friends of the mpibrain research

Friends of the
Max Planck Institute for Brain Research

newsletter 1/2020

editorial

in times of this pandemic, we review and **highlight news from 2019 and 2020**.
Since mid-March, the MPI for Brain Research has been operating with many people working from home, whilst allowing a minimum number of scientists and staff in the building to keep our science and operations running. While we have postponed many on-site events, including our annual Ethics in Science- and our Neuroscience Lectures, we are doing our best to keep science moving forward and to support our people and society.

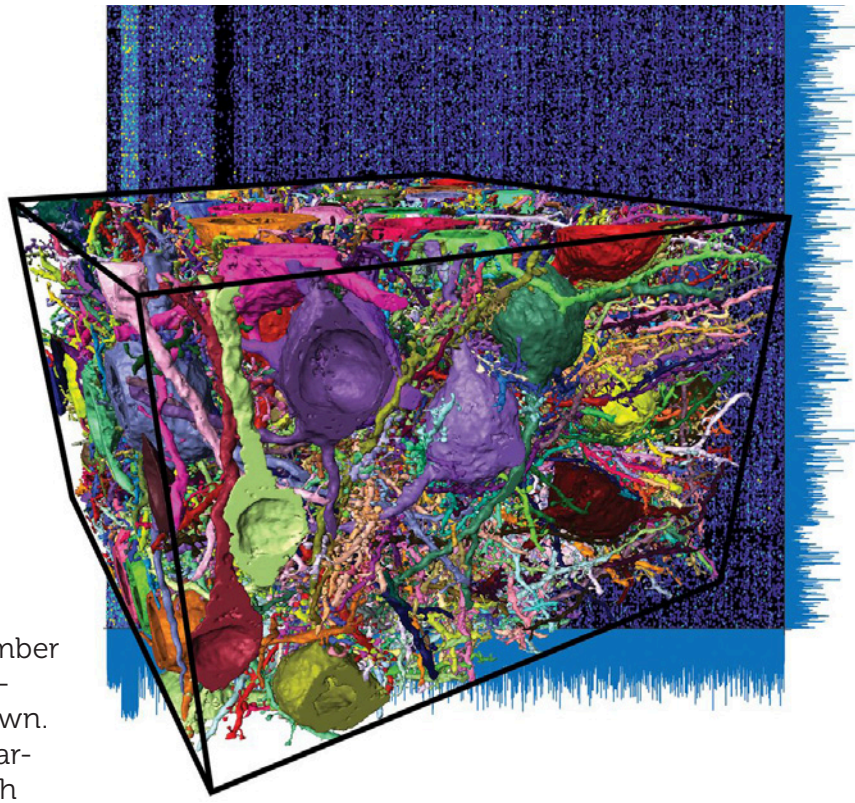
Browse through our **latest science news** (p. 1) and **selected publications** (p. 8). Many MPI scientists have been honored with **prestigious awards and fellowships** (p. 4). We have seen a number of fantastic **students successfully defend their PhDs** (p. 4), have celebrated **25th** and **40th** company anniversaries (p. 5), and have welcomed new institute members in leading roles positions (p. 6) to the Max Planck Institute for Brain Research. We have also shared our science and engaged in captivating discussions with the general public at a number of **Bar of Science** events (p. 6), and hosted (among others) a visit from a great interdisciplinary group of **DAAD France Alumni** (p. 7). Finally, we were able to win back a **"new old Friend"** (p. 7).

Irina Epstein

Graduate Education and Outreach Coordinator,
Press and Public Relations,
Max Planck Institute for Brain Research

Science News from the MPI for Brain Research

Deep inside the brain: Unraveling the dense networks in the cerebral cortex



Dense connectome from the mouse cerebral cortex, the largest connectome to date. Reprinted with permission from A. Motta et al., Science.

mammalian brains, with their unmatched number of nerve cells and density of communication between them, are the most complex networks known. While methods to analyze neuronal networks sparsely, accessing about one in every ten thousandth nerve cell have been available for decades, the dense mapping of neuronal circuits by imaging each and every synapse and all neuronal wires in a given piece of brain tissue has been a major challenge.
In an article published on October 24, 2019 in the journal Science, researchers from the Helmstaedter Lab at the Department of Connectomics report that they succeeded in the dense connectomic mapping of about half a million cubic micrometers of brain tissue from the mouse cerebral cortex using 3-dimensional electron microscopy and AI-based image analysis.

Moritz Helmstaedter

continued

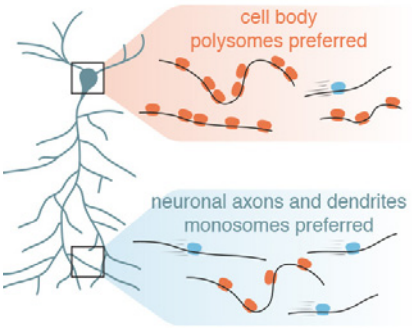
The team imaged and analyzed a piece of tissue from the cerebral cortex of a 4-week old mouse, obtained via biopsy from the somatosensory cortex, a part of the cortex occupied with the representation and processing of touch. Here, the researchers applied optimized AI-based image processing and efficient human-machine interaction to analyze all of the about 400,000 synapses and about 2.7 meters of neuronal cable in the volume.

With this, they produced a connectome between about 7,000 axons and about 3,700 postsynaptic neurites, yielding a connectome about 26 times larger than the one obtained from the mouse retina more than half a decade ago. Importantly, this reconstruction was at the same time larger and about 33-times more efficient than the one applied to the retina, setting a new benchmark for dense connectomic reconstruction in the mammalian brain.

Alessandro Motta

Erin Schuman

Solitary ribosomes supply synapses with protein



Single ribosomes actively translate synaptic proteins.

the complex architecture of brain cells requires unique solutions for protein supply problems – including making proteins on-site or "locally". At synapses, though, the detection of the conventional protein-making machine (a "polyribosome" – multiple ribosomes associated with a single messenger RNA) has been limited. In the January 31, 2020 issue of Science, a team of scientists, headed by Erin Schuman at the Department for Synaptic Plasticity, challenge the dogma of mammalian cell biology. By mapping the position of ribosomes on the mRNAs (using a technique called "ribosome profiling") on isolated monosome and polysome fractions from neuronal compartments, the scientists show that – surprisingly – monosomes represent the active protein-making machine that constitutively supply synapses with proteins.

"Our finding bridges the gap between the relative shortage of visualized translational machinery in neuronal processes and actual measurements of local translation", explains Schuman. "The capacity for constitutive "on-site" protein production is much higher than previously assumed, owing to the presence of translationally active monosomes. Monosomes are the solution to the extreme spatial limitations within dendritic spines and axonal boutons, they fit better into the small space and can supply neurons with diverse proteins with limited machinery", Schuman says.

Anne Biever

Caspar Glock

Hidden away: An enigmatic mammalian brain area revealed in reptiles

Gilles Laurent

the laboratory of Professor Gilles Laurent, Director of the Department for Neural Systems and Coding, is interested in brain function, dynamics, evolution and sleep. To study these topics, his group works on several animal model systems that now include reptiles (turtles and lizards) and cephalopods (cuttlefish). A few years ago, the Laurent Lab provided evidence for the existence of rapid-eye-movement (REM) and non-REM sleep in the Australian bearded dragon Pogona vitticeps, suggesting that the two main brain sleep states (REM and non-REM) date back at least to the time when vertebrate animals first colonized the terrestrial landmass, over 300 million years ago.

Hiroaki Norimoto

In a paper published on February 12, 2020 in the journal Nature, Gilles Laurent and his team describe how they found – in reptiles – a mammalian claustrum homolog, a brain area previously suspected to play a role in mammalian higher cognitive processes, and establish its role in controlling brain dynamics in sleep. This is the first evidence of the existence of a claustrum in non-mammalian animals. To make its discovery – which was entirely fortuitous – the scientists combined techniques such as single-cell RNA sequencing and viral tracing of brain connectivity.

Lorenz Fenk

"The fact that we find a claustrum homolog in reptiles suggests that the claustrum is an ancient structure, likely present already in the brain of the common vertebrate ancestor of reptiles and mammals", Laurent explains. "Our results indicate that the claustrum may play an important role in the control of brain states (such as in sleep), due to input from the mid- and hindbrain, its widespread projections to the forebrain, and its role in sharp-wave generation during slow-wave sleep", Laurent concludes.

The Australian bearded dragon Pogona vitticeps. Photo: Stephan Junek.

Selected awards and honors for institute's members

In 2019/2020, researchers at the Max Planck Institute for Brain Research received distinguished prizes and awards.

Erin Schuman has been awarded the prestigious 2020 **Louis-Jeantet Prize for Medicine** recognizing her work on local protein synthesis at neuronal synapses.

Schuman has recently also been elected member of the United States **National Academy of Sciences (NAS)**. Membership in NAS represents an international recognition of excellence and extraordinary achievement in science and is considered one of the highest honors that a scientist can receive.

Tatjana Tchumatchenko has been appointed fellow of the **Young Academy of Europe**, an initiative of recognized European young scientists with outspoken views about science and science policy.

Helene Schmidt has been awarded the **Otto Hahn Medal** and **Otto Hahn Award** at the Max Planck Society's 70th annual meeting in Hamburg for her PhD work carried out in collaboration between Michael Brecht at HU Berlin and the Helmstaedter Lab at the MPI for Brain Research.

David Hain has received an award for the **best Master degree** of the year 2018/2019 at the Department of Biosciences at Goethe University. David completed his Master thesis in Gilles Laurent's lab at MPI for Brain Research.

In addition, numerous MPI scientists have been awarded prestigious **fellowships and grants**

2019 PhD and Postdoc prizes

using funds from the Friends of the Max Planck Institute for Brain Research, the Institute awarded the 2019 Scientific Discovery Awards to graduate student Alessandro Motta (Helmstaedter Lab) and postdoc Vidhya Rangaraju (Schuman Lab, now research group leader at MPFI) for their outstanding scientific contributions. Both prizes were awarded at the Institute's Winter Party (December 10, 2019) by research group leader Tatjana Tchumatchenko.

Tatjana Tchumatchenko is awarding the PhD prize to Alessandro Motta (Helmstaedter Lab, left) and the Postdoc prize to Vidhya Rangaraju (Schuman Lab, right).

Friends of the Max Planck Institute for Brain Research

PhD graduations

congratulations to Drs. **Benedikt Staffler** (Helmstaedter Lab), **Leona Enke** (Letzkus Lab), **Mike Hemberger** (Laurent Lab), **Elisabeth Abs** (Letzkus Lab, IMPRS), **Bruno Del Papa** (Triesch Lab, IMPRS), **Tim Herfurth** (Tchumatchenko Lab, IMPRS), **Alina Peter** (Fries Lab, IMPRS) and **Ali Karimi** (Helmstaedter Lab) for defending their doctoral theses in 2019 / 2020!

Creativity has no limits: A PhD hat made by colleagues at the MPI (a German graduation tradition).

Company anniversaries

in October 2019, **Dieter Herzberger** celebrated his *40-year* company anniversary at the MPI for Brain Research. Herzberger has worked in the IT & Electronics Department for 32 years, and has been working with Facility Management since 2011. He has also been serving on the works council since many years. The Institute and the Max Planck Society, on behalf of the President, Martin Stratmann, warmly congratulated him.

Dieter Herzberger (left) receives his long service certificate from the MPI for Brain Research managing director, Moritz Helmstaedter (right)

in April 2020, **Nicole Fürst** (virtually) celebrated her *25th* company anniversary. Nicole has worked as a technical assistant in the Department of Neurochemistry (headed by Emeritus Director Heinrich Betz) for 14 years before joining the Department of Synaptic Plasticity in 2009. In the Schuman Lab, Nicole is part of the so called 'prep-team' culturing the beautiful neurons featured in many of our publications.

Dishes of cultured neurons, Nicole Fürst's "specialty". Photo: HG Esch.

Welcome to the institute

in late 2019 and early 2020 **Daniel Brenner, Tanja Hagedorn, and Peter-Michael Rückert** joined the MPI for Brain Research as new heads of IT, Administration and Facility Management, respectively. We warmly welcome our new colleagues!

Daniel Brenner

Tanja Hagedorn

Peter-Michael Rückert

Outreach spotlight

Bar of Science

since March 2019, we have hosted four great **Bar of Science** events featuring seven captivating talks by scientists from the MPI for Brain Research, FIAS and ESI, a fruitful collaboration with Hinter der Natur e.V. We can't wait to bring you back together for some wine and science!

Left: Nina Merkel (ESI) on 'thunderstorms (epilepsy) in the brain'.
Middle: The location: Denkbar in Frankfurt Nordend.
Right: Irina Epstein (MPI, left) and Wolfgang Platen (Hinter der Natur e.V., right) – brainstorming the series.

Visit from the DAAD Alumni France Association

on November 1, 2019 the German Academic Exchange Service Alumni group France visited the MPI for Brain Research to learn about the institute's history and ongoing research as part of a three-day academic retreat to Frankfurt.

"We were particularly impressed by the laboratory visits and the insight into your everyday research, which is so different from the everyday life of most of our alumni group", says Christian Thimme, Director of DAAD France. After the tours, the DAAD group invited the participating scientists and coordinator at MPI for an informal exchange at the local restaurant 'Zum Lahmen Esel'. "The visit to the Max Planck Institute for Brain Research was the highlight of our study trip", concludes Eske Ewen (DAAD) who initiated the visit.

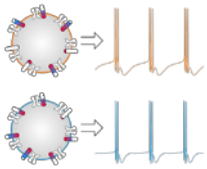
We hosted a visit from the DAAD Alumni France Association – a great setting for exchange and impulses.

News at Friends

Irina Epstein (IMPRS for Neural Circuits alumna) was elected **new CEO of Friends of the MPI for Brain Research**. Irina is an alumna of the institute's graduate school, the IMPRS for Neural Circuits, and returned to the MPI after postdoctoral training in San Francisco, California. Since July 2019, she coordinates graduate education and runs the press and public relations office at the institute.

At Friends, Irina will support the chairs – Matthias Kaschube and Erin Schuman – with the daily business. "I am thrilled to be back and have the opportunity to contribute to the exceptional programs the MPI leadership and my predecessor Arjan Vink have established", Irina says.

Selected publications 2020



Onasch S. and Gjorgjieva J. (2020). **Circuit stability to perturbations reveals hidden variability in the balance of intrinsic and synaptic conductances.** J Neurosci 40(16): 3186–3202

Two model neurons: Similar firing pattern (right) despite differences in on channel expression (left).

Dörrbaum, A.R., Alvarez-Castelao, B., Nassim-Assir, B., Langer, J.D., and Schuman, E.M. (2020). **Proteome dynamics during homeostatic scaling in cultured neurons.** eLife 2020;9:e52939

Shahar, O.D. and Schuman, E.M. (2020). **Large scale cell-type-specific imaging of protein synthesis in a vertebrate brain.** eLife, 2020;9:e50564

Norimoto H., Fenk L.A., Li HH., Tosches M.A.,2, Gallego-Flores T., Hain D., Reiter S., Kobayashi R., Macias A., Arends A., Klinkmann M., Laurent G. (2020) **A claustrum in reptiles and its role in slow-wave sleep.** Nature 2020 Feb;578(7795):413-418

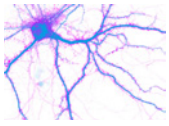
Biever, A., Glock, C., Tushev, G., Ciirdaeva, E., Dalmay, T., Langer, J.T. and Schuman, E.M. (2020). **Monosomes actively translate synaptic mRNAs in neuronal processes.** Science 367

2019

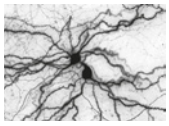
Dalmay T., Abs E., Poorthuis R.B., Hartung J., Pu D., Onasch S., Lozano Y.R., Signoret-Genest J., Gjorgieva J., Letzkus J.J. (2019). **A critical role for neocortical processing of threat memory.** Neuron, 104:1180-1194

Distribution of a synaptic protein (magenta) within dendrites of a neuron (blue).

Motta A., Berning M., Boergens K., Staffler B., Beining M., Loomba S., Hennig P., Wissler H., Helmstaedter M. **Dense connectomic reconstruction in layer 4 of the somatosensory cortex.** Science 366 (6469)



Fonkeu Y., Kraynyukova N., Hafner A.-S., Kochen L., Sartori F., Schuman E.M, Tchumatchenko T. (2019) **How mRNA Localization and Protein Synthesis Sites Influence Dendritic Protein Distribution and Dynamics.** Neuron, 103(6):1109-1122.e7



Hemberger, M., Shein-Idelson, M., Pammer, L., and Laurent, G. (2019). **Reliable sequential activation of neural assemblies by single pyramidal cells in a three-layered cortex.** Neuron 104: 353-369.

Two cortical pyramidal neurons in the cerebral cortex of a turtle. Staining by Mike Hemberger.

Hafner, A.S., Donlin-Asp, P.G., Leitch, B., Herzog, E., and Schuman, E.M. (2019). **Local protein synthesis is a ubiquitous feature of neuronal pre- and postsynaptic compartments.** Science, 364, (6441), 650

Galuske, R.A.W., M.H.J. Munk and W. Singer. (2019) **Relation between gamma oscillations and neuronal plasticity in the visual cortex.** Proceedings of the National Academy of Sciences of the USA 116(46): 23317-23325.

Alvarez-Castelao, B., Schanzenbaecher, C.T., Langer, J.D., and Schuman, E.M. (2019). **Cell-type-specific metabolic labeling, detection and identification of nascent proteomes in vivo.** Nature Protocols, 14(2):556-575

Rangaraju, V., Lauterbach, M., and Schuman, E.M. (2019). **Spatially stable mitochondrial compartments fuel local translation during synaptic plasticity.** Cell, 176, 1-12

Contact

Friends of the MPI for Brain Research
Max-von-Laue-Str. 4
60438 Frankfurt am Main
friends@brain.mpg.de
www.brain.mpg.de/friends