:00	**A. Blake (Microsoft Research, Cambridge, UK)**	*Face-fitting Stereoscopically*
7:00 - 7:30		*Pause*

Neurophysiology in awake, behaving rodents

Mark Laubach (Yale), Marshall Shuler (Johns Hopkins)

Abstract

The goal of this workshop is to clarify issues that are specific to studies of neural activity in rodents, to discuss how data sets are collected with state-of-the-art methods, to discuss how these techniques can be combined with manipulative approaches (e.g., genetic and pharmacological methods), and to attempt to clarify how our studies relate to computational and theoretical studies, including how can we effectively share our methods and data. Our speakers will cover topics related to cognitive processing (morning session) and sensory processing (evening session). Each talk will be 20 min, followed by a 10 min discussion period. There will be general discussion for 30 min (or longer) at the end of each session.

Schedule (Monday, March 3, White pine)

Morning Session: Cognitive systems

8:00 - 8:10		*Introductory remarks by the organizers*
8:10 - 8:40	**Mark Laubach (Yale)**	*Dynamic encoding of stimulus value by the dorsomedial striatum*
8:40 - 9:10	**Carlos Brody (Princeton)**	*Flexible sensorimotor mapping: the ProAnti task.*
9:10 - 9:40	**David Foster (Johns Hopkins)**	*The role of hippocampal replay in navigational learning*
9:40 - 10:10	**Don Katz (Brandeis)**	*Cognitive and neural taste dynamics?*
10:10 - 10:40	**Zach Mainen (Cold Spring Harbor and Instituto Gulbenkian de Cincia)**	*Reaction times, psychometric curves, and decision making*
10:40 - 11:00		*General Discussion*

Afternoon Session: Sensory systems

4:30 - 4:40		*Introductory remarks by the organizers*
4:40 - 5:10	**Marshall Shuler (Johns Hopkins)**	*Reward timing in the primary visual cortex*
5:10 - 5:40	**Mark Andermann (Harvard)**	*Towards functional and anatomical mapping of supragranular neurons in behaving mouse V1*
5:40 - 6:10	**Daniel O'Connor (Janelia Farms)**	*Somatosensory decision-making in the head-fixed mouse*
6:10 - 6:40	**Chris Moore (MIT)**	*Does rodent somatosensory cortex presuppose an embodied natural scene?*
6:40 - 7:10	**Tony Zador (Cold Spring Harbor)**	*Task-dependent suppression of sound-evoked responses in auditory cortex*
7:10 - 7:30		*General Discussion*

Real-time processing and the processing of time.

Sophie Deneve (ECS), Dean Buonomano (UCLA)

Abstract

The brain's ability to make sense of the "blooming buzzing confusion" that is our sensory environment relies on the ability of the cortex to extract patterns out of a continuous stream of sensory information. This information is encoded in both space (which afferents are active) and time (the temporal patterns with which afferents are activated). The processing of spatio-temporal patterns must be performed continuously in a real-time fashion. The brain needs to extract information about timing, but also, to use time in order to process information.

Using time to process information: We constantly receive inputs from our sensory receptors and this sensory information needs to be integrated over time. However, in most cases, this integration cannot rely on simple temporal summation of the sensory input: This is because the world and the state of the variables that one tries to infer is likely to vary unpredictably at any time: While it is important to extract as much information as possible from the recent input, it is equally important to forget older inputs that are no longer relevant. Traditional approaches to the most studied perceptual system, the visual system, have emphasized static problems, such as how to localize or recognize an object, or segment an image. This is very far from natural vision whose aim is to detect a succession of visual events, as far as possible, on-line.

Extracting information about timing: Natural stimuli, such as speech, are rich in spatial as well as temporal information. Indeed, speech, for example, can be essentially collapsed into a purely temporal code - Morse Code - which can be decoded in either the auditory, visual or somatosensory modalities.

A neglect of the temporal dimension can be observed in many computational models of neural coding. Neurons fire spikes, which is inherently a time-based code. However, rate coding approach assumes that information is contained in the mean number of action potential. This deprives the spikes of their "event based" nature and relegates them as random samples of the only relevant signal: the rate. Similarly, while significant advances have been made regarding how cortical circuits discriminate static spatial patterns, relatively little is known about how the brain decodes information about timing and temporal patterns.

In this workshop we will bring together neurophysiologist and computational neuroscientists that have worked on 1. Sensory processing on-line, in real time. 2. Neural processing and representation of temporal information

We will in particular investigate whether these two related topics face the same issues and are based on similar neural mechanisms. In particular, do spike times or burst of spikes precisely signal relevant events? Is it related to predictive coding? What are the contributions of inhibition, synaptic short term plasticity, adaptation, refractoriness for perception on-line and perception of time? How do networks of neurons decode temporal information? Is it useful to formalize these problems in a statistical framework, for example as a hidden Markov Model?

Schedule (Monday, March 3, Superior B)

8:00 - 8:10		*Introduction*
8:10 - 8:45	**Dean Buonomano**	*Telling Time with State-Dependent Networks and Short-Term Synaptic Plasticity*
8:45 - 9:20	**Gilad Silberberg**	*Temporal Properties of Excitation & Inhibition in Neocortical Microcircuits*
9:20 - 9:40		*Break*
9:40 - 10:15	**Daniel Butts**	*How does natural vision drive precise timing in the visual system, and why?*
10:15 - 11:00	**Fritz Sommer**	*Temporal recoding in retina/LGN: spike timing precision that is not stimulus-locked*
4:30 - 5:05	**Michael Kilgard**	*Effect of Neural Correlations on Speech Discrimination*
5:05 - 5:40	**Michael Mauk**	*Timing and Temporal Coding in the Cerebellum*

5:40 - 6:00		*Break*
6:00 - 6:35	**Haim Sompolinsky**	*Processing of Time Through Space*
6:35 - 7:10	**Sophie Deneve**	*Spiking neural networks performing Bayesian inference over time.*
7:10 - 7:30		*Discussion*

Spiking Networks and Reinforcement Learning

Botond Szatmary, Eugene Izhikevich (The Neurosciences Institute)

Abstract

This workshop will bring together eminent experimental biologists and theoretical scientists to discuss learning in spiking networks.

There have been abundant experimental and theoretical results on the dynamics of spiking neurons and networks, emphasizing the importance of precise firing patterns. Likewise, reinforcement learning (RL) has a long history as a research topic in machine learning. However, there have only been a few attempts to connect this theory to neuroscience and express RL in a framework of spiking neurons.

The goal of this workshop is to enable the participants to catch up on the most recent experimental data, to introduce new theories, and to see if we can bring the theory and experimental data more closely into agreement with each other.

Schedule, Day 1 (Monday, March 3, Magpie B)

8:00 - 8:45	**Eugene Izhikevich**	*Solving the Distal Reward Problem through the linkage of Dopamine Signaling and STDP*
8:45 - 9:30	**Razvan Florian**	*Relating reinforcement learning and STDP*
9:30 - 10:15	**Florentin Woergoetter**	*Neural control and three-factor differential hebbian earning in behaving systems*
10:15 - 11:00	**Mayank Mehta**	*Resonance Learning*
4:30 - 5:15	**Botond Szatmary**	*Behavioral correlates of prefrontal cell assemblies*
5:15 - 6:00	**Gloster Aaron**	*Searching for organization in the activity of cortical networks*
6:00 - 6:45	**Peter Latham**	*How noisy is the brain? A bottom up approach*
6:45 - 7:30	**Ken Harris**	*Axonal backpropagation in real neuronal networks*

Schedule, Day 2 (Tuesday, March 4, Magpie B)

8:00 - 8:45	**Harel Shouval**	*Learning Reward Timing using Reinforced Expression of Synaptic Plasticity*
8:45 - 9:30	**Walter Senn**	*Reinforcement learning in populations of spiking neurons*
9:30 - 10:15	**Wulfram Gerstner**	*Spike-based reinforcement learning of navigation*
10:15 - 11:00	**Michael Hasselmo**	*Cortical mechanisms of memory-guided behavior: Oscillations, grid cells, arc length and RL*
		Break
4:30 - 5:15	**Guoqiang Bi**	*Emergence and evolution of reverberatory activity in neuronal networks*
5:15 - 6:00	**Maxim Bazhenov**	*Control of sparseness of odor representations in the insect olfactory system*
6:00 - 6:45	**Aristodemos Cleanthous**	*Can Networks of Leaky Integrate-and-Fire Neurons with Spike-based Reinforcement Learning Play Games?*
6:45 - 7:30	**Robert Legenstein**	*Theoretical analysis of learning with reward-modulated spike-timing-dependent plasticity*

How to solve systems neuroscience problems with molecular tools

Ed Boyden (MIT)

Abstract

What the workshop is to address and accomplish: The last decade has seen a huge surge of creativity in the development of new molecular tools for the observation and manipulation of neural circuits, which in principle will open up vast new horizons in our understanding of the brain. However, to use these tools for optimal power will take time and ingenuity (look at the permutations that patch clamping, or confocal microscopy, have taken over decades of use). We will set out to understand the art of applying novel molecular technologies to the understanding of neural circuits. By bringing together scientists who are both inventing new tools and applying them to neural circuit functions, we will explore this frontier in the informal CoSyNe workshop format.

Why the topic is of interest: Due to the anatomical complexity, inaccessibility, and heterogeneity of the brain, neuroscience is, perhaps more than any other field, impacted by technology. Brain slices, cell culture, the microelectrode, patch clamping, GFP, confocal and two-photon microscopy, calcium dyes – each has led to a huge advance in our understanding of the brain. However, tools are now appearing at a fast rate: we must not only invent tools, but learn how to apply them in creative ways. We will explore this topic in this CoSyNe workshop. We must develop not only new and revolutionary technologies, but methodologies and principles of usage, to open up entirely new frontiers on the brain.

Who the targeted group of participants is: Neuroscientists interested in doing ground-breaking, scientifically-impactful experiments.

Schedule (Tuesday, March 4, White pine)

All talks 30 minutes followed by 5 minutes of questions.

8:00-8:10		*introduction*
8:10-8:45	**Thomas Knopfel**	*Targeted optical probing of neuronal circuit dynamics using fluorescent protein sensors*
8:45-9:20	**Dejan Vucinic**	*Wearable Acousto-Optic Brain Interface*
9:20-9:40		*break*
9:40-10:15	**Liam Paninski**	*Statistical inference of spike times, calcium dynamics, and voltage given noisy, intermittently-sampled fluorescence imaging data*
10:15-10:50	**Alan Jasanoff**	*MRI contrast agents for functional molecular imaging of brain activity*
4:30-5:05	**Ehud Isacoff**	*Engineered light-gated excitatory receptors for analysis of the neural basis of behavior*
5:05-5:40	**Ed Boyden**	*Genetically-Targeted Optical Neuromodulation: Towards Circuitwide Control of Normal and Pathological Neural Computation*
5:40-6:00		*break*
6:00-6:35	**Ed Callaway**	*Viral and Genetic Methods for Mapping and Manipulating Neural Circuits*
6:35-7:10	**Botond Roska**	*Rescuing visual sensitivity by cell type specific expression of ChR2 in retinal ON bipolar cells*
7:10-7:30		*Open discussion*

Linking Auditory Neurophysiology to Perception

Jan Schnupp (University of Oxford)

Abstract

The ultimate goal of sensory neurosciences is to describe the neural basis of perception. Yet in the auditory neurosciences, the vast majority of studies have hitherto pursued either psychophysical or physiological approaches separately, with perhaps not sufficient effort to try to link the two approaches together to form a coherent picture. Work done in the visual and somatosensory systems has shown that studies which reveal carefully established parallels between neurophysiological responses and perception can be very insightful, even if it remains very difficult to demonstrate causal relationships between neural responses and perception unequivocally in any sensory modality. In this workshop we hope to highlight some recent auditory neuroscience research which tries to bring neurophysiological and psychophysical accounts of auditory function closer together, and we will debate some of the technical and conceptual difficulties that need to be overcome it we are to establish firmer links between putative neural codes to auditory perception. The examples presented cover a wide range of perceptual tasks and stations of the auditory pathway, from simple signal detection in the auditory nerve through monaural and binaural temporal processing to the representation of vocalizations and speech signals in primary and higher order cortical areas.

Schedule (Tuesday, March 4, Wasatch A)

8:00 - 8:10	**Jan Schnupp (Oxford University)**	*Welcome*
8:10 - 8:40	**Peter Heil (Leibniz Institute, Magdeburg)**	*Towards a unifying basis of absolute auditory thresholds*
8:40 - 9:10	**Lutz Wiegrebe (University of Munich)**	*Psychophysical and physiological evidence for fast binaural processing*
9:10 - 9:40		*BREAK for coffee*
9:40 - 10:10	**Tony Zador (Cold Spring Harbor Laboratory)**	*Millisecond spike timing can guide behavior in auditory cortex*
10:10 - 10:40	**Kerry Walker (University of Oxford)**	*A spike pattern based neurometric analysis for the discrimination of natural sounds*
10:40 - 11:00		*panel discussion*
11:00		*BREAK for lunch and heated discussion in a snow-cooled outdoor acoustic environment*
4:30 - 5:00	**Kamal Sen (Boston University)**	*Discrimination of Complex Natural Sounds in Songbirds: Neurons & Behavior*
5:00 - 5:30	**Mike Kilgard (University of Texas)**	*Cortical Activity Patterns Predict Speech Discrimination Ability*
5:30 - 6:00		*BREAK for coffee etc*
6:00 - 6:30	**Jennifer Bizley (University of Oxford)**	*The Neural Basis of Pitch Perception*
6:30 - 7:00	**Shihab Shamma (University of Maryland)**	*Encoding task rules and performance in auditory and frontal cortex of the ferret*
7:00 - 7:30	**Yale Cohen (Dartmouth University)**	*Auditory attention and auditory categorization in primate ventrolateral prefrontal cortex*

Reactivation and Memory Consolidation

Kamran Diba (Rutgers), Ken Harris (Rutgers)

Abstract

How is the long-term storage of neural representations consolidated in the brain? Following sensory input, the brain demonstrates self-organized means of reactivating behaviorally relevant neural representations. The goal of this workshop will be to discuss potential substrates of memory consolidation through the reactivation of assemblies of neurons. Epochs of reactivation occur spontaneously, during restful periods, during various sleep rhythms, et cetera. The role that reactivation plays in memory consolidation and sequence learning is largely unknown and often debated. We will discuss the various paradigms under which reactivation is observed, and the potential impact on plasticity and learning in the brain, along with potential mechanisms.

Schedule (Tuesday, March 4, Wasatch B)

EVENING SESSION ONLY

4:30 - 5:05	**Michale S. Fee (MIT)**	*A cortical sequence generator in the singing (and maybe sleeping) songbird.*
5:05 - 5:40	**Daoyun Ji (MIT)**	*Memory trace replay during sleep: from the hippocampus to visual cortex*
5:40 - 6:15	**Kamran Diba (Rutgers U)**	*Forward and reverse hippocampal place-cell sequences during waking ripples*
6:15 - 6:50	**Michael Hasselmo (Boston U)**	*Cortical dynamics during waking and sleep regulated by cholinergic modulation of synaptic transmission and persistent spiking.*
6:50 - 7:30	**Artur Luczak (Rutgers U)**	*Spontaneous events outline the realm of possible sensory responses in auditory cortex*
7:30 - 8:00	**William Levy (U Virginia)**	*A consistent mapping of behavioral and biological timescales into a minimal model of CA3*

Top down or bottom up? measuring, modeling and understanding cross-scale neural interactions

Tim Blanche (UC Berkeley), Kilian Koepsell (UC Berkeley)

Abstract

The brain functions on multiple spatial and temporal scales spanning several orders of magnitude. Most experimental neuroscientists and theoreticians study the brain at a single scale, regarding lower scales as 'implementational detail' and higher scales as phenomena to explain using the scale under study. While much progress has been made using this approach, the success of this paradigm rests on the assumption that the process or mechanism being studied at one scale operates largely independently of lower and higher scales, despite the fact that descriptions at different scales are the same thing at different resolutions. The central themes of this workshop are thus: to what extent can overall brain function be understood one scale at a time? What has been learned by measuring and modeling brain processes across scales? Is there an optimal scale to model brain function? What are the correlational dependencies across levels in neural data? What information is processed at a given scale, how much redundancy is there, and what are the upward and downward flows of information across time?

These are not new questions, but the data and tools emerging to answer them are. Our invited speakers use experimental and theoretical techniques that give a window on brain dynamics from single neurons to whole brains, modeling data obtained from whole cell recordings, implantable multi-electrode arrays, high-density EEG and epidural electrode arrays, fMRI, and MEG. The risk with such a workshop is that it becomes a series of loosely connected talks. We hope to avoid this veritable "Tower of Babel" by having speakers whose research endeavors explicitly span two or more scales of measurement and analysis:

Schedule (Tuesday, March 4, Magpie A)

8:00 - 8:10	**Tim Blanche**	*Welcome.*
8:10 - 8:50	**Kilian Koepsell**	*Spike timing in the context of network dynamics from retina to cortex.*
8:50 - 9:30	**Ryan Canolty**	*Tracking multi-scale interactions between distinct brain regions during complex behavior.*
9:30 - 10:10	**Charles Schroeder**	*Hierarchically coupled neuronal oscillations as instruments in bottom-up and top-down processing.*
10:10 - 10:30		*Break*
10:30 - 11:00	**Tony Bell**	*Levels, loops and neural learning.*
11:00 - 12:30		*Discussion Session led by Tony Bell*
4:30 - 5:10	**David McCormick**	*Intracortical network dynamics.*
5:10 - 5:50	**Pascal Fries**	*Communication through coherence: A mechanism for dynamic gain change.*
5:50 - 6:10		*Break*
6:10 - 6:50	**Jean-Philippe Lachaux**	*Long-range synchrony in the gamma band : Evidence from intracerebral recordings in humans.*
6:50 - 7:30	**Peter Robinson**	*Multiscale brain dynamics: Toward a first-cut 'working brain' model.*

Recent advances in activity-dependent plasticity

Paul Munro (University of Pittsburgh)

Abstract

Hebb's publication of his Neurophysiological Postulate over 50 years ago profoundly altered our view of learning and memory, and has been the inspiration for dozens of mathematical models (e.g., Hopfield, 1977; Bienenstock, et al, 1982; Song et al, 2000) and hundreds of experiments (e.g., LTP, LTD, STDP). The primary goal of this workshop is to bring together top theoretical researchers with some of the leading experimentalists in the area of activity-dependent synaptic plasticity. This will be the fifth in a series of workshops on this topic. The other four were held at NIPS (1999, 2001), CNS (2003) and Cosyne (2006).

Schedule (Tuesday, March 4, Superior A)

8:00 - 8:20	**Paul Munro**	*Welcome and Introduction*
8:20 - 9:00	**Daniel Ben Dayan Rubin**	*Long memory lifetimes require complex synapses and limited sparseness*
9:00 - 9:40	**Claudia Clopath**	*Voltage model of STDP leads to BCM and ABS*
9:40 - 10:20	**Julie Haas**	*Spike-Timing Dependent Plasticity of Inhibitory Cortical Synapses*
10:20 - 11:00		*Discussion*
4:30 - 5:10	**Joshua Young**	*STDP and the didactic reorganization of cortical response properties*
5:10 - 5:50	**Yoonsuck Choe**	*Delay compensation through facilitating synapses and STDP: A Neural Basis for Orientation Flash-Lag Effect*
5:50 - 6:30	**TBA**	*TBA*
6:30 - 7:10	**Rob Froemke**	*Spike-timing-dependent plasticity and neuromodulation in the adult cortex*
7:10 - 7:30		*Discussion*

What can functional imaging tell us about population coding in sensory systems?: Bridging computation, single neurons and imaging

Justin Gardner (Center for Neural Science / Department of Psychology, NYU), Alex Huk (Neurobiology / Center for Perceptual Systems / Imaging Research Center, The University of Texas at Austin), Denis Schluppeck (School of Psychology, University of Nottingham)

Abstract

Any given sensory stimulus is typically encoded by the simultaneous activity of a large number of neurons in the brain. What types of measurements can experimentalists make that will most reveal the basis of the population codes that are used by these neurons to represent the sensory world? The great majority of our knowledge is based on measurements that have been made from single or small numbers of neurons at a time– but do these measurements miss the forest for the trees? Functional imaging techniques such as fMRI and optical imaging are capable of measuring activity over a much larger area of cortex than single electrodes; either directly through voltage sensitive dyes or indirectly through measurements of changes in local concentrations of deoxyhemoglobin. Both fMRI and optical imaging are currently capable of making measurements at the scale of cortical columns and in principle can be used to glean knowledge of sensory population coding that other techniques might not be sensitive to.

In this workshop we aim to critically evaluate what we have learned and what we could potentially learn from functional imaging studies of sensory population coding.

This workshop will facilitate the debate over how imaging techniques can complement electrophysiological measurements to characterize population coding. The talks will cover the following topics: What aspects of population activity might functional imaging be better at assessing than electrophysiological measurements (particularly single electrode measurements)? What biases (e.g. large output neurons) might electrode measurements be biased towards that could skew knowledge of populations? What biases (e.g. metabolic activity related to synaptic inputs) is functional imaging susceptible to? How might different techniques be used in conjunction to overcome each others limitations? Can imaging techniques tell us about higher order representations that are missed by looking at neurons one-by-one? What spatial and temporal resolution does functional imaging need to make useful inferences? What are the fundamental physiological limitations to measuring indirectly from vascular signals? Can clever experimental design and data analysis (e.g., adaptation, classification schemes) be used to overcome some of these limitations? What is the role of interneuronal correlation in population-level computations, and what is the best technique for assessing them?

This workshop is aimed at scientists of diverse backgrounds who have a common interest in population coding: Theorists working on modeling of population coding and dynamics who have a perspective on what types of measurements are needed to distinguish different theoretical proposals. Experimentalists with measurements of population activity that can guide theory. Physiologists who currently use electrophysiological measurements from single units or using multi-electrode arrays who are interested in complementary measurements of population activity with functional imaging. Those who are using functional imaging, either with fMRI or optical imaging, who are interested in applying these techniques to find a principled way of attacking problems related to population activity.

Schedule (Tuesday, March 4, Superior B)

8:00 - 8:40	**Chou Hung (National Yang Ming University)**	*Weak signal or no signal? How imaging and firing rate signals missed a robust functional circuit for brightness*
8:40 - 9:20	**Manabu Tanifuji (RIKEN Brain Science Institute)**	*Object representation in IT cortex at a columnar level - Comparison between columnar and single cell level representations*
9:20 - 10:00	**Eyal Seidemann (UT-Austin)**	*Statistical properties of neural population responses in the visual cortex: Consequences for efficient neural decoding*
10:00 - 10:40	**Matteo Carandini (Smith-Kettlewell)**	*Imaging the dynamics of population responses in visual cortex*

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4:30 - 4:50	**Denis Schluppeck (Nottingham)**	*Imaging visual and somatosensory cortex with high resolution (f)MRI at 7T*
4:50 - 5:10	**Christopher Tyler (Smith-Kettlewell)**	*Nonlinear dynamic forward modeling of the metabolic coupling between neurons and BOLD*
5:10 - 5:50	**Matthew Smith (CMU)**	*Spatial and temporal scales of correlation in spikes and the local field potential*
5:50 - 6:30	**Adam Kohn (Albert Einstein)**	*Adaptation and population coding in visual cortex*
6:30 - 7:30	**moderated by Justin Gardner (NYU), Alex Huk (UT Austin), and Denis Schluppeck (Nottingham)**	*Discussion session ('rants'): Matteo Carandini, Eyal Seidemann, Manabu Tanifuji, Chou Hung, Christopher Tyler, Matthew Smith and Adam Kohn*