COSYNE

WORKSHOPS
Snowbird UT
Feb 27–28

2017

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COSYNE 2017 WORKSHOPS

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Organizers:

Laura Busse

Alfonso Renart

COSYNE 2017 Workshops

February 27–28, 2017

Snowbird, Utah

Monday, February 27, 2017	**Organizer(s)**	**Location**
1.1 “Deep learning” and the brain: Promises and limitations of using deep neural networks as a tool for neuroscience – Day 1	BF Grewe B Richards A Kell A Christensen T Lillicrap D Yamins	*Wasatch*
1.2 Automated tools for high dimensional neuro-behavioral analysis – Day 1	A Calhoun T Pereira S Linderman J Cunningham L Paninski	*Primrose A*
1.3 Computations and neural mechanisms underlying decision commitment	T Hanks	*Golden Cliff*
1.4 Allocortex: Circuits, coding and general principles	K Franks A Fleischmann	*Maybird*
1.5 Neural dynamics of learning: bridging experiments and theory	K Kuchibhotla S Ostojic	*Primrose B*
1.6 Gamma: fumes or fundamental?	J Cardin V Sohal	*Magpie A*
1.7 Electrons, fluorophores, and nucleotides: bridging the gaps in high-throughput connectomics	A Vaughan A Cardona	*Magpie B*
1.8 Joint modeling of encoding and decoding in specific sensory-perceptual tasks	J Burge	*Superior A*
1.9 Advances in experimental and theoretical studies of astrocyte-neuron interactions	K Obermayer J Schummers	*Superior B*

Workshop Co-Chairs	**Email**
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Maps of Snowbird are on page 5 of this booklet.

COSYNE 2017 Workshops

February 27–28, 2017

Snowbird, Utah

Tuesday, February 28, 2017	Organizer(s)	Location
2.1 "Deep learning" and the brain: Promises and limitations of using deep neural networks as a tool for neuroscience – Day 2	BF Grewe B Richards A Kell A Christensen T Lillicrap D Yamins	*Wasatch*
2.2 Automated tools for high dimensional neuro-behavioral analysis – Day 2	A Calhoun T Pereira S Linderman J Cunningham L Paninski	*Primrose A*
2.3 From perception to valuation: Bridging neuro-computational mechanisms of perceptual and economic decisions	I Kraibich R Polania	*Golden Cliff*
2.4 Error-based learning in short-term and episodic memory	D Pinotsis D Talmi	*Maybird*
2.5 New methods for understanding neural dynamics and computation	J Pillow M Aoi A Charles	*Primrose B*
2.6 On the dark side - new twists in luminance representation that shed light on the organization of the visual system	J Kremkow M Kaschube	*Magpie A*
2.7 Neural basis of movement control: towards bridging systems theory, behavior, motor circuits and spike trains	F Crevecoeur	*Magpie B*
2.8 Relevant information: in search of a causal link between neural responses and behavior	A Koulakov D Rinberg	*Superior A*
2.9 Perception and learning of temporal structure in sensory streams	C Honey	*Superior B*

Maps of Snowbird are on page 5 of this booklet.

Schedule

Each workshop group will meet in two sessions from ~8–11am and from 4.30–7.30pm.

Workshop summaries and schedules are available starting on page 6 of this booklet.

Transportation

Marriott Downtown to Snowbird: Free shuttle provided for registered attendees (first shuttle leaves @ 4pm, last @ 5pm on Sunday, 26 Feb 2017).

Snowbird to Salt Lake City Airport:

Shuttle can be arranged at Snowbird, or online at:

http://www.canyontransport.com

Further information about transportation to/from Snowbird is available at:

https://www.snowbird.com/about/maps/

For further information on transportation or other logistics please contact Leslie Weekes (cosyne.meeting+leslie@gmail.com).

Discounted workshop rates

Snowbird walk up rate: $10 off adult day ticket ($96)

Equipment rental coupons available at the registration desk: 30% discount on ski rentals.

Pick up at the Cliff ticket window (level 1 of the Cliff Lodge next to the ski rental shop) or at the ticket window on the top level of the Snowbird Center (the plaza deck).

Spa facility discount for Cosyne guests: 20 % off select spa treatments and 50% spa access discount

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Meals included with registration

Breakfast (Day 1 and Day 2) - The Cliff Ballroom

Dinner (Day 2) - The Cliff Ballroom

Coffee breaks during morning and afternoon sessions

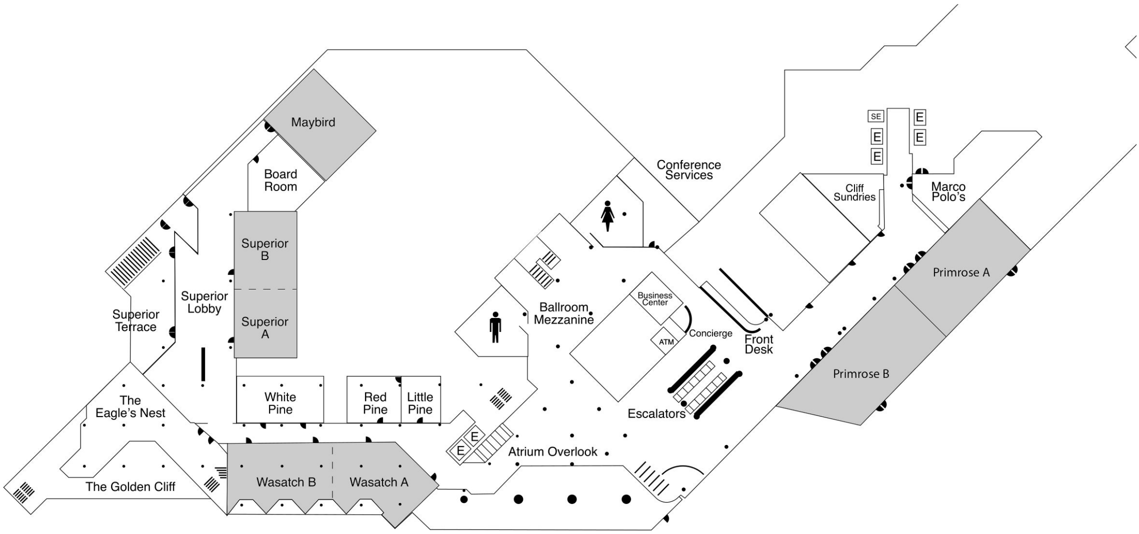
Snowbird wi-fi

SSID: Cosyne

Password: snowbird17

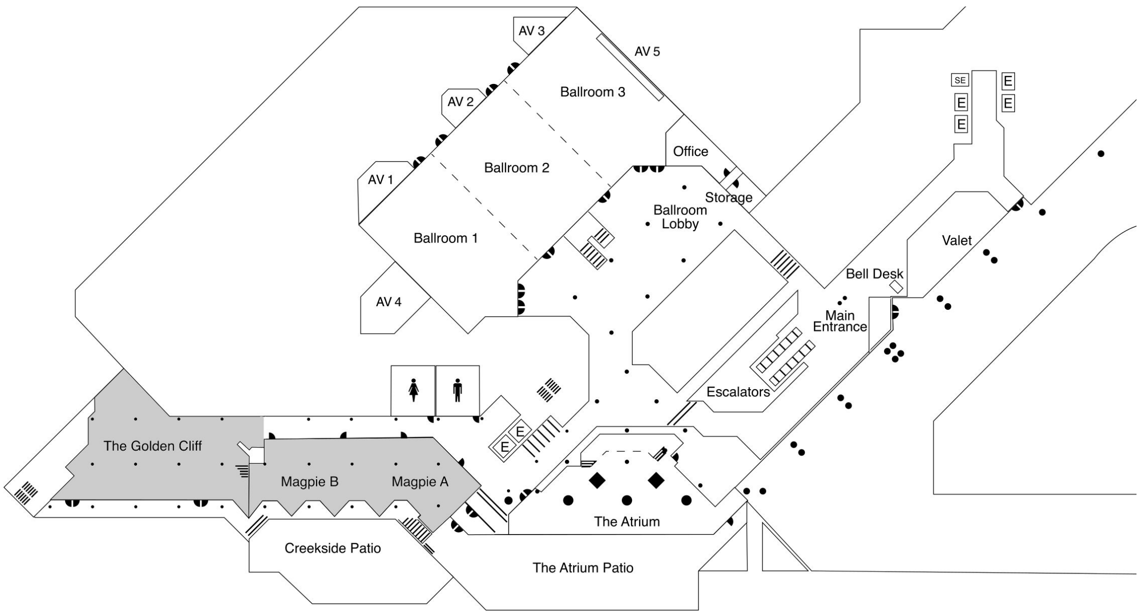
The Cliff Lodge – Level C (Upstairs)

Wasatch (A+B), Superior A, Superior B, Maybird, Primrose A, Primrose B



The Cliff Lodge – Level B (Downstairs)

Golden Cliff, Magpie A, Magpie B



1.1 “Deep learning” and the brain: Promises and limitations of using deep neural networks as a tool for neuroscience–Day 1

Monday, February 27, 2017

Organizers: Benjamin Grewe, Blake Richards, Alex Kell

Co-Organizers: Daniel Yamins, Timothy Lillicrap, Amelia Christensen

Deep learning in artificial neural networks (ANNs) has revolutionized the field of artificial intelligence, providing unprecedented performance on many real-world tasks, such as image or speech recognition. Given that deep ANNs were inspired by biological neural networks, it has been speculated that (1) deep networks can provide greater insight into experimental data, and (2) deep learning algorithms may approximate how learning occurs in the real brain. However, the principles of computation in deep ANNs remain poorly understood, making their application to data analysis complicated. As well, many facets of deep learning algorithms in ANNs are biologically implausible, leaving a gap between theory and experimentation. The overall goal of this workshop is to bring together scientists from the fields of machine learning and neuroscience to discuss the principles and applications of deep learning in neuroscience.

Day 1: Understanding neural representations with deep neural networks – progress and limitations

Thanks to advances in deep ANNs, for the first time in the history of neuroscience, we have stimulus-computable models that achieve human-levels of performance on certain perceptual tasks. Interestingly, deep convolutional neural networks predict visual and auditory cortical responses to natural stimuli better than any existing alternatives, and recurrent networks recapitulate aspects of the dynamics in motor and prefrontal cortex. But, despite this success, there are reasons to be circumspect. Deep networks are generally trained on classification tasks, yet perception is far richer than classification. As a result, many deep ANNs are confused by so-called “adversarial images” that appear nearly identical to human observers. Furthermore, while deep ANNs can predict cortical responses quite well, gaining intuitions about the computations they implement has proven difficult.

In this session we will examine the promise, and limitations, of using deep neural networks as a tool to understand large-scale neural data. We will explore and discuss a number of open questions. What are good tests to falsify a given deep network model of a neural system? What additional constraints may allow these models to overcome these falsifications? Given that we have the full connectome and responses of all units in these models, what does it mean to “understand” a neural network (either biological or artificial)? Day 1 of the workshop will provide the opportunity to delve into these and other questions.

1.1 “Deep learning” and the brain: Promises and limitations of using deep neural networks as a tool for neuroscience–Day 1

Wasatch

Understanding neural representations with deep neural networks – progress and limitations

Morning session

08.00–08.10a	Introduction by *Alex Kell and Dan Yamins*
08.10–08.40a	*Nikolaus Kriegeskorte*, Testing complex brain-computational models to understand how the brain works
08.40–08.55a	*Michael Oliver*, Convolutional models of the ventral stream
08.55–09.25a	*Marcel van Gerven,* ANN-based prediction of neural and behavioural responses inhumans
09.25–09.45a	Coffee break
09.45–10.00a	*Alex Kell*, Hierarchical computation in human auditory cortex revealed by deep neural networks
10.00–10.30a	*Matthias Bethge*, What neuroscience can learn from computer vision
10.30–10.45a	*Niru Maheswaranathan and Lane McIntosh*, Deep learning models of the retinal response to natural scenes

Afternoon session

04.30–05.00p	*Konrad Körding,* Problems with the non-deep-learning based approach to neuroscience and how to fix them
05.00–05.15p	*Olivier Henaff*, Geodesics of artificial and biological representations
05.15–05.45p	*Daniel Yamins,* Some new, less heavily supervised, loss functions for training computational models of the visual system
05.45–06.05p	Coffee break
06.05–06.20p	*SueYeon Chung,* Manifold representations in deep networks
06.20–06.50p	*Friedeman Zenke,* Learning in spiking neural networks
06.50–07.05p	*Ingmar Kanitscheider,* Hippocampal coding arises from probabilistic self-localization across many ambiguous environments

1.2 Automated tools for high dimensional neuro-behavioral analysis—Day 1

Monday, February 27, 2017

https://neurobehavioranalysis.wordpress.com/

Organizers:
Adam Calhoun, Talmo Pereira, Scott Linderman, John Cunningham, Liam Paninski

One of the major goals of neuroscience is to understand the biological mechanisms underlying behavior. Modern recording technologies now enable us to simultaneously measure the activity of hundreds of neurons while making high-dimensional measurements of behavior, yet we struggle to make use of all of this information. Traditional tools such as PCA and GLMs seem insufficient to fully capture the richness and dynamics of these data sets suggesting the need for new computational methods. Combining these new technologies and techniques will offer an unprecedented opportunity to study the relationship between neural activity and natural behaviors. This workshop will bring together a mix of experimental and computational neuroscientists to address these major challenges, as well as identify where models developed for one community can be profitably used by the other community.

Day 1: Automated behavioral analysis
While great strides have been made in neural data analysis, behavioral analysis has lagged far behind. Traditionally, quantification and analysis of behavioral data has largely relied on laborious and subjective manual labeling. With recent advances in machine learning and related fields, more powerful and unsupervised computational methods for signal processing and for segmenting behavioral time series into biologically meaningful data have begun to be adopted more widely in the neuroscience community. However, this rapidly coalescing community does not yet have a single place to gather to discuss these techniques or their limitations. By unifying the diverse perspectives of systems neuroscientists and computer vision/machine learning researchers in the first day of this workshop, we hope this burgeoning community will be able to overcome the challenges of dealing with highly heterogeneous behavioral data. In particular, we believe that these methods can help in finally answering questions from classic ethological frameworks with an emphasis on its mechanistic links to systems neuroscience.

1.2 Automated tools for high dimensional neuro-behavioral analysis—Day 1

Primrose A

Automated behavioral analysis

Morning session

08.00–08.05a	*Adam J Calhoun,* Introduction
08.10–08.40a	*Ji Hyun Bak,* Adaptive optimal training of animal behavior
08.45–09.15a	*Gordon Berman,* Predictability and hierarchy in animal behavior
09.15–09.45a	Coffee Break
09.45–10.15a	*Adam J Calhoun,* Estimating behavioral state
10.20–10.50a	*Benjamin de Bivort,* Systematic exploration of unsupervised methods for mapping behavior

Afternoon session

04.30–05.00p	*Andre Brown,* Natural variation in worm behaviour
05.05–05.35p	*Megan Carey,* Establishing a quantitative framework for locomotor coordination with LocoMouse
05.35–06.05p	Coffee Break
06.05–06.35p	*Elizabeth Buffalo,* Large-scale recordings of memory and spatial navigation in the primate hippocampus
06.40–07.10p	Panel discussion, Chaired by *Talmo Pereira*

1.3 Computations and neural mechanisms underlying decision commitment

Monday, February 27, 2017

Organizer:
Timothy Hanks

Decision making involves deliberation between multiple competing courses of action or propositions. To be useful, this deliberation process must eventually lead to a choice. Thus, one of the fundamental components of decision making is commitment.

Research examining how deliberation is stopped to result in decision commitment has involved a variety of perspectives from theoretical to experimental and spanning model systems from rodents to monkeys to humans. The goal of this workshop is to attempt to connect insights gained from these various perspectives. To this end, we have brought together speakers who have already begun to make these connections through their own work. While the topics covered will all revolve around the central question of decision commitment, the workshop will likely be of relevance for anyone interested in questions related to decision making more generally.

1.3 Computations and neural mechanisms underlying decision commitment

Golden Cliff

Morning session

08.00–08.10a	*Tim Hanks,* Opening remarks
08.10–08.40a	*Long Ding,* Unbounded thoughts on the neural implementation of decision bounds
08.40–09.10a	*Emilio Salinas,* Modeling urgent decisions: How perception modulates ongoing motor plans
09.20–09.50a	Coffee break
09.50–10.20a	*Jeff Schall,* Neural mechanisms of saccade speed accuracy tradeoff: Frontal Eye Field
10.20–10.50a	*David Thura,* The basal ganglia do not select reach targets but control the urgency of commitment

Afternoon session

04.30–05.00p	*Tim Hanks,* Neural signals related to decision commitment in monkeys and rats
05.00–05.30p	*Masa Murakami,* Neural substrates of action timing decisions
05.30–06.00p	Coffee break
06.00–06.30p	*Jennifer Trueblood,* Modeling perceptual decision-making under changing information
06.30–07.00p	*Chris Summerfield,* The influence of information volatility on human choices, response latencies and confidence

1.4 Allocortex: circuits, coding and general principles

Monday, February 27, 2017

Organizers:
Kevin Franks, Alexander Fleischmann

The past decade has witnessed an explosion in our understanding of neural computations performed by different allocortical structures, including mammalian hippocampus, entorhinal cortex and olfactory cortex, as well as trilaminar cortices in fish and reptiles. These relatively simple brain structures form high dimensional and multiplexed representations of relatively abstracted information, such as an animals' speed and location in space or different features of an odor, like identity, intensity and valence. Importantly, these structures also share many common neural circuit motifs, suggesting that they perform similar operations on different types of information. This workshop brings together a group of investigators that, collectively, use a diverse array of theoretical experimental and approaches in different allocortical systems using different model systems, with the view that a comparative conversation will lead to deeper general insights into what these structures do and how they do it. The focus of this workshop is to present an updated overview of the different types of information that are represented in these different allocortical structures and the different coding strategies that are used to represent them, as well as to compare the different cellular and circuit properties that support their implementation. A deeper understanding of how these circuits represent and transform their relevant types of information is therefore likely to reveal general principles for implementing these fundamental computations performed throughout the brain. This workshop will therefore be of broad interest to interested in how neural circuits represent, compute and transform high dimensional data.

1.4 Allocortex: circuits, coding and general principles

Maybird

Morning session

08.00–08.05a	Introductory remarks
08.05–08.30a	S*andeep Robert Datta,* Population coding in an innately relevant olfactory area
08.30–08.55a	*Brent Doiron,* Building stable assemblies with STDP in the face of noise
08.55–09.20a	*Anne Marie Oswald,* Give me SOM space
09.20–09.45a	Coffee break
09.45–10.10a	*Michael Yartsev* (or *Maimon Rose*), Exclusive encoding of learned vocalizations in the developing brain of bats
10.10–10.35a	*Kevin Franks,* Representations of odor identity and odor intensity in piriform cortex: A crucial role for recurrent circuitry
10.35–11.00a	*Lisa Giocomo* (or K*iah Hardcastle*), A multiplexed, heterogeneous and adaptive code for navigation in medial entorhinal cortex

Afternoon/evening session

04.30–04.55p	*Donald Wilson,* Behavior-dependent competition between bottom-up and top-down inputs to piriform cortex
04.55–05.20p	*Stefan Leutgeb,* Perturbation of local circuits in the superficial layers of medial entorhinal cortex
05.20–05.45p	*Yaniv Ziv,* Multiplexing information about where and when in hippocampal neural codes
05.45–06.10p	Coffee break
06.10–06.35p	*Ila Fiete,* Emergence of hippocampal properties from learning to localize across multiple ambiguous environments
06.35–07.00p	*Rainer Friedrich*, Neuronal computations for olfactory pattern classification
07.00–07.25p	*Jay Gottfried,* Odor coding and content in human piriform cortex
07.25–07.35p	Closing remarks

1.5 Neural dynamics of learning: bridging experiments and theory

Monday, February 27, 2017

Organizers:
Kishore Kuchibhotla, Srdjan Ostojic

Most of our understanding of the neural mechanisms underlying behavior is based on experiments in which animals are first extensively trained on a task before neural activity is measured. While this approach has revealed a number of important principles, the impact of the prior training on the recorded activity remains to be assessed. How does the neural activity after training relate to the activity in naive animals? How does the neural activity evolve during learning? How much do established results rely on over-training ?

A number of experimental labs are currently using chronic recordings (calcium or electrophysiology) to record the evolution of neural network dynamics during sensorimotor learning. This new set of experiments offers an unprecedented opportunity to address the issues outlined above and revisit some of the basic principles of neural coding and computations.

This workshop will bring together experimentalists performing recordings during sensorimotor learning and theorists studying learning and dynamics in networks of neurons. The aim of the workshop will be to discuss how models and data can be combined to understand the evolution of neural dynamics during learning and its relationship to behavior.

1.5 Neural dynamics of learning: bridging experiments and theory

Primrose B

Morning session

08.20–08.25a	Introduction
08.25–09.00a	*Bence Olveczky,* Lessons from continuous months-long neural and behavioral recordings.
09.00–09.35a	*Maneesh Sahani,* Changes in cortical coding and dynamics with learning.
09.35–09.50a	Coffee break
09.50–10.25a	*Kishore Kuchibhotla,* Dissociating task knowledge from performance during associative learning
10.25–11.00a	*Mark Schnitzer,* Neural ensemble dynamics underlying associative learning and memory

Afternoon session

04.10–04.45p	*Rob Froemke,* Maternal behavior and learned categorical perception of vocalizations
04.45–05.20p	V*ijay Namboodiri,* Projection specific two photon imaging during reward learning
05.20–05.55p	*Larry Abbott,* Properties of random representations for learning and generalization
05.55–06.15p	Coffee break
06.15–06.50p	*Simon Peron,* Dynamics of murine cortical representations while learning a somatosensory decision task
06.50–07.25p	*Robert Guetig,* How could we measure the spike-threshold-surface? Should we bother?

1.6 Gamma: fumes or fundamental?

Monday, February 27, 2017

Organizers:
Jessica Cardin, Vikaas Sohal

Rhythms in the brain are one of the most frequently studied elements of neural function. Gamma oscillations have received particularly intense experimental and computational interest. However, despite decades of examination and debate, there is little consensus on either the detailed mechanistic underpinnings of gamma oscillations or their functional role in neural coding. It remains unclear how many distinct forms of gamma are generated in the cortex and hippocampus and whether they arise from distinct or overlapping circuit mechanisms. Furthermore, although there are several theories about the role of gamma oscillations in neural coding, there has been little direct or causal testing of these ideas.

Recent work using new techniques has confirmed some classic models of gamma generation, but also identified new potential cell type-specific sources of rhythmic synaptic activity in the cortex and hippocampus. In addition, optogenetics and electrophysiology, in combination with behavior, have provided nuanced views of the role of GABAergic interneurons in generating gamma rhythms and the multifaceted role of those rhythms in perception and cognition. However, these findings remain highly contentious and our understanding of resonant circuit properties is still incomplete.

In this workshop, we will focus on models of gamma generation and function that are emerging from the application of new techniques and approaches in the field. We will examine several conflicting theories of the role of rhythmic activity in encoding and transmitting information within and between neural circuits. In addition, we will explore new findings that challenge the canonical view of gamma as a single phenomenon and explore the idea that the multiple forms of gamma oscillations may not only be generated by distinct circuit interactions but also make distinct contributions to encoding operations within the circuit.

1.6 Gamma: fumes or fundamental?

Magpie A

Morning session

08.00–08:20a	*Jess Cardin,* A role for VIP interneurons in the development of rhythmic cortical activity
08:30–08:50a	*Hillel Adesnik,* Cortical gamma band synchronization through somatostatin interneurons
09.00–09:20a	*Chris Borgers,* A study of effects of recurrent excitation on neuronal rhythms
09:30–09:50a	Coffee break
09:50–10:10a	*Aman Saleem,* Narrow-band Gamma in the mouse visual system
10:20–10:40a	*Cris Niell,* State dependent rhythmic activity and visual processing in mouse cortex
10:50–11.00a	Brief summary and discussion of morning session

Afternoon session

04:30–04:40p	Intro, additional thoughts from morning session
04:40–05.00p	*Mark Histed,* Synchronized spiking, mouse behavior, and input–output transformations in cortical networks
05:10–05:30p	*Martje van de Wal,* Modeling gamma: from rhythms to mechanisms and back
05:40–06.00p	Coffee break
06.00–06:20p	*Thilo Womelsdorf,* Dynamic circuit motifs of gamma underlying prefrontal and cingulate coordination of attention networks
06:30–06:50p	*Vikaas Sohal,* Prefrontal gamma oscillations and cognitive flexibility
07.00–07:30p	Discussion and action points

1.7 Electrons, fluorophores, and nucleotides: bridging the gaps in high-throughput connectomics

Monday, February 27, 2017

Organizers:
Alex Vaughan, Albert Cardona

In recent years, a variety of techniques have enabled connectomic insights at unprecedented scale and detail. Technological breakthroughs have enabled massive new datasets arising from diverse modalities – high-throughput electron microscopy, large-scale virus injections, Brainbow, and in situ sequencing – that share similar goals of reconstructing neural circuit anatomy at the micro- to macro-scale.

This workshop aims order to help cross-pollinate this diverse field. We hope to find common ground in analytical tools, technical tricks, methods, and in particular, suitable neural circuits for validating and comparing each inferred structure despite the large diversity in technique. In addition, we hope to spark links between connectomics and broader questions in behavioral and physiological approaches that have historically driven systems neuroscience.

1.7 Electrons, fluorophores, and nucleotides: bridging the gaps in high-throughput connectomics

Magpie B

Morning session

08.00a	*Mitya Chklovskii,* Theory for relating connectomes to function
08.30a	*Marta Costa,* Using NBLAST to bridge light level and EM connectomics data
09.00a	*Justus Kebschul,* Exploiting high-throughput sequencing for projection mapping and connectomics
09.30a	*Alex Vaughan,* The perils and promises (and methods) of sequence-based connectomics
10.00a	*Marco Tripodi,* Life-long genetic access to neural circuits using Self-inactivating Rabies
10.30a	Discussion

Afternoon session

04.30p	*Albert Cardona,* Identified neurons as the key to bind RNAseq, ephys, LSM, EM and behavior
05.00p	*Dagmar Kainmueller,* Leveraging shape knowledge for automated analysis of fly brain imagery
05.30p	*Alexi Koulakov,* Barcoding the brain: From network cloning to network alignment
06.00p	*Anna Kreshuk,* Automated circuit reconstruction from 3D EM data
06.30p	*Uygar Sümbül,* Tools for color coded connectomics
07.00p	*Adam Marblestone,* Towards a 'best of all worlds' connectomics: Integrating expansion microscopy 3D morphology, in-situ barcoding and machine learning

1.8 Joint modeling of encoding and decoding in specific sensory-perceptual tasks

Monday, February 27, 2017

Organizer:

Johannes Burge

Evolution selects organisms because they perform certain critical sensory, perceptual, and behavioral tasks better than their evolutionary competitors. Certain features of sensory stimuli are more useful for some tasks than others. The stimulus features that are most useful to encode thus depend on the task-relevant latent variables that will be decoded from the stimuli. However, many models of neural encoding do not explicitly consider the tasks for which the encoded information will decoded, and many task-specific models of neural decoding do not explicitly consider how sensory stimuli and neural encoders constrain the information available for decoding. This workshop will highlight inter-disciplinary research that has probed the retina, the cortex, and visual perception with artificial and natural stimuli to understand the joint encoding and decoding of sensory stimuli in the service of particular tasks. Common themes in the answers to these questions may point the way towards unifying principles.

1.8 Joint modeling of encoding and decoding in specific sensory-perceptual tasks

Superior A

Morning session

08.00–08.40a	*Adam Kohn,* Encoding of naturalistic images in primary visual cortex
08.40–09.20a	*Alan Stocker,* The prior (always) rings twice
09.20–10.00a	*Robbe Goris,* Origin and function of tuning diversity in Macaque visual cortex
10.00–10.40a	*Johannes Burge,* Free-parameter-free models of natural tasks
10.40–11.00a	Discussion

Afternoon session

04.30–05.10p	*Eyal Seidemann,* Encoding and decoding neural population responses in visual topographic maps
05.10–05.50p	*Andrew Welchman,* On sensing what's not there
05.50–06.30p	*Bas Rokers,* Systematic misperceptions of 3D motion explained by Bayesian inference
06.30–07.10p	*Eero Simoncelli,* A Scientific Talk To Be Determined
07.10–07.30p	Discussion

1.9 Advances in experimental and theoretical studies of astrocyte-neuron interactions

Monday, February 27, 2017

Organizers:
Klaus Obermayer, James Schummers

Astrocytes are now considered to respond to neural activity, in large part though calcium signaling mechanisms, and more importantly to influence neural information processing through interactions that depend activation of these calcium-dependent pathways. These relatively recent discoveries have generated experimental and computational models of astrocyte function that have evolved mainly separately. A venue to bring together both approaches has been critically missing. This workshop would be the first to explicitly do so in order to foster dialogue between theorists building models, and experimentalists designing experiments.

The content of the workshop can be divided into two parts: First, we will discuss the behavior of single astrocytes and astrocytes networks and their response to different external stimuli, like neurotransmitters or potassium. Second, we will discuss the function of astrocytes in combination with neuronal networks and which role astrocytes play in neural information processing. A mixture of experimentalists and theoreticians gives the possibility to discuss the above named aspects from different points of view.

1.9 Advances in experimental and theoretical studies of astrocyte-neuron interactions

Superior B

Morning session

08.00–08.05a	Introduction
08.05–08.45a	*Alexey Semyanov,* Signaling mediated by potassium within the tripartite synapse
08.45–09.30a	*Maurizio de Pitta,* Functional implications of gliotransmission
09.30–10.15a	*Hugues Berry,* Modelling intercellular and subcellular calcium signal propagation in astrocytes
10.15–11.00a	*Franziska Oschmann*, Compartmental modelling of two different Ca signaling mechanisms in astrocytes

Afternoon session

04.30–05.15p	*Alfonso Araque,* Circuit-specific synaptic regulation by astrocytes
05.15–06.00p	*James Schummers,* Compartmentalized calcium responses to local neural activity in visual cortical astrocytes
06.00–06.45p	*Alla Boriyuk,* Diversity of evoked astrocyte calcium responses: Experiments and modeling
06.45–07.15p	Discussion and conclusion

2.1 "Deep learning" and the brain: Promises and limitations of using deep neural networks as a tool for neuroscience–Day 2

Tuesday, February 28, 2017

Organizers: Benjamin Grewe, Blake Richards, Alex Kell

Co-Organizers: Daniel Yamins, Timothy Lillicrap, Amelia Christensen

Deep learning in artificial neural networks (ANNs) has revolutionized the field of artificial intelligence, providing unprecedented performance on many real-world tasks, such as image or speech recognition. Given that deep ANNs were inspired by biological neural networks, it has been speculated that (1) deep networks can provide greater insight into experimental data, and (2) deep learning algorithms may approximate how learning occurs in the real brain. However, the principles of computation in deep ANNs remain poorly understood, making their application to data analysis complicated. As well, many facets of deep learning algorithms in ANNs are biologically implausible, leaving a gap between theory and experimentation. The overall goal of this workshop is to bring together scientists from the fields of machine learning and neuroscience to discuss the principles and applications of deep learning in neuroscience.

Day 2: Bridging the gap between learning in biological and deep artificial neural networks

Deep learning works, in part, by mimicking some of the mechanisms of information processing found in the real brain. As well, deep neural networks can match, or even exceed, human-level performance in pattern recognition and control. These observations suggest that something akin to deep learning may, in fact, be occurring in the real brain. However, deep learning as it is usually implemented in ANNs is biologically unrealistic. In particular, the backpropagation of error algorithm that is ubiquitous in machine learning utilizes a number of biologically implausible mechanisms, such as non-local synaptic update rules. Additionally, training deep networks with backpropagation requires large amounts of labeled data and only produces skills in restricted domains. Given that the brain is a highly general purpose learning machine with feedback processes acting at multiple spatial and temporal scales, there are numerous aspects of learning in the real brain that are clearly not captured by current deep ANNs.

In this session, we will bring together researchers who are currently seeking answers to these mysteries. Does the brain engage in deep learning? What would experimental evidence for deep learning in the brain even look like? If deep learning does occur in the real brain, how is it achieved with local synaptic updates? Furthermore, what mechanisms of deep learning in the real brain permit general purpose learning? What can biology tell us about the brain's solution to cost function optimization? On Day 2 of this workshop, we will explore some of the existing proposals for how deep learning could be implemented in the real brain, and discuss the latest experimental data that speaks to potential mechanisms for cost function optimization in biological neural networks.

2.1 "Deep learning" and the brain: Promises and limitations of using deep neural networks as a tool for neuroscience–Day 2

Wasatch

Bridging the gap between learning in biological and deep artificial neural networks

Morning session

08.00–08.10a	Introduction by *Benjamin Grewe and Blake Richards*
08.10–08.40a	*Yoshua Bengio,* On biologically plausible deep credit assignment
08.40–09.10a	*Walter Senn,* Error-prediction and deep learning by pyramidal neurons
09.10–09.40a	*Alison Barth,* Cortical transformations of sensory input during learning
09.40–09.55a	Coffee break
09.55–10.25a	*Rafael Bogacz,* An approximation of the back-propagation algorithm with local Hebbian plasticity
10.25–10.55a	*Jesse Goldberg,* Neural implementation of reinforcement learning in the songbird

Afternoon session

04.15–04.45p	J*ennifer Raymond,* Synaptic learning rules specialized for functional constraints
04.45–05.15p	*Matthew Larkum,* Neurons in biological deep neural networks
05.15–05.45p	*Robert Gütig,* Learning across space and time in spiking neural networks through aggregate-labels
05.45–06.15p	*Adam Kepecs,* A cortical neural circuit for prediction error
06.15–06.45p	Coffee break
06.45–07.30p	Final Panel Discussion *(Benjamin Grewe, Timothy Lillicrap, Blake Richards, Robert Gütig, Konrad Körding, Walter Senn, Daniel Yamins, Yoshua Bengio*)

2.2 Automated tools for high dimensional neuro-behavioral analysis—Day 2

Tuesday, February 28, 2017

https://neurobehavioranalysis.wordpress.com/

Organizers:
Adam Calhoun, Talmo Pereira, Scott Linderman, John Cunningham, Liam Paninski

One of the major goals of neuroscience is to understand the biological mechanisms underlying behavior. Modern recording technologies now enable us to simultaneously measure the activity of hundreds of neurons while making high-dimensional measurements of behavior, yet we struggle to make use of all of this information. Traditional tools such as PCA and GLMs seem insufficient to fully capture the richness and dynamics of these data sets suggesting the need for new computational methods. Combining these new technologies and techniques will offer an unprecedented opportunity to study the relationship between neural activity and natural behaviors. This workshop will bring together a mix of experimental and computational neuroscientists to address these major challenges, as well as identify where models developed for one community can be profitably used by the other community.

Day 2: Toward joint neuro-behavioral analysis
Ultimately, our goal is to relate these rich behavioral measurements to underlying neural activity, which we can now collect at a massive scale. The second day will emphasize the challenges of modeling joint neural and behavioral recordings when both domains are equally complex. Interestingly, we have seen a convergence of methodology, with both neural and behavioral analyses drawing upon similar sets of tools. Day 2 will highlight the many similarities between neural and behavioral modeling and leverage these similarities to suggest new directions for future work.

2.2 Automated tools for high dimensional neuro-behavioral analysis—Day 2

Primrose A

Toward joint neuro-behavioral analysis

Morning session

08.00–08.05a	Introduction, *Scott Linderman*
08.10–08.40a	*Kristin Branson,* Mapping behavior to neural anatomy using machine vision and thermogenetics
08.45–09.15a	*Nicholas Foti*, Automatically parsing intracranial EEG using Bayesian nonparametric dynamic models
09.15–09.45a	Coffee Break
09.45–10.15a	*Brian Duistermars*, A neural module for threat display in Drosophila
10.20–10.50a	*Rui Costa*, Organizing self-paced actions

Afternoon session

04.30–05.00p	*Scott Linderman*, Recurrent switching linear dynamical systems for neural and behavioral data
05.05–05.35p	*Josh Shaevitz*, TBD
05.35–06.05p	Coffee Break
06.05–06.35p	*Robert Sandeep Datta*, Relating brain to behavior through motion sequencing
06.40–07.10p	Panel discussion, Chaired by *Talmo Pereira*

2.3 From perception to valuation: Bridging neuro-computational mechanisms of perceptual and economic decisions

Tuesday, February 28, 2017

Organizers:

Ian Krajbich, Rafael Polania

Unlike perceptual decisions, which are based on objective states of the world, economic decisions are based on subjective preferences and are often driven by internal states of the organism. Also unlike perceptual decisions, the neural mechanisms of how economic decisions emerge remain poorly understood. In the last few years there has been an increasing interest in using the knowledge from well-established neuro-computational mechanisms of perceptual decision-making to explain preference-based or economic decisions. This interdisciplinary venture has led to important scientific contributions that have advanced our knowledge of how humans and other animals decide what they want.

This workshop will bring together work by theorists and experimentalists from several fields of research including neuroscience, psychology, and economics, to discuss current developments in the understanding of value/economic/reward decision making that are inspired by neuro-computational theories of perceptual decision-making. We will discuss how these models can be applied to behavioral/neural data, and we will discuss to what extent (if any) mechanisms from the perceptual domain can be extended to valuation and decision processes.

The workshop is targeted at anyone interested in decision making and/or perception. The goal is to bring these people together and create a constructive debate and eventual consensus on how current findings and future research from the two fields (perception and valuation) might be brought together in order to move toward a general framework for understanding decision-making in humans and other animals.

2.3 From perception to valuation: Bridging neuro-computational mechanisms of perceptual and economic decisions

Golden Cliff

Morning session	**Moderator: Ian Krajbich**
08.15–08.45a	*Rafael Polania*, Efficient encoding and bayesian decoding in subjective estimations?
08.45–09.15a	*Michael Woodford*, Risk attitude as a perceptual bias
09.15–09.45a	*Jan Drugowitsch*, Activity normalization as essential, beneficial ingredient of multi-alternative decisions
09.45–10.00a	Coffee break
10.00–10.30a	*Christopher Summerfield*, Optimality and irrationality in human decision-making
10.30–11.00a	*Erie Boorman*, Computational and representational analysis approaches to associative learning
Afternoon session	**Moderator: Rafael Polania**
04.30–05.00p	*Jennifer Trueblood*, Using perceptual decision-making to understand preference reversals in multi-attribute choice
05.00–05.30p	*Ryan Webb,* Pairwise normalization: A theory of multi-attribute choice
05.30–05.45p	Coffee break
05.45–06.15p	*Erin Rich*, Dynamic encoding of choice in the orbitofrontal *cortex*
06.15–06.45p	*Michael Platt,* Neuronal mechanisms of cooperation
06.45–07.15p	*Ian Krajbich*, Discussion

2.4 Error-based learning in short-term and episodic memory

Tuesday, February 28, 2017

Organizers:

Dimitris Pinotsis, Deborah Talmi

Memory is one of the most fundamental human capacities. Short term memory, the capacity to store and retrieve patterns within seconds or minutes, underlies higher cognitive functions, like attention, decision making and action selection, while long-term episodic memory holds the key to our personal life stories, relationships and cultural belonging. Although the distinction between the two memory stores is controversial among researchers of human memory, many researchers with neurobiological, clinical, and computational expertise assume that short- and long-term memory operate differently, and study them independently from each other. The emergence of general powerful approaches for studying intelligent behavior, including Reinforcement learning (RL) and the Bayesian Brain hypothesis (BBh) provides momentum to a unified study of memory across time scales.

A common assumption in RL, BBh and related approaches like error coding and error-driven learning is that learning occurs as a result of differences between sensory predictions and incoming stimuli that are incongruent with these predictions. The prediction that emerges from these approaches is that how well memories can be retrieved depends on how surprising the stimuli were during their presentation. Interestingly, the proposal that surprise at encoding leads to higher retrieval rates is inherently scale invariant, applying equally to short-term and long-term memories. This is interesting because it holds promise to unify the distinct research literature on short and long-term episodic memory. For example, relevant work using BBh has mostly focused on the encoding of short term memories, while RL has often been used to explain the effect of episodic memory on decisions.

This workshop will provide a forum for discussing these recent advances and their potential for explaining fundamental memory functions. It will bring together researchers from different backgrounds including cognitive scientists who are interested in human behavior and computational scientists and modelers who often study biophysical mechanisms or artificial neural networks. Emphasis will be placed on how the brain learns from errors and how online changes in the brain's model of the world affect memory storage and retrieval.

This workshop will elucidate differences and commonalities between RL, BBh and related approaches and address open questions like the exact role of incongruent stimuli, how these might trigger hippocampal processes, how prediction errors affect retrieval of episodic representations and the role of training, dopamine and invasive stimulation for improving short term memory performance. The workshop will be of interest to both cognitive scientists and computational neuroscientists who are keen on understanding memory function and developing model-driven unifying explanations of higher cognitive functions.

2.4 Error-based learning in short-term and episodic memory

Maybird

Morning session

08.00–08.05a	*Dimitris Pinotsis and Deborah Talmi*, Welcome
08.05–08.30a	*Alireza Soltani*, Error-driven learning during probabilistic inference: exploring the nature of the error
08.30–08.55a	*Will Alexander*, Error representations in dorsolateral prefrontal cortex
08.55–09.20a	*Jiri Cevora*, The difficulty of proving that learning is driven by prediction error
09.20–09.45a	Coffee break
09.45–10.10a	*Katherine Duncan*, Learning from the unexpected to improve hindsight: forming rich episodic memories may be particularly helpful when we don't know what to learn
10.10–10.35a	*Vishnu Murty*, Motivational context shunts encoding of surprising events to discrete medial temporal lobe targets
10.35–11.00a	*Deborah Talmi*, Context at the helm of emotion: A model of emotional enhancement of memory

Afternoon session

04.00–04.25p	*John O'Doherty*, Model-based and model-free mechanisms in Pavlovian conditioning
04.25–04.50p	*Sandro Romani*, Novel synaptic plasticity rule bridging the gap between physiological and behavioral time scales supports the emergence of feature selectivity in CA1
04.50–05.15p	*Dimitris Pinotsis*, Which cortical layer might be computing prediction error?
05.15–05.40p	Coffee break
05.40–06.05p	*Christos Constantinidis*, Prefrontal cortical activity during learning in a working memory task
06.05–06.30p	*Matthew Leavitt*, Correlated variability modifies working memory fidelity in primate prefrontal neuronal ensembles
06.30–06.55p	*Alison Adcock*, Beyond errors: sustained modulation of midbrain networks
06.55–07.20p	*Mate Lengyel*, Episodic memory: learning and control without prediction errors
07.20–07.30p	Discussion

2.5 New methods for understanding neural dynamics and computation

Tuesday, February 28, 2017

Organizers:
Jonathan Pillow, Mikio Aoi, Adam Charles

The dynamics of biological neural networks are inherently tied to their computational role in perception, control and cognitive processes. Understanding neural computation thus hinges on understanding the role of neural dynamics across tasks and behaviors. Recently, a number of advanced statistical and machine-learning techniques have been developed to infer the typically low-dimensional dynamics underlying high-dimensional neural population activity. Concurrently, there has been fruitful theoretical work exploring candidate dynamical mechanisms that biological neural networks might exploit to compute complex sensory, motor, and cognitive behavior. These methods have provided insight into the potential computations permitted by observed neural dynamics or the properties of biological neural networks that confer efficient computation.

This workshop aims to provide a combined forum for researchers pursuing statistical and computational approaches to the study of neural dynamics. This will strengthen connections between theoretical notions of computation in neural networks and the statistical tools used for analyzing neural population data. We hope that this workshop will lead to increased interaction between researchers in these fields, inspiring new methods and applications for data analysis that include computational theories, as well as allowing theoretical models to better adapt to collected data.

Specific topics of interest are:

Computations performed by recurrent network models to accomplish well-characterized behaviors

Inference for latent dynamical systems from noisy neural population data

The role of stability and chaos in network computations

Explicit dynamical representations of sensory, motor, and cognitive tasks performed by neural networks.

2.5 New methods for understanding neural dynamics and computation

Primrose B

Morning session

07.50–08.00a	*Mikio Aoi*, Introduction
08.00–08.30a	*Tamas Madarasz*, Context-dependent discrimination learning through inference in a dynamic olfactory circuit
08.30–09.00a	*Mark Churchland*, Relating motor cortex activity to movement; the enduring challenge of reversing causality
09.00–09.30a	Coffee break
09.30–10.00a	*Memming Park*, Inference and Interpretation of Nonlinear Neural Trajectories
10.00–10.30a	*Ila Fiete*, Unsupervised decoding from neural time-series data: How dynamics in the head-direction circuit change from wake to sleep
10.30–11.00a	*Nicholas Foti*, Functional connectivity in MEG via graphical models of time series

Afternoon session

04.30–05.00p	*Adrienne Fairhall*, Analysing behavior with bidirectional dimensionality reduction
05.00–05.30p	*Larry Abbott*, Exploiting instabilities in neural networks
05.30–06.00p	Coffee break
06.00–06.30p	*Xaq Pitkow*, Inference by reparameterization in neural population codes
06.30–07.00p	*Maneesh Sahani*, Continuous-time latent-variable models

2.6 On the dark side - new twists in luminance representation that shed light on the organization of the visual system

Tuesday, February 28, 2017

Organizers:
Jens Kremkow, Matthias Kaschube

Luminance changes across space and time are the perhaps most fundamental cues in visual processing. Sensory systems have evolved to encode both luminance increments (ON system) and decrements (OFF system) in the natural environment. It has long been thought that the ON and OFF systems were mirror copies of each other, differing only in polarity. Recently, however, several important asymmetries in the function and organization between the two systems have been described in the visual cortex1-3, in the LGN4,5 and in the retina6,7. These asymmetries may be rooted in the statistics of natural scenes6,8 and may be linked to a perceptual ON/OFF-asymmetry that was recently observed in humans9-12. Whether these asymmetries subserve a specific computational purpose, how they arise during development and how they are interrelated with basic neural response properties in visual cortex remain open questions. This workshop brings together experts from diverse fields to shed new light on the issue of ON/OFF asymmetries from various perspectives with the aim to leverage potential synergies to unravel the principles underlying the functional organization of the visual system. The topic of this workshop is fundamental and cross-disciplinary and the potential target group includes theoreticians and experimentalists working on sensory coding, cortical development, psychophysics and computational vision.

2.6 On the dark side - new twists in luminance representation that shed light on the organization of the visual system

Magpie A

Morning session

08.00–08.10a	*Matthias Kaschube*, Introduction
08.10–08.50a	*Chun-I Yeh*, Generation of dark-dominant responses in macaque V1
08.50–09.30a	*David Fitzpatrick*, Visualizing the cellular and synaptic architecture for orientation selectivity in visual cortex
09.30–09.40a	Coffee break
09.40–10.20a	*Jens Kremkow*, ON/OFF asymmetries in the functional architecture of the visual cortex
10.20–11.00a	*Julijana Gjorgjieva*, The dependence of the optimal distribution of ON and OFF on noise and stimulus statistics

Afternoon session

04.30–05.10p	*Jose-Manuel Alonso*, Functional consequences of ON/OFF asymmetries in cortical physiology and human vision
05.10–05.50p	*Qasim Zaidi*, Lightness estimates from ON and OFF interactions
05.50–06.00p	Coffe break
06.00–06.40p	*Emily Cooper*, What more can natural images tell us about ON and OFF pathways?
06.40–07.20p	*Vijay Balasubramanian*, Visual perception of complex textures and the natural statistics of light
07.20–07.40p	*Matthias Kaschube*: Discussion

2.7 Neural basis of movement control: towards bridging systems theory, behavior, motor circuits and spike trains

Tuesday, February 28, 2017

Organizer:
Frederic Crevecoeur

Movement control is a major function of the nervous system, as the only way we can interact with our environment and even influence it is through motor neuron activation and muscle recruitment. A central challenge for sensorimotor research is that the input/output characterization of motor behavior is often difficult to map onto neural processing mechanisms occurring at the level of single cells or circuits. The goal of this workshop is to link low-level models of neural information processing with the emergent sensorimotor behavior characterized at the macroscopic scale. This workshop will bring together speakers investigating a broad range of motor functions, including visuomotor control, reaching, grasping, locomotion and singing, across different models (humans, monkeys, birds, cats and rodents), and using different theoretical or experimental approaches to highlight how the combination of these apparently different studies can collectively provide important insight into the neural basis of sensorimotor control.

2.7 Neural basis of movement control: towards bridging systems theory, behavior, motor circuits and spike trains

Magpie B

Morning session

08.30a	General Introduction
08.35a	*F Crevecoeur,* A common framework for motor prediction and optimal estimation during closed-loop control of eye and upper-limb movements
09.00a	*T Takei,* Neural mechanisms for sophisticated feedback motor control
09.30a	Coffee break
09.50a	*D Nozaki*, Visuomotor map determines online and offline movement corrections.
10.20a	*E Azim,* Internal feedback circuits for skilled limb movements.
11.10a	Discussion

Afternoon session

04.00p	*M Carey*, *Cerebellar contribution to coordinated* locomotion in mice.
04.30p	*L Ting,* Force encoding in muscle spindles for sensorimotor control
05.00p	Coffee break
05.20p	*KP Kording,* What does Bayesian behavior imply about the brain?
05.50p	*SJ Sober,* Spike timing codes for motor control.
06.20p	Discussion

2.8 Relevant information: in search of a causal link between neural responses and behavior

Tuesday, February 28, 2017

Organizers:
Alex Koulakov, Dima Rinberg

Modern era of optogenetics, multineuronal recordings, and connectomics made possible previously unthinkable experiments. If not today, then tomorrow, we will be able to monitor and alter activity of large neuronal populations, and will have information about their connectivity. Such datasets will allow us to pose questions about the role of individual neurons or group of neurons in a specific computation with the rigor which was not possible before. Knowing that responses of a specific group of neurons are correlated with stimuli and with behavior is sometimes not sufficient to establish their causal role in this behavior. Intervention techniques sometimes allow to make such links, however, they are prone to multiple caveats and interpretations. Several approaches have emerged recently that attempt to link neural responses to behavior, such as decision making analysis, network controllability, and stimulus-behavior intersection analysis. In this workshop, we will initiate discussion of approaches to determining of the causal relationship between neural responses and behaviors. We will attempt to discuss questions ranging from the definition of relevant or causal information to what it means that a specific neuron or a group of neurons drive a behavior?

2.8 Relevant information: in search of a causal link between neural responses and behavior

Superior A

Morning session

08.00–08.05a	*Dima Rinberg*, Welcoming remarks
08.10–08.40a	*Stefano Panzeri*, Intersection information: A mathematical framework to study the relevance of neural codes for behavior
08.40–09.10a	*Ilya Nemenman*, Building spiking-behavior dictionaries along motor pathways: From correlation to causation
09.10–09.30a	Coffee break
09.30–09.50a	*Peter Latham*, TBA
09.50–10.30a	*Alex Koulakov*, On identifying control elements in neural circuits
10.30–11.00a	Discussion

Afternoon session

04.00–04.40p	*Michael Shadlen*, Causal neuroscience in more complex brains. It's complicated.
04.40–05.05p	*Chris Harvey*, Dynamic reorganization of neuronal activity patterns in parietal cortex
05.05–05.30p	*Karel Svoboda*, Multi-regional interactions underlying cognitive behavior
05.30–05.50p	Break
05.50–06.15p	*Simon Peron*, Cellular-resolution ablation and the behavioral role of cortical ensembles
06.15–06.40p	*Dan O'Connor*, Analysis of choice-related activity in mouse somatosensory cortex.
06.40–07.00p	Discussion

2.9 Perception and learning of temporal structure in sensory streams

Tuesday, February 28, 2017

Organizer:
Christopher Honey

Our laboratory experiments often measure neural responses to transient and temporally isolated stimuli. This is an appropriate simplification when the sequence of input is unstructured. However, the stream of sensory input within real environments is temporally structured, and neural systems are sensitive to this structure.

In what way do neural responses to a particular stimulus depend on its temporal context? The speakers in this workshop will address this question both empirically and theoretically, with data and models ranging from neuronal to whole-brain levels.

The basic empirical question is: How do neural responses changed when stimuli are presented within a structured sequence? Workshop speakers will describe the nature and timescale of context dependence in early auditory cortex and early visual cortex, using circuit physiology in animal models. Speakers will also characterize the temporal context dependence in higher order cortical circuits and in the hippocampus, as observed in human behavioral and neuroimaging work.

In light of ubiquitous temporal context dependence, we must next ask: Are there common functional principles that explain temporal context sensitivity? And do common circuit mechanisms enable history-dependent computation? Speakers will present models of local recurrent dynamics, models of temporal auto-association in hippocampal sub-regions, as well as models of optimal sequential inference.

By bringing together empirical and theoretical work across multiple levels of description, this workshop aims to close the gap between (i) functional models of learning and perception in time and (ii) local-circuit mechanisms that enable history-dependent processing.

2.9 Perception and learning of temporal structure in sensory streams

Superior B

Morning session

08.00–08.05a	*Chris Honey*, Session Introduction
08.05–08.40a	*Maria Geffen*, Adaptation to repeated sounds and mechanisms for predictive coding in the primary auditory cortex.
08.40–09.15a	*Michael Berry*, Predictive coding of novel versus familiar stimuli in the primary visual cortex.
09.15–09.25a	Coffee break
09.25–10.00a	*Jeff Gavornik*, Learning temporal relationships in the visual cortex.
10.00–10.35a	*Taro Toyoizumi*, Efficient signal processing in random networks that generate variability.
10.35–10.45a	Coffee break
10.45–11.20a	*Biyu J He*, Neural mechanisms of temporal prediction in naturalistic auditory stimuli.

Afternoon session

04.30–04.35p	*Chris Honey*, Session introduction
04.35–05.10p	*József Fiser*, Two cautionary tails about sequential effects during adaptive perceptual decision making.
05.10–05.45p	*Anna Schapiro*, Complementary learning systems within the hippocampus.
05.45–05.55p	Coffee break
05.55–06.30p	*Nick Myers*, Temporal context guides reactivation of working memory templates for perceptual decisions.
06.30–07.05p	*Subutai Ahmad*, Why do neurons have thousands of synapses? A theory of sequence learning in neocortex.
07.05–07.30p	All–speaker discussion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