SOMATOSENSORY & MOTOR RESEARCH

http://informahealthcare.com/smr
ISSN: 0899-0220 (print), 1369-1651 (electronic)

Somatosens Mot Res, Early Online: 1–6
 DOI: 10.3109/08990220.2014.882303

informa healthcare

ORIGINAL ARTICLE

An ocean full of BARRELS: Barrels XXVI meeting report

Philip Chu[1], Chia-Chien Chen[2], & Joshua C. Brumberg[1,3,4]

[1]Neuropsychology PhD Program (Psychology), The Graduate Center, CUNY, New York, NY, USA, [2]Department of Molecular, Cell, and Developmental Biology, University of California Santa Cruz, Santa Cruz, CA, USA, [3]Department of Psychology, Queens College, CUNY, Flushing, NY, USA, and [4]Neuroscience PhD Program (Biology), The Graduate Center, CUNY, New York, NY, USA

Abstract

The 26th annual Barrels meeting was convened on the campus of the University of California San Diego, not far from the shores of the Pacific Ocean. The meeting focused on three main themes: the structure and function of the thalamic reticular nucleus, the neurovasculature system and its role in brain metabolism, and the origins and functions of cortical GABAergic interneurons. In addition to the major themes, there were short talks, a data blitz, and a poster session which highlighted the diversity and quality of the research ongoing in the rodent whisker-to-barrel system.

Keywords

Barrel cortex, GABAergic interneurons, neurovasculature, thalamic reticular nucleus, whiskers

History

Received 18 December 2013
Accepted 20 December 2013
Published online 6 February 2014

The 26th annual Barrels meeting was hosted in the Atkinson Auditorium on the campus of the University of California San Diego in sunny La Jolla, California on Thursday, 7 November and Friday, 8 November 2013. The meeting witnessed 94 attendees from 11 countries being presented with the latest findings in the rodent whisker-to-barrel system. The conference focused on three main themes: the structure and function of the thalamic reticular nucleus, the neurovasculature system and its role in brain metabolism, and the origins and functions of cortical GABAergic interneurons. For a detailed listing of the talks and speakers, please consult the Appendix.

Thalamic reticular nucleus

The first day opened with **Chris Moore** (Brown University) moderating a session on the synaptic and circuit dynamics of the thalamic reticular nucleus (TRN). He reminded the audience of the anatomical location of the TRN and how from its central position it can modulate many aspects of brain processing such as attention and rhythmic oscillations. As a final note he pointed out that traditionally the TRN had been assumed to be a monolithic structure but recent data have shown that not all TRN neurons respond in the same manner to identical stimuli.

The first speaker **Michael Beierlein** (University of Texas Medical School at Houston) highlighted the differential impacts of cholinergic input into the TRN from the basal forebrain vs. the brainstem. Based on anatomical data the basal forebrain cholinergic inputs should be considered similar to classical synapses such as those made by glutamatergic inputs and not like diffuse inputs that are traditional of neuromodulators. The TRN is one of the few brain structures that receive cholinergic input from both the nucleus basalis of meynert (NBM) and the cholinergic brainstem nuclei. In a series of studies it was shown that following stimulation of NBM afferents there is activation of a fast inward nicotinic response followed by a long outward muscarinic response. In some cases cholinergic input is sufficient to induce post-synaptic action potentials. In a second set of studies the reciprocal connection between TRN and the ventral basal thalamic complex (VB) was investigated. It was concluded that TRN inputs onto VB neurons showed strong divergence influencing many VB neurons whereas VB connections to TRN show little divergence. The next speaker, **Anita Lüthi** (University of Lausanne), highlighted how single channel conductances in the TRN can impact sleep behavior. Initially, the differences between human and rodent sleep were detailed, with an explanation on how rodents exhibit much more frequent transitions and how sleep has been shown to be important in synaptic development and learning. Using a synthesis of whole cell and field recordings in wild type and transgenic animals it was shown that the interplay of the calcium channel $Ca_v3.3$ and the Ca^{2+}-dependent K^+ channel SK2 regulate the bursting behavior of TRN cells. Specifically, in $Ca_v3.3$ knockout animals there are fewer bursts and in SK2 overexpressing animals there are more bursts observed in TRN neurons. The impact on sleep behavior was assessed *in vivo* and it was seen that SK2 overexpressing mice showed fewer transitions during their sleep phase and that they were harder to arouse in response to auditory tones.

Correspondence: J. C. Brumberg, PhD, Department of Psychology, Queens College, CUNY, 65–30 Kissena Boulevard, Flushing, NY 11367, USA. Tel: +1 718 997 3541. Fax: +1 718 997 3257. E-mail: joshua.brumberg@qc.cuny.edu

Finally, **Michael Halassa** (Massachusetts Institute of Technology) presented data from *in vivo* recordings from TRN cells. Using optogenetic techniques it was shown that when TRN cells are activated they evoke bursting behavior in ventral posterior medial (VPM) thalamic cells. In awake behaving animals it was demonstrated that some TRN cell firings are correlated with ongoing spindle behavior and some are not. Some TRN neurons showed correlated firing to behavioral tests, while others did not. The latter two results taken together provide evidence that TRN neurons have heterogeneous functions.

Short talks

Following a short break in the rejuvenating sun, **Matthew Diamond** (SISSA, Trieste, Italy) moderated the first set of short (15 min) talks. First up was **Carsten Pfeffer** (University of California San Diego) whose talk addressed the issue of inhibition of inhibitory cells within the mouse visual cortex. Using genetic techniques to label distinct GABAergic populations along with an adenovirus tagged with channel rhodopsin, the interconnectivity of these cells was addressed. Using single-cell polymerase chain reaction (PCR) from the nuclei of the recorded cells it was possible to identify five classes of GABAergic neurons in layers 2/3 and 5. In sum, vasointestinal peptide $(VIP)^+$ neurons predominantly inhibited somatostatin$^+$ neurons, parvalbumin$^+$ neurons inhibited other parvalbumin$^+$ neurons and pyramidal cells whereas somatostatin$^+$ cells inhibited all classes of cells except somatostatin$^+$ neurons. Next, **Robin Wagener** (University of Medicine, Goettingen, Germany) showed that in the severely disorganized cortex of the reeler mouse it was still possible to have intact thalamocortical inputs. Using molecular markers that differentiate cortical laminae it was shown that thalamocortical axons target layer 4 fated neurons and using optogenetics it was possible to show that these synapses can be activated and lead to columnar-like activation in the reeler mouse. The short talk session was concluded by **Hong Li** (Yale University) who demonstrated that the proper development of barrel cortex requires thalamocortical neurotransmission. A double knockout mouse was constructed where glutamate receptors VGlut1 and VGlut2 were deleted and it was shown that somatotopy was disrupted when the resultant brains were stained with Nissl or the thalamocortical afferents were analyzed despite the fact that within these animals the trigeminal and thalamic nuclei develop normally. Further analysis of these animals showed that layer 4 was reduced in width and it had fewer stellate cells.

Following lunch **Dirk Schubert** (Radboud University, the Netherlands) moderated another session of short talks. Leading off was **Matthew Diamond** (SISSA, Trieste, Italy) who defined the issue of what the rodent is sensing through its whiskers in a neuroethological context, specifically can it when living in underground tunnels detect vibrations made by predators above the ground. To that end, a behavioral test was devised where different vibrations were presented to the left vs. right whisker pads which the rat was trained to discriminate. Rats were able to make discriminations at delays of up to 8 s (humans could perform a comparable task with delays up to 12 s). Recordings from anterior motor cortical regions (M2) showed that some neurons responded to the go signal and based on their firing rates it was possible to predict the behavior of the animal. **Matthew Evans** (University of Sheffield, UK) considered issues concerning how the firing rates of cortical neurons can be interpreted based on different encoding schemes. A key concept was the idea that sensory systems are tuned to the state of the environment they are interacting with. To attack this problem a four-stage program was proposed of measurement (done by mechanoreceptors), preprocessing (neuronal tuning curve distributions), representation (neuronal tuning curve shapes), and inference (cortical outputs). Following the short talks, **Joshua C. Brumberg** (Queens College, CUNY) moderated the annual data blitz where attendees presented their latest results in quick secession before the meeting adjourned to the poster session and finally an alfresco dinner by the sea.

Neurovasculature coupling

The second day of Barrels XXVI began with an introduction and then moderation by **David Kleinfeld** on the topic of neurovascular structure and control of brain metabolism. **Serge Charpak** (University Paris V) began the first talk of the morning with work demonstrating the ability of 2-photon phosphorescence lifetime microscopy to image the partial pressure of oxygen (PO_2) at micron-scale resolution in the olfactory bulb of rats. He found that PO_2 levels peak in individual erythrocytes and that PO_2 levels between two peaks represents the PO_2 levels existent in the neuropil. He presented *in vivo* data from chronically imaged rats and found that sniffing an odor selectively resulted in a PO_2 decrease prior to functional hyperemia in the nerve layer of the glomeruli. He emphasized that the dip that is seen in functional imaging techniques prior to hyperemia, such as those seen in fMRI, is reflected in the micron scale within capillaries and suggested that measuring the prehyperemia ''dip'' could be a way to gain higher temporal resolution in functional imaging studies. The second talk of the day was given by **Anna Devor** (University of California San Diego and the Harvard Medical School) who began by noting the overarching goal of using model systems to understand the human brain. Using 2-photon microscopy she presented data that blood vessel dilation speed is specific to cortical depth and branch order. Specifically, that deeper cortical layers dilate faster than superficial layers, emphasizing that although layer 4 is thought to be the most metabolically active, it does not have the fastest dilating vessels. It was then demonstrated that local glutamate application caused dilation of vessels in layer 1 and that astrocyte calcium signaling was locked to vascular dilation patterns. Interestingly, astrocyte activity was shown to peak after maximum vasodilatation, and thus astrocytes appear too slow to control vasculature behavior. Further, using an IP_3R2-knockout mouse, in which astrocyte signaling is blocked in response to mGluR activity, it was shown that dilation still occurred. Taken together these data suggest that astrocytes are not playing a direct role in regulating vasodilation. She then went on to propose a hypothesis of local signaling within compartments of neurons that may selectively secrete prostaglandins. Next, **Catherine Hall** (University College London) differentiated the role of

pericytes on capillaries as opposed to the smooth muscle surrounding arterioles. An introduction into pericyte physiology showed that depolarizing activity constricts them and their associated capillary which they ensheathe. Using time sequence videography it was possible to follow the sequence of propagation starting from capillary dilation to arteriole. Following ischemic conditions of low cerebral blood flow (CBF) a transient rebound to high levels of CBF occurs, which is then followed by a prolonged decrease in CBF. Using a cocktail of glutamate antagonists that prevent pericyte death and their prolonged contraction during ischemia, she showed that pericytes regulate the prolonged period of low CBF after ischemia. The final presentation for the morning session was given by **Philbert S. Tsai** (University of California San Diego), who showcased a method of reconstructing all the vasculature within the barrel cortex using all-optical histology. Using a community analysis algorithm, he demonstrated that in contrast to classical work from Thomas Woolsey, microvasculatures form a continuous network within the barrel cortex and that the high vein to artery ratio provides low resistance sinks to prevent lateral flow in the vasculature. Their data were verified against *in vivo* data and modeled to show that passive flow dynamics can explain much of the cerebral vasculature flow without most of the active processes. Then, in response to a previous speaker, **Serge Charpak** stepped forward to present a new GcAMP mouse crossed with a connexin reporter line and showed preliminary data that astrocytes can in fact respond quickly, but made no argument that their activity is coupled to the vasculature.

Short talks

A short discussion and coffee break was followed by short platform talks introduced and moderated by **Robert Sachdev** (Yale University School of Medicine). **Christian L. Ebbesen** (Humboldt University) began the session by sharing his results using tetrode recordings to show changes in vibrissa motor cortex (VMC) during social facial touching among rats. Specifically, he presented findings of decreased level of activity in the VMC during social facial touching, where the effect was greater for males than for females and stimulating the VMC decreased social facial touching. **Jerry L. Chen** (University of Zurich) followed up by presenting data on the relationship between long-range projecting neurons and local circuits *in vivo* using 2-photon calcium imaging and viral retrograde tracers injected into S1. Using the go, no-go and pole location discrimination behavioral tasks, he found that $S1 \rightarrow S2$ projecting neurons show more touch-related responses during texture discrimination and $S1 \rightarrow M1$ projecting neurons showed greater touch-related responses during object localization. It was also demonstrated that some cells could discriminate between hits vs. misses during discrimination tasks and that depended on whether the forward projection was to S2 or M1. The final short platform talk of the day was given by **Bettina Joachimsthaler** (Werner Reichardt Center for Integrative Neuroscience) who used *in vivo* 2-photon imaging of dendritic spines during a classic eye-blinking task using a whisker stimulus as the conditioned stimulus (CS). She found that the CS whisker column showed a decrease in absolute spine number and increase in spine turnover.

After the lunch break, the short platform talks were moderated by **Bryan (Mac) Hooks** (Janelia Farm Research Campus). **Robert Sachdev** (Yale University School of Medicine) presented data demonstrating that although network activity and local field potentials fluctuated rhythmically, the spontaneous activities were not directly correlated with changes in blood flow. It was determined that spontaneous neuronal activity and blood flow rate are not necessarily coupled in linear fashion. **Alan Urban** (INSERM) followed by introducing whole brain functional sonography, a non-invasive imaging modality that is based on micro-Doppler effect that offers both high spatial and temporal resolutions. Using this imaging technique, it was demonstrated that stimulation of the whiskers can change the cerebral blood volume (CBV) by 20%. Using the correlative map to investigate the anatomical functionality of the barrel cortex, the changes in CBV were positively correlated with the number of pulses and was also shown to be temporally specific to stimulation. Next, **Simon Musall** (University of Zurich) showed that using an optogenetics approach, adaptation in rat barrel cortex is frequency dependent. It was shown that rats can detect and discriminate trains of light pulses with high reliability. When there is adaptation in whisker response, the discrimination rate is decreased and when the light-activated adaption is absent, the discrimination rate is increased. Therefore, it was suggested that the adaption in pulses might be responsible for desensitization in tactile detection. Last, **Simon Peron** (Janelia Farm Research Campus) showed that, using the large-scale calcium imaging method, it is possible to quantitatively understand the neural coding of behaving mice. Some neurons exhibit touch-related activity, while some fire all the time. Approximately 25% of the neurons stay relatively silent, while 30–40% of neurons show touch-related activities in layers 2/3, 4, and 5, and the rest were classified as neurons responding to whisking. Neuronal activity was sparse in layers 2/3 and denser for layer 5 that responded to touch, and a surprisingly low (<5%) percentage of neurons in the principal whisker were responsible for coding of touch-related activities, and the touch representation rate declined as a function away from the principal whisker. The session concluded with a vigorous discussion, followed by a coffee break.

GABAergic interneurons

The final afternoon session focused on the origin and role of cortical interneurons which was moderated and introduced by **Jochen Staiger** (Georg-August-Universität). He reminded the audience about the birth of inhibitory neurons in the medial ganglion eminence and their long migratory route during development into the cerebral cortex. The audience received a very comprehensive review on the many categories of inhibitory neurons regarding the heterogeneity in their molecular profiles and functional roles in the cortex.

The initial speaker was **Gordon Fishel** (New York University), who showed input-specific control of cortical circuit assembly, especially regarding three subtypes of inhibitory neurons: VIP^+, $calretinin^+$, and $reelin^+$, and how

the differential expression of these inhibitory neurons alters the morphological development of neurogliaform in the superficial layers of the cerebral cortex. It was found that silencing reelin positive cells during the first postnatal week led to specific and significant morphological alterations on the neurogliaforms, while silencing VIP$^+$ inhibitory neurons had minimal effects. Furthermore, it was determined that this morphological development is also dependent on proper sensory and glutamatergic input. This was based on the finding that whisker plucking resulted in alterations of the morphology of neurogliaform cells, particularly retraction of their dendrites, and this result was mimicked by selectively knocking out the NR1 subunit of the NMDA receptor, and administering NMDA in the whisker-plucked mice rescued these morphological alterations. Last, it was shown that the loss of the NR1 subunit changes the afferent drive from thalamus, and these morphological changes of interneurons may result from the loss of selective thalamocortical connectivity mediated by nerve-growth factor.

The second afternoon speaker **Mingshan Xue** (University of California San Diego) shifted the focus from barrel cortex to visual cortex. He began by reminding the audience about the balance of excitatory and inhibitory (E/I ratio) networks within the cerebral cortex. By investigating the layer 4 to layer 2/3 connection, he established that the E/I ratio is evenly matched and strongly correlated across networks, suggesting the strength of inhibition matches the strength of excitation. Then, by investigating c-fos$^+$-GFP neurons and comparing to neighboring fos$^-$ neurons, it was possible to understand how sensory activity alters the excitatory and inhibitory balance in the presence of visual information. It was found that out of the many subtypes of inhibitory neurons, the parvalbumin$^+$ interneurons are the main inhibitory drivers responsible for equalizing the E/I ratio among layer 2/3 pyramidal neurons. Further, by genetically manipulating the excitability of pyramidal neurons it was determined that each excitatory neuron can regulate the presynaptic inhibitory output it receives in an activity-dependent and cell-autonomous manner. This effect is limited to connections between excitatory neurons to parvalbumin$^+$ inhibitory neurons, as this activity-dependent regulation is not seen to affect excitatory neuron to somatostatin$^+$ cell connections.

The final afternoon speaker was **Shankar Sachidhanandam** (Ecole Polytechnique Federale de Lausanne, Switzerland) who presented data on how inhibitory neuronal activity can influence whisker detection sensitivity. Mice were trained to associate the detection of whisker stimuli to licking of a liquid reward. Optogenetic stimuli were used to substitute for physical whisker stimulation, and pharmacological inactivation in barrel cortex blocked this whisker-stimulation associated reward behavior. Through whole cell recording in behaving animals, it was determined that the secondary late depolarization accompanied by spiking in excitatory neurons was strongly correlated with hit trials compared to misses. Finally, it was demonstrated that optogenetically activated inhibitory circuit, mediated by parvalbumin$^+$ (PV) interneurons, can inactivate this late phase of excitation. It was concluded that there are two portions of excitatory neuronal activity: the early phase that is responsible for the detection of the stimuli and the later phase that is responsible for the post-stimulus-related behavioral response. Furthermore, the inhibitory interneurons, particularly PV$^+$ neurons, mediate the response tuning curve in these excitatory neuronal activities.

The meeting adjourned with a commitment to continue the longest running satellite meeting and convene again prior to next year's Society for Neuroscience meeting in Washington, DC. The 27th annual Barrels meeting will return to the birthplace of the Barrels, Johns Hopkins University in Baltimore, Maryland.

Acknowledgements

The event's hosting was facilitated by Dr David Kleinfeld and Ms Nancy Steinmetz. The 2013 meeting was co-organized by Drs Joshua C. Brumberg, David Kleinfeld, Daniel O'Connor, Robert Sachdev, and Jochen Staiger. The organization is indebted to the services of Nancy Steinmetz and Kathy Diekmann.

Declaration of interest

The Barrels meeting was generously supported by NINDS (1R13NS065167-01). The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

Appendix: BARRELS XXVI schedule

Thursday, 7 November	
9:00–9:05	Welcome: **Joshua C. Brumberg**, *Queens College, CUNY*
9:05–11:00	**Synaptic and circuit dynamics of the thalamic reticular nucleus**
9:05–9:15	Introduction/overview: **Chris Moore**, *Brown University*
9:15–9:45	**Michael Beierlein**, *University of Texas Medical School at Houston* Cholinergic synaptic inputs to TRN trigger thalamic network activity
9:45–10:15	**Anita Lüthi**, *University of Lausanne* SK channel overexpression enhances thalamic spindle activity and consolidates sleep
10:15–10:45	**Michael Halassa**, *Massachusetts Institute of Technology* State-dependent organization of thalamic reticular microcircuits
10:45–11:00	Discussion

(*continued*)

11:00–11:30	Coffee Break
11:30–12:30	**Short Platform Talks 1**
	Moderator: **Matthew Diamond**, *SISSA, Trieste, Italy*
11:30–11:45	**Carsten K. Pfeffer[1,2], Mingshan Xue[1], Miao He[3], Z. Josh Huang[3], and Massimo Scanziani[1, 2]**
	Inhibition of inhibition in cortex: The logic of connections between molecularly distinct interneurons
	[1]Howard Hughes Medical Institute, University of California San Diego, La Jolla, California, USA, [2]Center for Neural Circuits and Behavior, Neurobiology Section and Department of Neuroscience, University of California San Diego, La Jolla, California, USA, and [3]Cold Spring Harbor Laboratory, Cold Spring Harbor, New York, USA
11:45–12:00	**Robin J. Wagener, Mirko Witte, and Jochen F. Staiger**
	Intact thalamocortical target selection in the severely disorganized neocortex of the reeler mouse
	Georg-August-Universität, Gottingen, Germany
12:00–12:15	**Hong Li[1], Sofia Fertuzinhos[1], Ethan Mohns[1], Thomas S. Hnasko[2,3], Matthijs Verhage[4], Robert Edwards[2], Nenad Sestan[1,5], and Michael C. Crair[1,5,6]**
	Laminar and columnar development of barrel cortex relies on thalamocortical neurotransmission
	[1]Department of Neurobiology, Yale University School of Medicine, New Haven, CT, USA, [2]Departments of Neurology and Physiology, University of California at San Francisco, San Francisco, CA, USA, [3]Present address: Department of Neurosciences, University of California at San Diego, La Jolla, CA, USA, [4]Department of Functional Genomics/Clinical Genetics, Center for Neurogenomics and Cognitive Research (CNCR), Vrije Uiniversiteit (VU) and VU Medical Center, Amsterdam, the Netherlands, [5]Kavli Institute for Neuroscience, Yale University School of Medicine, New Haven, CT, USA, and [6]Department of Ophthalmology and Visual Science, Yale University School of Medicine, New Haven, CT, USA
12:15–12:30	Discussion
12:30–2:30	**Lunch Break**
2:30–3:00	**Short Platform Talks 2**
	Moderator: **Dirk Schubert**, *Radboud University Nijmegen Medical Centre*
2:30–2:45	**Arash Fassihi[1], Athena Akrami[2], Vahid Esmaeili[1], and Matthew E. Diamond[1]**
	Vibrissal working memory: Psychometrics and neuronal activity
	[1]SISSA, Trieste, Italy and [2]Princeton University, USA
2:45–3:00	**Matthew H. Evans and Tony J. Prescott**
	Efficient and sparse coding in the whisker system
	University of Sheffield, UK
3:00–3:15	**S. Peron, V. Iyer, Z. Guo, C. Guo, and K. Svoboda**
	The brain activity map of mouse barrel cortex
	HHMI/Janelia Farm Research Campus, Ashburn, VA, USA
3:15–3:40	**Data Blitz**
	Moderator: **Joshua C. Brumberg**, *Queens College, CUNY*
3:40–6:30	**Poster Session**
6:30	**Dinner**
Friday, 8 November	
8:45–11:00	**Neurovascular structure and control of brain metabolism**
8:45–8:55	Introduction/moderator: **David Kleinfeld**, *University of California San Diego*
8:55–9:25	**Serge Charpak**, *University Paris V*
	Imaging brain activity from capillaries
9:25–9:55	**Anna Devor**, *University of California San Diego & Harvard Medical School*
	How to build a hemodynamic response from scratch?
9:55–10:25	**Catherine Hall**, *University College London*
	Regulation of brain energy supply by capillaries
10:25–10:55	**Philbert S. Tsai**, *University of California San Diego*
	Blood flow and angio-architecture in relation to the vibrissae barrels
10:55–11:10	Discussion
11:10–11:30	Coffee Break
11:30–12:45	**Short Platform Talks 3**
	Moderator: **Robert Sachdev**, *Yale University School of Medicine*
11:30–11:45	**Christian L. Ebbesen and Michael Brecht**
	Suppression of rat vibrissa motor cortex activity during social facial touch
	Bernstein Center for Computational Neuroscience, Humboldt University, Berlin, Germany
11:45–12:00	**Jerry L. Chen[1], Stefano Carta[1,2], Joana Soldado-Magraner[1,3], Bernard L. Schneider[4], and Fritjof Helmchen[1,2]**
	Task-dependent transmission of activity in mouse barrel cortex
	[1]Brain Research Institute, University of Zurich, Zurich, Switzerland, [2]Neuroscience Center Zurich, University of Zurich/ETH Zurich, Zurich, Switzerland, [3]Institute of Neuroinformatics, University of Zurich/ETH Zurich, Zurich, Switzerland, and [4]Brain Mind Institute, Ecole Polytechnique Federale de Lausanne (EPFL), EPFL SV BMI LEN, Lausanne, Switzerland
12:00–12:15	**B. Joachimsthaler[1,2,3,4], D. Brugger[1,2], A. Skodras[2,4], and C. Schwarz[1,2]**
	Structural plasticity on the level of dendritic spines underlying classical eyeblink conditioning in mouse barrel cortex
	[1]Werner Reichardt Center for Integrative Neuroscience, Tuebingen, Germany, [2]Hertie Institute for Clinical Brain Research, Tuebingen, Germany, [3]Graduate School of Neural and Behavioral Science, Tuebingen, Germany, and [4]German Center for Neurodegenerative Disease, Tuebingen, Germany
12:15–12:30	Discussion
12:30–1:45	**Lunch Break**
1:45–3:00	**Short Platform Talks 4**
	Moderator: **Bryan M. Hooks**, *Janelia Farm Research Campus*

(*continued*)

1:45–2:00	**Robert Sachdev, Yuguo Yu, Peter Herman, Basav Sanganahalli, David McCormick, and Fahmeed Hyder** State-dependent correlations between spontaneous neocortical activity and cerebral blood flow *Department of Neurobiology, Diagnostic Radiology, and Biomedical Engineering, Yale School of Medicine, New Haven, CT, USA*
2:00–2:15	**A. Urban, M. Heidmann, C. Brunner, and J. Rossier** Chronic imaging at high spatiotemporal resolution using whole brain functional sonography *Centre de Psychiatrie et Neurosciences, INSERM U894, Optogenetics and Brain Imaging, Paris, France*
2:15–2:30	**S. Musall[1,2], W. von der Behrens[2,3], J. Mayrhofer[2], B. Weber[2], F. Helmchen[1], and F. Haiss[2,4]** Impact of response adaptation on stimulus perception: Sensory stimulation versus optogenetic activation of primary somatosensory cortex *[1]Institute for Brain Research, University of Zurich, Zurich, Switzerland, [2]Institute of Pharmacology and Toxicology, University of Zurich, Zurich, Switzerland, [3]Institute of Neuroinformatics, University of Zurich, Zurich, Switzerland, and [4]Medical Faculty, RWTH University, Aachen, Germany*
2:30–2:45	**S. Peron, V. Iyer, Z. Guo, C. Guo, and K. Svoboda** The brain activity map of mouse barrel cortex *HHMI/Janelia Farm Research Campus, Ashburn, VA, USA*
2:45–3:00	Discussion
3:00–3:15	Coffee Break
3:15–5:30	**Cortical GABAergic interneurons: Origins, circuit maturation and unveiling of functions**
3:00–3:10	Introduction/overview: **Jochen Staiger**, *Georg-August-Universität*
3:10–3:40	**Gordon Fishel**, *New York University* The role of intrinsic and activity-regulated gene expression in the specification and maturation of cortical interneurons
3:40–4:10	**Z. Josh Huang**, *Cold Spring Harbor Laboratories* Cortical GABAergic interneurons: Origins, circuit maturation and functions getting unveiled
4:10–4:40	**Shankar Sachidhanandam**, *Ecole Polytechnique Federale de Lausanne* Gating of sensory perception by parvalbumin-expressing GABAergic neurons in mouse barrel cortex
4:40–5:00	Discussion
5:00	Adjourn