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Friends of the Max Planck Institute for Brain Research *newsletter* 2023

content

Science News: Cephalopod camouflage: searching for good matches

cephalopod camouflage, one of the most fascinating animal behaviors, was remarked upon already by Aristotle, around 350 BC. Many cuttlefish, octopus and squid species evolved means to imitate the substrate onto which they lie so as to escape detection by preys or predators. In a recent paper appearing in the journal Nature, scientists at the Max Planck Institute of Brain Research and the Okinawa Institute of Science and Technology describe the great sophistication and complexity of this behavior, opening the way towards a neurobiological understanding of its mechanistic and algorithmic underpinnings.

Camouflage starts with the eyes: indeed, cephalopods use vision to estimate the essential features of a substrate's patterning or "texture" in or on which they wish to hide. They never reproduce an exact copy of that pattern, but rather an approximation that is good enough to prevent detection.

A question that follows is whether such approximations belong to a small group of "typical and good-enough patterns" that individuals might expect to encounter in their life and could produce automatically, or whether they are on the contrary varied, highly adaptive, and composed of many independently controllable features. Using a large number of printed backgrounds, high-definition movies of camouflaging cuttlefish and sophisticated quantitative analysis of hundreds of thousands of images, the scientists provide evidence in support of the latter hypothesis: although not infinitely

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Tips of the arms of a cuttlefish showing the chromatophores (yellow, red and dark brown), the pixels of their skin display system.

capable, the patterns produced are far more variable, complex and high-dimensional than initially thought.

The scientists then examined the strategies used by the animals as they generate a camouflage. Cephalopods possess a unique system of specialized organs in their skin, called chromatophores, controlled by the brain. Each chromatophore contains pigment granules —the pigments come in 3 colors— in a cellular "bag" whose diameter can be controlled by a set of tiny radial muscles, themselves controlled by specialized neurons located in the brain. Each time the muscles contract, the chromatophore expands, up to about 0.3mm. Each time they relax, the chromatophore shrinks to a tiny, invisible dot.

With millions of chromatophores in its skin, the cuttlefish becomes a display system, akin to a TV screen, but with colored pixels that can vary in size rather than intensity.

By placing the animals successively on different substrates, by measuring the size changes of hundreds of thousands of chromatophores during these camouflaging bouts, and by analyzing these datasets using modern computational methods, the scientists found that the path to the perfect camouflage resembles a wandering search with progressive error correction. In addition, when examining the population of chromatophores undergoing changes, the scientists observed that they formed groupings of tens to thousands of chromatophores, with similar size-change dynamics during a transition between camouflages. But by repeating the analysis over many similar transitions between the same pairs of backgrounds, they observed that the groupings of chromatophores was different each time. "It is a bit as if, to grab a pen in front of me, I came up with a new strategy to move my arm every time" says graduate student Theodosia Woo, joint first author of the study. These results support the idea that the animals use a form of feedback (visual or other, this is not known yet) about how they may appear, compare this to the background they want to match, and progressively try to minimize the difference between the two until they are satisfied. The whole process is intermittent, fast at the beginning, and increasingly slow as the approximation becomes better.

The scientists then examined a different display, a skin whitening called blanching, produced when the animals feel threatened. During blanching, the behavior of the chromatophores was very reproducible and direct, contrasting with the explorative aspects of camouflage pattern search. But even once in a blanched state, the animal's chromatophores were not all equally contracted; rather they revealed very subtly the pattern that they had showed right before blanching.

Correspondingly, when the blanched display disappeared, it revealed the original camouflage display again. "This suggests that camouflaging and blanching are under separate control systems that are superimposed on one another" says postdoctoral fellow Dominic Evans, responsible for this experiment.

The information gathered during these studies reveal critical information about the neural strategies used by the animals to control these very sophisticated behaviors. "One of the most interesting aspects of these animals," says Gilles Laurent, Director at the MPI for Brain Research and leader of the project, "is that their lineage diverged from our own and that of their fish predators over 550 M years ago, from a very primitive, worm-like common ancestor. This means that the perception of textures, which must be reasonably similar in us, fish and cephalopods —otherwise camouflage would not work— must be the result of evolutionary convergence. The brains of cephalopods are enormous by invertebrates standards, but they are built very differently from those of vertebrates. This indicates that the neural underpinnings of this form of visual perception must be similar in some algorithmic respect, despite what we know to be major differences in physical implementation. Our next objective is to discover these profound algorithmic similarities."

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Science News: Empowering Women in Neuroscience

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Although women make up more than 50% of neuroscience PhD students, their representation drops dramatically at the postdoctoral level and drops even further among principal investigators.

»*a European* perspective on structural barriers to women's career progression in neuroscience", recently published in Nature Neuroscience, sheds light on the persistent gender disparities in European academic neuroscience. Despite an increase in the number of women entering the field, the transition from postgraduate studies to senior faculty positions remains a significant hurdle for female scientists. This insightful perspective, authored by Ashley M. Bourke, Teresa Spanò, and Erin M. Schuman, neuroscientists at the Max Planck Institute for Brain Research in Frankfurt, Germany, presents a thoughtful discussion of the challenges hindering women's progression and advocates for transformative changes in European academia.

The perspective highlights a disturbing and often-discussed trend: although women make up more than 50% of neuroscience PhD students, their representation drops dramatically at the postdoctoral level and drops even further among principal investigators. Contributors to this decline include deeply ingrained societal attitudes and institutional biases. From implicit gender bias in hiring decisions to the challenges of balancing family responsibilities with the demands of an academic career, the perspective delves into the multiple barriers women face on their academic journeys. To address these challenges, the authors propose a multi-pronged approach. A key recommendation is to expand data collection efforts to provide a more nuanced understanding of the issues at play. They emphasize the importance of collecting detailed, field-specific data to inform targeted interventions. In addition, Bourke et al. call for the implementation of family-friendly policies, including accessible and affordable childcare options, and advocate for equalizing the division of household labor through legislative action.

They also highlight the critical role of male allies in reshaping the academic landscape. By actively confronting bias and advocating for gender equity, male colleagues can go a long way toward fostering an inclusive environment where everyone's talents are recognized and valued. The authors urge academic institutions, policymakers, and professional organizations to collaborate on meaningful initiatives. They emphasize the need for a collective effort to break down the barriers that impede the progress of women in neuroscience and other STEM fields. By fostering an equitable environment where talent knows no gender, the scientific community can unlock unparalleled potential, leading to groundbreaking discoveries and advancements.

Institute News: Visit by MPG President Patrick Cramer

in February, Prof. Dr. Patrick Cramer, then president-elect of the Max Planck Society, visited the MPI for Brain Research. His visit was part of an ambitious plan to visit all 86 Max Planck Institutes before officially taking over from Martin Stratmann in June 2023 on the occasion of the 75th anniversary of the Max Planck Society. Accompanying Cramer were Katja Ketterle, the Head of the Max Planck Society's Institutes Department, and Christiane Barz, Institute Liaison. During his visit, Cramer engaged with the institute's directors and met with representatives from various departments, including researchers, IT professionals, scientific facilities, and equal opportunity officers. After a series of meetings, the group convened in the auditorium for a general assembly. Cramer emphasized the value of science and the importance of sharing new knowledge for the greater good. Following his remarks, he fielded questions from the audience. The day concluded with a dinner at the Minerva Bistro, where Cramer dined with representatives from the MPI for Brain Research.

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MPG President Patrick Cramer (far right) and Katja Ketterle (fourth on the left) with MPI for Brain Research Directors and Junior Research Group Leaders

German Neuroscience Olympiad Finals

DNO winner Helena Langanger

© Deutsche Neurowissenschaften Olympiade e.V.

in April, the MPI for Brain Research in Frankfurt hosted the German Neuroscience Olympiad (DNO) finals. The competition aims to encourage young people's interest in neuroscience and is run entirely by volunteer doctoral students and teachers. It is open to teenagers in grades 8 to 13 across the country.

The lecture hall and one of the meeting rooms were used for the exam rounds, while the institute's foyer served as a communication area. There, students and parents could conduct simple experiments and converse with experienced neuroscientists working in medicine or research. The winner of the competition was 17-year-old Bavarian Helena Langanger, who went on to represent Germany at the 2023 International Brain Bee World Championship in Washington, where she competed against finalists from more than forty countries.

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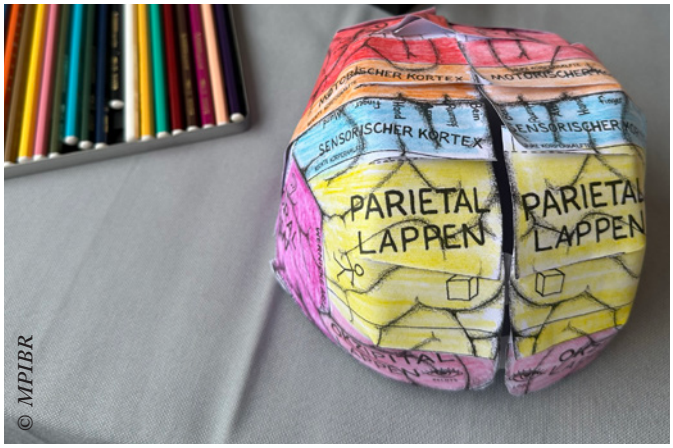
Science Market in Göttingen

the Max Planck Society has been celebrating its 75th anniversary in 2023 with a series of events throughout the year, and in June it returned to its birthplace in Göttingen to host a one-day science market in the medieval town square. The MPI for Brain Research joined forces with the MPI for Neurobiology of Behaviour - Caesar, the MPI for Biological Intelligence, and the Max Planck Florida Institute for Neuroscience to show the science-interested public their research activities and answer questions.

The day began with gloomy weather, but that did not stop the four institutes from showcasing their exhibits to an eager crowd. Visitors had the opportunity to compare animal brain models, look at fluorescent worms under microscopes, and operate a robotic claw with electrodes placed on their skin. Petra Broistedt, Lord Mayor of Göttingen, and Patrick Cramer, the new President of the Max Planck Society, were among the early visitors who explored the exhibit. As the sun came out in the afternoon, more families arrived and children enjoyed making "brain hats" out of paper, programming toy robots, and throwing sandbags at a goal while wearing prism glasses that distorted their vision. Visitors stayed engaged, asking questions and sharing their thoughts about the brain, with many spending a half-hour or more in the MPNeuro tent. The Science Market closed at 7 pm, but the evening continued with a Science Slam event at the Old Town Hall, where young scientists from various Max Planck Institutes presented their research.



PhD Retreat 2023 in Leuven

the MPI for Brain Research organized a PhD Retreat again this year, successfully resuming a valuable tradition after a pandemic-induced hiatus. The purpose of the retreat is to provide an opportunity to discuss scientific topics in a relaxed atmosphere, to give students the chance to network with each other and with invited speakers, and to expose them to different aspects of research and career development. All current MPI for Brain Research PhD students, as well as IMPRS students from our partner institutes, were invited, and in September a group of 30 students embarked on a 4-day adventure to Leuven, Belgium. The city is well-known for cutting-edge neuroscience research, and our students were treated to visits to various research institutions, such as the digital technology developer imec, the life-sciences institute VIB-KU Leuven Center for Brain & Disease Research, and Neuro-Electronics Research Flanders (NERF), an interdisciplinary research center founded by imec, VIB, and the University of Leuven. Our students participated in lab tours and engaged in interactive sessions and presentations with fellow PhD students from these institutions, fostering knowledge exchange and networking opportunities.

MPIBR Graduate Students during the IMPRS Retreat 2023 in Leuven/Belgium

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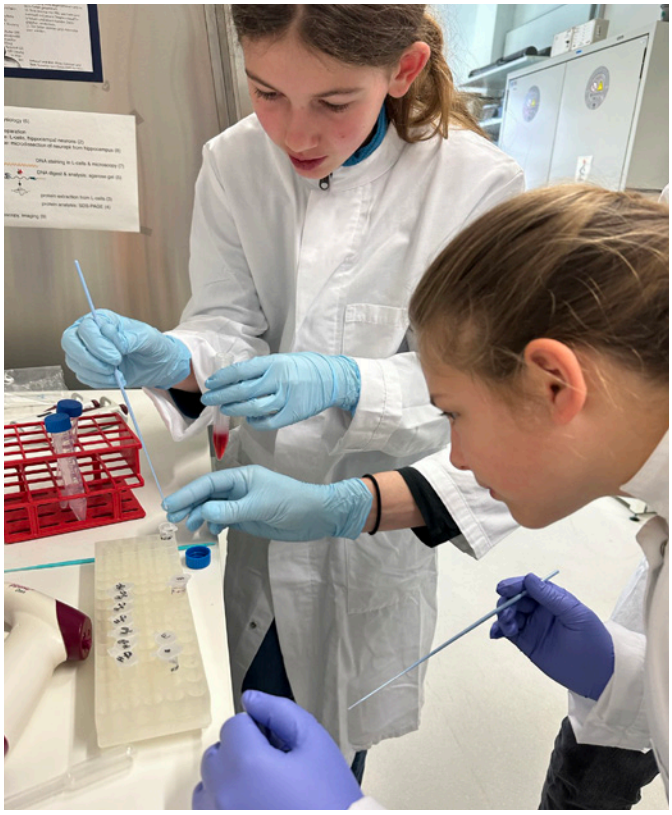
Outreach Spotlight: Girls' day

girls' day in April is an annual event in Germany designed to encourage girls and women to take up technical and scientific careers. As in previous years, the MPI for Brain Research participated in the event and invited a group of 10 girls from different schools in and around Frankfurt to step into the shoes of a neuroscientist for a day.

The girls, ranging in age from 10 to 18, were warmly welcomed and given a comprehensive introduction to and a guided tour of the institute. In the institute's teaching lab, they engaged in a hands-on activity—learning how to extract DNA from fruits such as raspberries and kiwis. This practical exercise led by Susanne tom Dieck (Staff Scientist in the Schuman Department) and colleagues not only provided them with a unique opportunity to understand the fundamental principles of DNA extraction but also showcased the interdisciplinary nature of neuroscience, where biology intertwines with the study of the brain. During lunch, the girls were treated to inspiring talks by four female scientists at different stages of their career, ranging from PhD graduate (Simone Rencken, Laurent Lab, and Alicia Strosche, Stempel Lab) to Max Planck Research Group Leader (Alison Barker and Vanessa Stempel). These researchers shared their personal journeys, discussing what sparked their interest in neuroscience and detailing the paths they pursued to reach their current positions. The talks shed light on the challenges they faced, the choices they made in terms of education and career, and the pivotal moments that shaped their trajectories. Such first-hand accounts offered valuable insights and served as powerful role models for the aspiring young neuroscientists.



Interview with PhD Graduate Marcel Jüngling

Marcel Jüngling joined the MPI for Brain Research in 2019, first as an intern and later as a research assistant in the group of Julijana Gjorgjieva. He is currently in his third year as a PhD student studying the molecular composition of synapses in the group of Erin Schuman. Unknown to many, he is also the current runner-up European champion in artistic cycling. We took the opportunity to ask him a few questions about his unconventional hobby.

© Marcel Jüngling

Marcel, you have been an artistic cycling athlete for 20 years. How did you get into this niche sport and what fascinates you about it?

I came to this sport by serendipity - there was a club in my hometown (Groß-Gerau) and as soon as I saw artistic cycling, I wanted to do it myself. I was six years old at the time and soon got fascinated by the variety of skills needed to achieve what initially feels impossible to do on a bike. That's also a big part of what still keeps me going today.

Are there certain physical or mental attributes that are particularly useful in artistic cycling?

In order to get to the top, high levels of flexibility, strength, endurance – and most importantly – coordination skills are necessary. Artistic cycling, however, is as much a mental sport as it is a physical one. Sometimes, to learn a new skill, thousands of repetitions are needed. This demands high levels of frustration tolerance. Also, especially at competitions, the athlete has to be extremely focused. Losing focus can lead to a fall or other faults that you cannot make up for anymore. The mental aspects are actually quite similar to what is useful for a scientist, I believe.

How often do you train, and how would you describe the training you do?

My training volume and focus depend on the time of the year, but generally I have three endurance training sessions, three sessions for flexibility and strength with a special focus on handstands, and three sessions for skill training on the bike per week, each session lasting between one and two hours. The skill training entails many repetitions of new figures, or already mastered ones you want to bring to perfection, as well as the whole competition routine.

How much does your training affect your everyday life?

I'm quite flexible with when and where I train because I have been very fortunate to gain access to several sports halls in the Frankfurt area. However, this does, of course, require some sacrifices, for example skipping certain social events.

You also take part in competitions. What have been your biggest successes so far?

My biggest successes so far have been earning three Vice European Champion & two Vice World Champion titles.

How important is winning for you?

I'm quite a process-oriented person. To me, winning is the culmination of and reward for hard work – and that always feels great! But if the process was great, for example you learnt a new figure, successively improved during training, performed well at a competition – then that's incredibly rewarding to me as well!

Friends of the Max Planck Institute for Brain Research

Thank you to the Friends

dear Friends of the MPI for Brain Research,

we wanted to express our sincere gratitude for your past support in furthering the efforts of our young scientists. Your contributions have allowed us to provide them with additional funds and awards, enabling them to make significant progress in their research.

Your continued support is essential in stimulating intellectual discourse and encouraging a passion for scientific exploration. It will help us foster talent, promote innovation, and interact with diverse communities.

Thank you again for your unwavering commitment.
We value your dedication to our mission and hope that we can count on your support once more.

Best wishes,
the Board of the Friends of the Frankfurt MPI for Brain Research

Company anniversaries

in August, **Andreas Umminger** celebrated his 40th anniversary at the MPI for Brain Research. Umminger was hired as a trainee under then managing director Wolf Singer. He later worked as a precision mechanic under the former managing director Heinz Wässle. In 2009, he was one of the first employees to join the new institute. Umminger has also been a member of the works council for many years. „I have had the pleasure of meeting many interesting people, and it has been a great experience," he said as he received his long service certificate from MPI for Brain Research Director Gilles Laurent.

Andreas Umminger

in November, **Belquis Nassim-Assir** celebrated her 25th company anniversary. Nassim-Assir started as a biological-technical assistant in 1998 in the department of Heinrich Betz in Niederrad. She has been working in the Schuman Lab since 2010. Her specialties in the department are histology, in situ, acute slices and electrophysiology. Beyond that, she also regularly delves deep into the secrets of protein biochemistry.

Selected Honors and Awards

Erin Schuman
@MPIBR / G. Laurent

Erin Schuman has been awarded the Brain Prize, the world's highest honor in neuroscience, for her pioneering work on the molecular mechanisms of brain development and plasticity.

Schuman was also elected to the American Academy of Arts and Sciences, one of the oldest and most prestigious honorary societies in the United States, recognizing excellence in the arts and humanities, business, public affairs, and science.

Grants and Fellowships

Hiroshi Ito has received his second ERC grant to study the neural mechanism of spatial navigation.

Hiroshi Ito

Vanessa Stempel has received a research award from the Behrens-Weise Foundation for her research on synaptic and neuronal network mechanisms of maladaptive behavioural plasticity after traumatic stress.

Vanessa Stempel

Sanjana Joshi has been awarded a Boehringer Ingelheim Fonds Fellowship for her research on the impact of early life environment on future social trajectories in the naked mole-rat.

Sanjana Joshi

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PhD graduations

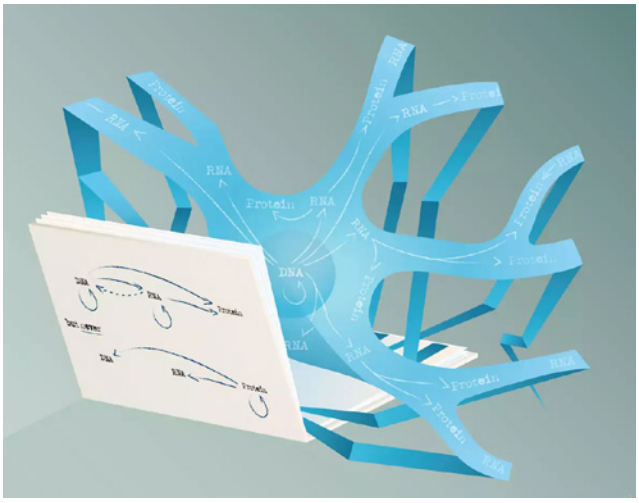
Congratulations to Danylo Batulin (Triesch Lab, IMPRS),
Kristina Desch (Schuman Lab), Jarrod Dowdall (Fries Lab/ Battaglia Lab),
Maria Tatiana Gallego-Flores (Laurent Lab), Jan Kirchner (Gjorgjieva Lab, IMPRS),
Sahil Loomba (Helmstaedter Lab), Christoph Miehl (Gjorgjieva Lab, IMPRS),
Irene Onorato (Vinck Lab, IMPRS), Juan Luis Riquelme (Gjorgjieva Lab, IMPRS),
Matteo Saponati (Vinck Lab, IMPRS), Shuai Shao (Gjorgjieva Lab, IMPRS),
Meike Sievers (née Schurr) (Helmstaedter Lab), and Benjamin Stauch (Fries Lab, IMPRS)
for completing their PhD projects in 2023!

Newly Elected Representatives

The MPI for Brain Research has elected a new works council to represent the interest of its employees and to collaborate with management on key decisions within the institute.

The newly elected works council members are:
Talha Ahmed, Florian Müller, Aleksandar Zivkovic (all IT Department),
Anett-Yvonn Loos, Marion Minde (both Animal Facility),
Kamonwan Thonphutsa (Administration), and
Andreas Umminger (Mechanical Workshop).

The current PhD and Postdoc Representatives are:
PhD Reps: **Petros Chalas** (Stempel Lab),
Sanjana Joshi (Barker Lab), and
Simone Rencken (Laurent Lab).
Postdoc Reps: **Alena Lemazina** (Barker Lab),
Eva Kaulich (Schuman Lab), and
Elena Kutsarova (Stempel Lab).



The central dogma decentralized.
Artwork by Max Planck Institute for Brain Research / Julia Kuhl

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Publications 2023

Barker, A. J.: **Acoustic communication: Deer mice join the chorus.** Current Biology (2023)

Bourke, A. M., Schwarz, A., & Schuman, E. M.: **De-centralizing the Central Dogma: mRNA translation in space and time.** Molecular Cell (2023)

Bourke, A. M., Spanò, T., & Schuman, E. M.: **A European perspective on structural barriers to women's career progression in neuroscience.** Nature Neuroscience (2023)

Campagner, D., Vale, R., Tan, Y. L., Iordanidou, P., Arocas, O. P., Claudi, F., Stempel, A. V., Keshavarzi, S., Petersen, R. S., Margrie, T. W., & Branco, T.: **A cortico-collicular circuit for accurate orientation to shelter during escape.** Nature (2023)

Fenk, L. A., Riquelme, J. L., & Laurent, G.: **Interhemispheric competition during sleep**. Nature (2023)

Giandomenico, S., & Schuman, E. M.: **Genetic manipulation and targeted protein degradation in mammalian systems: practical considerations, tips and tricks for discovery research.** FEBS Open Bio (2023)

Kesner, A. J., Mozaffarilegha, M., Rajamani, K. T., Arima, Y., Harony-Nicolas, H., Hashimotodani, Y., Ito, H., Song, J., & Ikemoto, S.: **Hypothalamic Supramammillary Control of Cognition and Motivation.** J. Neurosci (2023)

Ketkar, M. D., Shao, S., Gjorgjieva, J., & Silies, M.: **Multifaceted luminance gain control beyond photoreceptors in Drosophila.** Curr. Biol (2023)

Knobloch, J. A., Laurent, G., & Lauterbach, M. A.: **STED microscopy reveals dendrite-specificity of spines in turtle cortex.** Prog Neurobio (2023)

Lu, Y., & Singer, W.: **Dynamic signatures of the Eureka effect: an EEG study.** Cerebral Cortex (2023)

Meier-Credo, J., Heiniger, B., Schori, C., Rupprecht, F., Michel, H., Ahrens, C. H., & Langer, J.: **Detection of Known and Novel Small Proteins in Pseudomonas stutzeri Using a Combination of Bottom-Up and Digest-Free Proteomics and Proteogenomics.** Anal. Chem (2023)

Miehl, C., Onasch, S., Festa, D., & Gjorgjieva, J.: **Formation and computational implications of assemblies in neural circuits.** J Physiol (2023)

Riquelme, J. L., Hemberger, M., Laurent, G., & Gjorgjieva, J.: **Single spikes drive sequential propagation and routing of activity in a cortical network.** eLife (2023)

Sauer, A., Grent-'t-Jong, T., Zeev-Wolf, M., Singer, W., Goldstein, A., & Uhlhaas, P. J.: **Spectral and phase-coherence correlates of impaired auditory mismatch negativity (MMN) in schizophrenia: A MEG study.** Schizophrenia Research (2023)

Schroeder, A., Pardi, M. B., Keijser, J., Dalmay, T., Groisman, A. I., Schuman, E. M., Sprekeler, H., & Letzkus, J. J.: **Inhibitory top-down projections from zona incerta mediate neocortical memory. Neuron (2023)**

Schuhmacher, J. S., tom Dieck, S., Christoforidis, S., Landerer, C., Gallesio, J. D., Hersemann, L., Seifert, S., Schäfer, R., Giner, A., Toth-Petroczy, A., Kalaidzidis, Y., Bohnsack, K. E., Bohnsack, M. T., Schuman, E. M., & Zerial, M.: **The Rab5 effector FERRY links early endosomes with mRNA localization. Mol Cell (2023)**

Song, K., Feng, Z., & Helmstaedter, M.: **High-contrast en bloc staining of mouse whole-brain and human brain samples for EM-based connectomics.** Nat. Methods (2023)

Sun, C., Desch, K., Nassim-Assir, B., Giandomenico, S. L., Nemcova, P., Langer, J. D., & Schuman, E. M.: **An abundance of free regulatory (19 S) proteasome particles regulates neuronal synapses. Science (2023)**

Sun, C., & Schuman, E. M.: **A multi-omics view of neuronal subcellular protein synthesis.** Curr. Opin.Neurobiol. (2023)

van Oostrum, M., Blok, T. M., Giandomenico, S. L., Dieck, S. T., Tushev, G., Fürst, N., Langer, J. D., & Schuman, E. M.: **The proteomic landscape of synaptic diversity across brain regions and cell types.** Cell (2023)

Weber, R., Junek, S., & Heckel, A.: **A Blue Light and Two-Photon Activatable Rhodamine Fluorophore.** Chemistry (2023)

Woo, T., Liang, X., Evans, D. A., Fernandez, O., Kretschmer, F., Reiter, S., & Laurent, G.: **The dynamics of pattern matching in camouflaging cuttlefish.** Nature (2023)

Yiling, Y., Klon-Lipok, J., & Singer, W.: **Joint encoding of stimulus and decision inmonkey primary visual cortex.** Cereb Cortex (2023)

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