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Friends of the
Max Planck Institute for Brain Research

newsletter 1/2017

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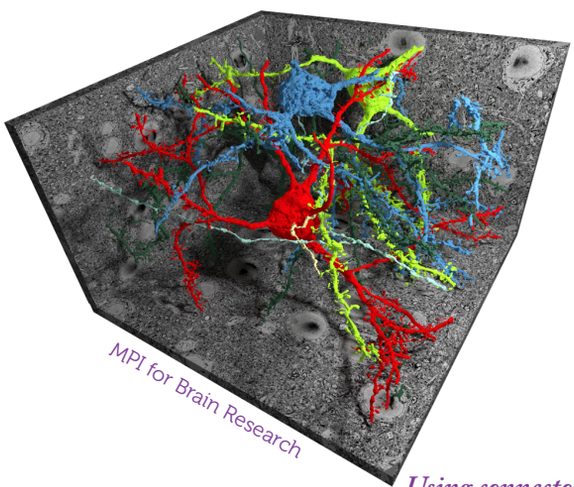

Using connectomics to map onnections between nerve cells in the mammalian brain

10-fold speed up for the reconstruction of neuronal networks

scientists working in the field of „connectomics" aim to completely map the connections between millions or billions of neurons found in mammalian brains. In spite of impressive advances in electron microscopy, the key bottleneck for connectomics is the amount of human labor required for the data analysis. A research team led by Moritz Helmstaedter has now found a novel highly efficient method of presenting these 3-dimensional images in-browser in such an intuitive way that humans can fly at maximum speed along the cables in the brain. Achieving unprecedented 1,500 micrometers per hour, human annotators can still detect the branch points and tortuous paths of the axons. „Think of racing at 100 mph through a curvy, hilly village", compares Helmstaedter. Researchers think that this flight speed is the maximum humans can achieve in 3D electron microscopic data of brain tissue – since the visualization is centered on the brain pilot, like in a plane, the steering is highly optimized for egocentric navigation. When combined with computer-based image analysis, the human part of data analysis in connectomics is now likely maximal, about 10-times faster than before. W: www.brain.mpg.de/news-events/news.html

Bright spots in brain cells

proteins are the building blocks of all cells. They are made from messenger RNA (mRNA) molecules, which are copied from DNA in the nuclei of cells. All cells, including brain cells, called neurons, carry out their functions by carefully regulating the amount and kind of proteins they make.
An important feature of neurons is their ability to communicate with one another at synapses, the points of contact between two cells. Synapses use proteins that are synthesized close-by to fuel communication and the formation of memories.
In neurons and other cells, protein synthesis is regulated by microRNAs, very small "non-coding" RNAs that bind, using complementary sequences, to mRNA and prevent the mRNA from being made into protein. microRNAs are made from larger precursor RNA molecules by several processing steps in the nucleus and cytoplasm. In individual cells, copy numbers of most microRNAs in single cells are relatively low in contrast to potential mRNA targets within individual cells where copy numbers can be up to 10,000 molecules. As such, the absolute number of potential mRNA targets within a cell for a single microRNA species could be very high (e.g. millions), raising the question of how a microRNA can effectively regulate a particular target mRNA.

continued

In the February 10th issue of Science, the Schuman and Heckel labs, from the MPI for Brain Research and Goethe University, respectively, show that neurons have solved the abundance problem by moving the site of microRNA maturation (or "birth") away from the cytoplasm out to the dendrites, thin processes, which are closer to where synapses are. This puts the newly born microRNA into much smaller environment with fewer mRNA target options.
"We tested this hypothesis by using a clever design of a fluorescent molecular reporter, modelled after an immature microRNA", Heckel says. "We filled neurons with this probe and then stimulated individual synapses. To our surprise, we could then see bright fluorescent spots at the stimulated synapses, showing us the birth of the microRNA. We then saw that the microRNA target was downregulated in the neighborhood of the dendrite where the microRNA was born.".
Schuman: "By moving the birthplace of the microRNA to the dendrites and synapses where it is closer to its targets, neurons have solved the microRNA-mRNA numbers game and gained a way for external events-resulting in the activation of synapses, to control the local expression of important brain molecules which is important for neuronal communication and also for memory formation.".

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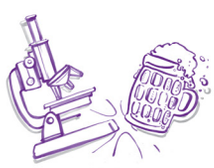
Bar of Science



Meet Scientists - Discuss Science
www.brain.mpg.de/barofscience

on June 27 and 28, Or Shahar (postdoc in the Schuman Lab) and Arjan Vink (public outreach officer) organised eight different lectures, not, as is usually done, at a scientific institution, but at five different bars and cafés in Frankfurt.
Our scientists discussed brain evolution, learning and memory, selective attention, new developments in visualizing the brain and camouflage behavior in cephalopods. The event lead to strong interest from the general public and will be organised again next year. The Institute thanks the speakers and the venues, as well as the Friends of the MPI for Brain Research, for their support.

Overview of the speakers and bar/cafés:
Johannes Letzkus - *Wie lernt unser Gehirn?* @Chinaski (Westend)
Rogier Poorthuis - *Stay tuned: neuronal networks for attention.* @ Dessauer (Riedberg)
Vidhya Rangaraju - *How are memories stored in the brain? What fuels it?* @ Cafuchico (Nordend)
Stephan Junek - *Im Dialog mit dem Gehirn.* @ Tower Café (Bonames) and milch und zucker (Nordend)
Sam Reiter - *Understanding cuttlefish camouflage.* @ Tower Café (Bonames)
Anne-Sophie Hafner - *The amazing journey of AMPA-type glutamate receptors / Understanding memory at the molecular level.* @ Dessauer (Riedberg)
Maria Tosches - *From genes to mind: the mystery of brain evolution.* @ Cafuchico (Nordend)

MPI for Brain Research

Impressions of the lectures at the different venues during the Bar of Science event.

Prizes and awards at the Institute

this year, researchers at the Max Planck Institute for Brain Research received an amazing number of prizes and awards:

MPI Director Erin Schuman was elected to the German National Academy of Sciences Leopoldina in June, whereas Wolf Singer (Director Emeritus) was elected as a Foreign Associate to the (US-based) National Academy of Sciences.

Erin Schuman received her second ERC Advanced Grant, 2.5 Million Euro from the European Research Council in April to study the extended function of the ribosome. One week earlier, an ERC Starting Grant was awarded to Max Planck Research Group Leader Hiroshi Ito to investigate neural circuits for goal-directed spatial navigation.

Hiroshi Ito also received the Young Investigator Award from the Japan Neuroscience Society, which will be presented at the Society's annual meeting.

Earlier this year, Graduate Student Anja Gemmer (Schuman Lab) received a grant from the Christiane Nüsslein Volhard Foundation to help her dealing with the challenging combination of a full time job in research and having a family.

More recently, two EMBO Long-Term Fellowship were awarded to postdocs from the Institute: Anne Biever (Schuman Lab) received her grant to investigate ribosomes in dendrites of the CA1 layer of hippocampus whereas Lorenz Fenk (Laurent Lab) will use his fellowship to explore plasticity in three-layered reptilian cortex.

Selected recent publications

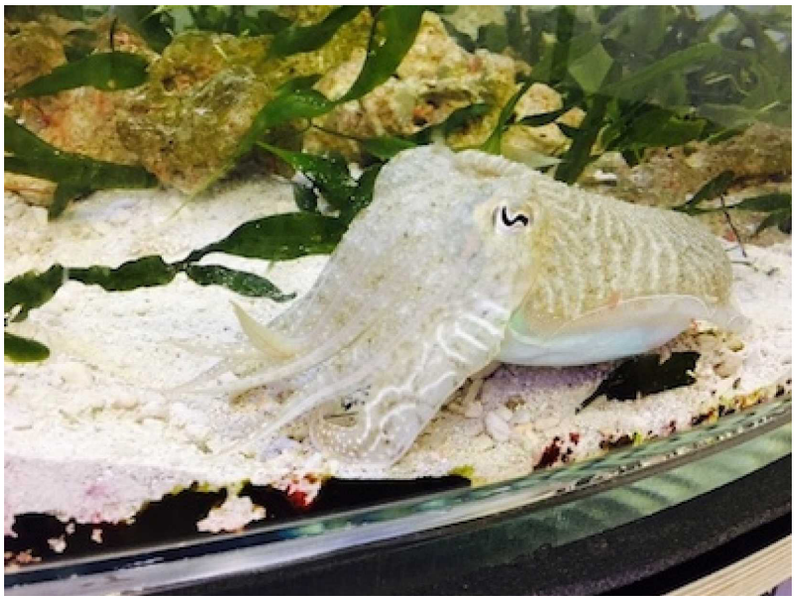
Boergens, K.M., Berning, M., Bocklisch, T., Bräunlein, D., Drawitsch, F., Frohnhofen, J., Herold, T., Otto, P., Rzepka, N., Werkmeister, T., Werner, D., Wiese, G., Wissler, H., and Helmstaedter, M. (2017). webKnossos: efficient online 3D data annotation for connectomics. Nature Methods 14(7): 691-694. *(see also page 1)*

Akbalik, G., Langebeck-Jensen, K., Tushev, G., Sambandan, S., Rinne, J., Epstein, I., Cajigas, I.J., Vlatkovic, I., and Schuman, E.M. (2017). Visualization of newly synthesized neuronal RNA in vitro and in vivo using click-chemistry. RNA Biology 14(1): 20-28.

Sambandan, S., Akbalik, G., Kochen, L., Rinne, J., Kahlstatt, J., Glock, C., Tushev, G., Alvarez-Castelao, B., Heckel, A., and Schuman, E.M. (2017). Activity-dependent spatially localized miRNA maturation in neuronal dendrites. Science 355 (6325), 634-637. *(see also page 1 and 2)*

Dettner, A., Münzberg, S., and Tchumatchenko, T. (2016). Temporal pairwise spike correlations fully capture single-neuron information. Nature Communications 15: 13805.

Weigand, M., Sartori, F.*, and Cuntz, H. (2017). Universal transition from unstructured to structured neural maps. PNAS 114(20): E4057–E4064. *Graduate Student Fabio Sartori is currently at the Tchumatchenko Lab and did his investigations as part of as a rotation project at the lab of Hermann Cuntz (Ernst Strüngmann Institute/Frankfurt Institute for Advanced Studies).



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During their March visit, the high-school students learned more about the amazing camouflage behavior of cephalopods.

meet the science

Meet the Science

on June 30, the first year of the „Meet the Science" project was concluded. This pilot project is a collaboration with the Saint-Angela-Schule in Königstein. As part of the project, a group of five to ten high-school students visited the Institute's monthly Friday seminars. The challenge was to prepare the students in such a way that they could understand one of the two presentations. In order to do so, the Institute prepared background materials and the students visited the MPI a few hours before the lecture where they were received by a scientists belonging to the same lab as the lecturer. At such a visit, the research was introduced, the students were given the opportunity to ask additional questions and they were offered a tour. Through this project, the students were introduced to various research topics within the Institute and got a chance to take an inside look into the labs and facilities. In addition, they are introduced to scientific journals and presentations as a way to disseminate scientific results. The students were very enthusiastic and will return after the summer holidays.

2017 and 2018 upcoming lectures

(all Lectures start at 11.00 hours at the Institute's Lecture Hall)
11.10.17 Jochen Triesch (Frankfurt Institute for Advances Studies, Germany) Neuroscience Lecture
17.01.18 Kristian Franze (Dept. of Physiology, Development and Neuroscience, University of Cambridge, UK) Neuroscience Lecture
21.02.18 Yiotaa Poirazi (Computational Biology Laboratory, Institute of Molecular Biology and Biotechnology, Heraklion, Crete) Neuroscience Lecture
21.03.18 Kay Tye (Dept. of Brain & Cognitive Sciences, MIT, Cambridge, USA) Neuroscience Lecture
11.04.18 Tatyana Sharpee (Computational Neurobiology Laboratory, The Salk Institute, La Jolla, USA) Neuroscience Lecture
12.06.18 Mark Hübner (MPI of Neurobiology, Martinsried, Germany) Neuroscience Lecture
W: www.brain.mpg.de/news-events/lectures-and-other-events.html

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