Bernstein Network Computational Neuroscience

Bernstein Newsletter

Recent Publications

The End of a Dogma – “Felt” Causality Judgments – Decision Maker in the Brain – Seeing Outside of the Visual Field

Meet the Scientist

Ulrich Egert

News and Events

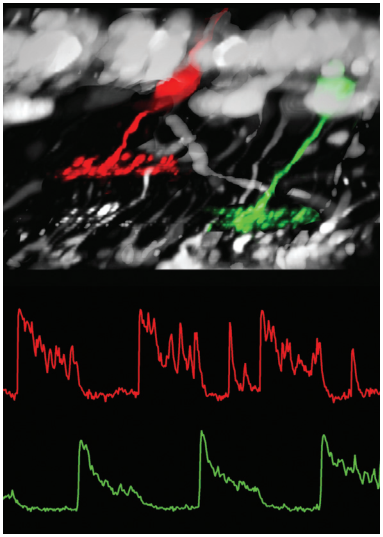
Personalia – Bernstein Conference 2012 – BFSD Inauguration – Leibniz Prize for Onur Güntürkün – Newly granted D-USA Collaborations – Call for Proposals: Bernstein Award 2013

03/2013

The end of a dogma

To make information transmission to the brain reliable, the retina first has to “digitize” the image. Until now, it was widely believed that this step takes place in the retinal ganglion cells, the output neurons of the retina. Scientists in the lab of Thomas Euler at the University of Tübingen, the Werner Reichardt Centre for Integrative Neuroscience and the Bernstein Center Tübingen were now able to show that already bipolar cells can generate “digital” signals. At least three types of mouse BC showed clear evidence of fast and stereotypic action potentials, so called “spikes”. These results show that the retina is by no means as well understood as is commonly believed.

The retina in our eyes is not just a sheet of light sensors that—like a camera chip—faithfully transmits patterns of light to the brain. Rather, it performs complex computations, extracting several features from the visual stimuli, e.g., whether the light intensity at a certain place increases or decreases, in which direction a light source moves or whether there is an edge in the image. To transmit this information reliably across the optic nerve—acting as a kind of a cable—to the brain, the retina reformats it into a succession of stereotypic action potentials—it “digitizes” it. Classical textbook knowledge holds that this digital code—similar to the one employed by computers—is applied only in the retina’s ganglion cells, which send the information to the brain. Almost all other cells in the retina were believed to employ graded, analogue signals. But the Tübingen scientists could now show that, in mammals, already the bipolar cells, which are situated right after the photoreceptors within the retinal network, are able to work in a “digital mode” as well.



Some bipolar cells in the mouse retina generate digital action potentials (in red) while others use only graded potentials for information propagation (green).

Using a new experimental technique, Tom Baden and colleagues recorded signals in the synaptic terminals of bipolar cells in the mouse retina. Based on the responses of these cells to simple light stimuli, they were able to separate the neurons into eight different response types. These types closely resembled those expected from earlier physiological and anatomical studies. But surprisingly, the responses of the fastest cell types looked quite different than expected: they were fast, stereotypic and occurred in an all-or-nothing instead of a graded fashion. All these are typical features of action potentials. Such “digital” signals had occasionally been observed in bipolar cells before, but these were believed to be rare exceptional cases. Studies from the past two years on the fish retina had already cast doubt on the long-held belief that bipolar cells do not spike. The new data from Tübingen clearly show that these “digital” signals are systematically generated in certain types of mammalian bipolar cells. Action potentials allow for much faster and temporally more precise signal transmission than graded potentials, thus offering advantages in certain situations. The results from Tübingen call a widely held dogma of neuroscience into question—and open up many new questions.

Baden T, Berens P, Bethge M, Euler T (2012): Spikes in mammalian bipolar cells support temporal layering of the inner retina. Current Biology, 23 (1):48-52.

Causality judgments can be “felt”

A glass of milk is knocked over by a hand. The causality judgment arises from fundamental visual processes, as demonstrated by researchers at Bernstein Center Berlin.

We often make causality judgments when we perceive successive visual events, such as “the glass was knocked over by the hand”. A research team led by Martin Rolfs at the Bernstein Center and the Humboldt University of Berlin, has now revealed that these judgments arise from fundamental visual processes—without involving higher cognitive reasoning. They showed that, with prolonged viewing of causal events, an adaptation process takes place that resembles those observed in the perception of size, color, or motion of an object. The result ends a long-standing debate about the level at which higher-order properties of visual events are computed.

The hand hits a glass, it falls over, and the milk spills over the kitchen table. The observer is immediately sure that it was the clumsy hand that caused this little mishap. Until now, researchers have disagreed whether this causality judgment depends on higher brain functions such as cognitive reasoning, or whether it emerges at an earlier stage during perception, similar to the evaluation of size, color, or motion of an object. An international team of researchers including Martin Rolfs at the Bernstein Center Berlin, Michael Dambacher at the University of Konstanz, and Patrick Cavanagh at the University Paris Descartes has now found the answer to this question: Rapid causality judgments are made at the level of visual perception.

In their study, participants watched a repeating video clip in which one disc moved towards another, and the latter disc started to move after being touched by the first. Instead of seeing one disc stopping and the next disc starting to move, both events are seen as one continuous action where the first disc launches the second—similar to colliding billiard balls. Rolfs and his colleagues have now demonstrated that after the repeated observation of these collision scenes, an adaption process occurs: Subsequent interactions involving two discs are less likely to be seen as causal. Similar adaptation aftereffects are known after the repeated perception of basic properties such as color: After looking at an orange light for a short while, you will see a light blue spot when looking at a white wall. These visual aftereffects suggest a habituation of the populations of neurons in those parts of the brain that analyze these specific qualities.

The main result of the study: The adaptation to collision events was specific to the location where the collisions had been seen. Moreover, when the eyes moved, these adapted locations moved with the eyes, just as the color afterimage shifts as you move the eyes around. According to the researchers, these results show that the neuronal structures involved in the judgment of causality must be part of the early visual process as higher level cognitive processes do not show this specificity to eye position. Main investigator Rolfs: “The result moves functions that have previously been thought of as achievements of cognitive deduction into the realm of basic perception, with implications for fields as diverse as philosophy, psychology, and robotics.”

Rolfs M, Dambacher M, Cavanagh P (2013): Visual adaption of the perception of causality. Current Biology, 23 (3): 250-254.

Who decides in the brain?

Whether in society or nature, decisions are often the result of complex interactions between many factors. Because of this it is usually difficult to determine how much weight the different factors have in making a final decision. Neuroscientists face a similar problem, since decisions made by the brain always involve many neurons. Within a collaboration of the University of Tübingen and the Max Planck Institute for Biological Cybernetics, supported within the framework of the Bernstein Network, researchers lead by CIN professor Matthias Bethge have now shown how the weight of individual neurons in the decision-making process can be reconstructed despite interdependencies between the neurons.

When we see a person on the other side of the street who looks like an old friend, the informational input enters the brain via many sensory neurons. But which of these neurons are crucial in passing on the relevant information to higher brain areas, which will decide who the person is and whether to wave and say 'hello'? A research group lead by Matthias Bethge has now developed an equation that allows us to calculate to what degree a given individual sensory neuron is involved in the decision process.

To approach this question, experimental researchers have so far considered the information that an individual sensory neuron carries about the final decision. Just as an individual is considered suspicious if he or she is found to have insider information about a crime, those sensory neurons whose activity contains information about the decision are presumed to have played a role in reaching it. The problem with this approach is that neurons—much like people—are constantly communicating with each other. A neuron which itself is not involved in the decision may simply have received this information from a neighboring neuron, and "join the conversation". Actually, the neighboring cell sends out the crucial signal transmitted to the higher decision areas in the brain. The new formula that has been developed by scientists addresses this by accounting not just for the information in the activity of any one neuron but also for the communication that takes place between them. This formula will now be used to determine whether only a few neurons that carry a lot of information are involved in the brain's decision process, or whether the information contained in many neurons gets combined. In particular, it will be possible to address the more fundamental question of for which decisions the brain uses information in an optimal way, and for which decisions it is processing suboptimally.

Large flocks of birds can rapidly change their direction without it being clear how such a decision develops, and whether some birds have a larger influence on it than others. Since the behavior of any one bird depends on that of its neighbors, answering this question is rather complicated. Neuroscientists face a similar problem when wanting to find out which neurons in a large network caused a particular decision.

Haefner R M, Gerwinn S, Macke J H, Bethge M (2013): Inferring decoding strategies from choice probabilities in the presence of correlated variability. Nature Neuroscience, 16 (2): 235-242.

Out of Sight, out of Mind?

Even when they are not directly in sight, we are aware of our surroundings: So it is that when our eyes are fixed on an interesting book, for example, we know that the door is to the right, the bookshelf is to the left and the window is behind us. However, research into the brain has so far concerned itself predominantly with how information from within our field of vision is coded in the visual cortex. Therefore, it was not known how the brain codes our surroundings beyond the field of view from an egocentric perspective (that is, from the point of view of the observer).

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In the latest issue of the renowned journal Current Biology, Andreas Schindler und Andreas Bartels, scientists at the Werner Reichardt Center for Integrative Neuroscience of the University of Tübingen, present for the first time direct evidence of this kind of spatial information in the brain.

The participants in their study found themselves in the center of a virtual octagonal room, with a unique object in each corner. As the brain's activity was monitored by means of functional magnetic resonance imaging, the participants stood in front of one corner and looked at its object. Now they were instructed to determine the position of a second randomly chosen object within the room, relative to their current perspective (for example, the object behind them). After a few trials, the participant turned around, so that the next object was brought into the field of view, and the task started over. The whole procedure was repeated until every object had been looked at once.

The scientists discovered that patterns of activity in the parietal cortex code the participant's egocentric position, that is, the relative position to his or her surroundings. The spatial information discovered there proved to be independent of the particular object, its absolute position in the room or that of the observer—that is, it encoded egocentric spatial information on the three-dimensional surroundings. This result turns out to be particularly interesting because damage to the brain in the parietal cortex can lead to serious disruption of egocentric spatial awareness. Hence, it is difficult for patients suffering from optical ataxia to carry out coordinated grasping movements. Lesions in the parietal cortex can also lead to a symptom called spatial neglect, where patients have difficulties in perceiving their surroundings on the side opposite to the lesion. The brain areas identified in the present study coincided precisely with the areas of brain damage in such patients and provide for the first time insights regarding their function in the healthy brain.

Schindler A, Bartels A (2013): Parietal cortex codes for egocentric space beyond the field of view. Current Biology, 23 (2): 177-182.

Ulrich Egert

The device that Ulrich Egert holds between his fingers looks like a cross breed of a computer component and a petri dish. Numerous electrodes cover its bottom and seem to meet in the middle. “The little plastic ring on top,” Egert explains, “is designed to contain a growth medium for the nerve cells that are supposed to grow and be investigated in the dish”. The device constitutes an interface between biology and technology, and was originally developed by the group of Andreas Hierlemann at ETH Zurich. With such a recording chamber—also called microelectrode array, or MEA, in short—nerve cells can be very closely examined. “With these MEAs, we can measure at more than 11,000 locations, distributed over about four square millimeters, how the electrical activity of neurons in a network unfolds,” states Ulrich Egert. He is a biologist with an affection for technological developments. Since 2008, he is Professor for Biomicrotechnology at Albert Ludwigs University Freiburg, and acts as coordinator of the Bernstein Focus Neurotechnology Freiburg-Tübingen and founding director of the Excellence Cluster BrainLinks-BrainTools.

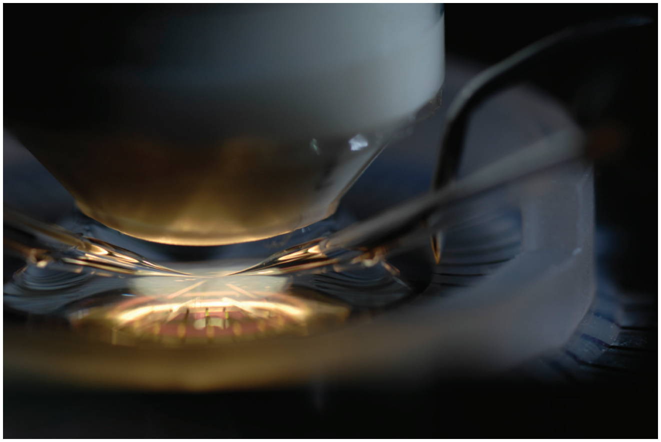
“For my doctoral thesis, I needed a recording system that was able to measure the activity of individual cells in neural networks, but a suitable device was not commercially available at the time,” said Egert. Therefore, together with specialists from the Natural and Medical Sciences Institute (NMI) at the University of Tübingen, he pondered how to build a technical system for the biological question. “Being a biologist, I first had to learn to think like an engineer. That helped a lot in solving problems and exchanging ideas,” so Egert. Until today, the collaboration with his colleagues at NMI Reutlingen, with the company Multi Channel Systems, a close collaborator of NMI in manufacturing and systems development of MEAs, and engineers at the IMTEK of the University of Freiburg is instrumental in driving further technological advances in a variety of recording systems.

Just like Ulrich Egert himself, who acts as a moderator between technology and biology, his research is also located at the crossroads between theory and experiment. The neural networks that Egert investigates are grown according to defined specifications. The number of nerve cells, their motility and the density of the network can be adjusted in cell cultures. “We simplify many features of natural nervous tissue. This allows us to determine which characteristics of the network are important for its activity dynamics and which are not. Compared to simulations, our models, however, are closer to biological reality but less complex than intact tissue”, said Egert. Together with theoreticians like Stefan Rotter and Arvind Kumar from the Bernstein Center Freiburg, he tests the predictions of theoretical models under controlled biological conditions. In this way, we learn about the fundamental properties of neural networks. Not only that: The causes of specific disease-related neuronal dysfunctions can also be studied using this approach.

About one percent of all people suffer from epilepsy – one of the most common groups of neurological disorders with a whole range of different causes. Common to all forms of epilepsy is the phenomenon that a group of nerve cells engages in unnaturally synchronous activity, which, in consequence, prevents information processing. Together with colleagues like Carola

Haas and Arvind Kumar, Egert examines how such seizure activity arises. Clues towards this question can be gathered by studying electrical activity of thin brain slices using MEAs. These basic results are further investigated in animal models of epilepsy. One of the findings in their experiments has been the insight that epileptic activity seems to require an interaction between the epileptic focus and brain areas outside of it to “ignite”.

In the long run, such studies—besides gaining a fundamental understanding of the disease—will provide the basis for the development of new therapies. In a number of patients, surgery or drugs fail to suppress seizures. To find a way to help these patients, the scientists are working on systems that can predict the probability for upcoming seizures based on the brain activity that they measure. If successful, this would allow specific interventions to prevent the seizure—for instance, by electrical stimulation. Most prediction systems available today, however, are still quite unreliable. “It is not enough to predict that a seizure will occur at some point within the next 24 hours,” Egert dampens excessive hopes. Yet, the scientists have already succeeded to reliably detect seizures in mice up to ten seconds in advance—a time window that would suffice to initiate a quick intervention like electrical stimulation.



A microelectrode array (MEA): An array of electrodes at the bottom measures the activity of nerve cells, while the plastic ring on top supplies the cells with a growth medium.

The therapeutic use of electrical stimulation, as it is already successfully applied during deep brain stimulation in Parkinson‘s patients, however, is a tricky business. To gain a better understanding of how deep brain stimulation works, research on networks grown on chips can be very helpful. “An electrode implanted into the brain affects about the same number of cells as our MEAs.” Therefore, MEAs are well suited to examine how electrical stimulation effects induction and propagation of changes of network activity, and how these interact with ongoing activity. The aim of this research is to specifically influence the network’s activity state, such that it can be redirected into a normal regime.

The new Cluster of Excellence “BrainLinks-BrainTools”, in which, besides Egert, twelve other members of the Bernstein Center Freiburg are involved, is providing a huge boost to such research approaches that integrate technology, medicine and biology. Egert is convinced that “the cluster will massively strengthen the field of neurotechnology, with respect to human resources as well as the necessary technologies”. The cluster focuses on the development of brain-computer interfaces and on improvements of devices for deep brain stimulation, as well as other implants and prostheses. In this endeavor, Egert’s technical expertise and his ability to translate between disciplines will most certainly be highly welcome.

Personalia

Ernst Bamberg (BFNT Göttingen, MPI of Biophysics Frankfurt) was honored with the K.J. Zülch Prize 2012 of the Gertrud Reemtsma Foundation for his contribution to the establishment of optogenetics.
www.nncn.de/nachrichten-en/zuelchpreis2012/

Niels Birbaumer and **Surjo Soekadar (**both BFNT Freiburg-Tübingen, University of Tübingen) received the BCI Research Award 2012. **Niels Birbaumer** was also honored with the Fürst Donnersmarck Foundation Honorary Award 2012.
www.nncn.de/nachrichten-en/soekadarbirbaumer/
www.nncn.de/nachrichten-en/donnersmarkehrenpreis/

Daniel Bölinger (BCCN Munich, MPI of Neurobiology Martinsried) received the Young Scientist Award 2013 of the MPI of Neurobiology.
www.nncn.de/nachrichten-en/youngscientistaward/

Roland Fleming (D-USA Collaboration, BCCN Tübingen, University of Gießen) coordinates the newly funded Marie Curie Initial Training Network "Perceptual Representation of Illumination, Shape and Materials (PRISM)".
www.nncn.de/nachrichten-en/flemingeuprojekt/

Andreas Heinz (BCCN Berlin, BFNL Complex Human Learning, Charité Berlin) was elected member of the mathematical and natural sciences class in the Academy of Sciences and Literature.
www.nncn.de/nachrichten-en/andreasheinz/

Archana Jalligampala from the laboratory of Eberhart Zrenner (BCCN and University of Tübingen) and **Dennis Plachta** from the laboratory of Thomas Stieglitz (BCF and University of Freiburg) received the poster awards of the "International Conference on Neuroprosthetic Devices 2012".
www.nncn.de/nachrichten-en/icnpdposterpreise2012/

Klaus-Robert Müller (BFNT and BCCN Berlin, BCOL Neurovascular Coupling, D-J Collaboration, TU Berlin) was elected member of the German Academy of Sciences Leopoldina.
www.nncn.de/nachrichten-en/muellerleopoldina/

Alexander Sartorius (BCCN Heidelberg-Mannheim, ZI Mannheim) and his PhD student **Sarah Biedermann** were awarded the Hans Heimann Prize 2012 for Biedermann's dissertation.
www.nncn.de/nachrichten-en/hansheimannpreis2012/

Constance Scharff (BFNL Sequence Learning, FU Berlin) was elected new member of Berlin-Brandenburg Academy of Sciences and Humanities (BBAW).
www.nncn.de/nachrichten-en/bbaw/

Vanessa Schmitt received the Sponsorship Prize 2012 of the German Primate Center for her dissertation in the laboratory of Julia Fischer (BCCN, DPZ and University of Göttingen).
www.nncn.de/nachrichten-en/dpzfoerderpreis2012/

Martin Rolfs (HU Berlin) and **Klaus Wunderlich** (LMU Munich) will establish new DFG-funded Emmy Noether Research Groups at the Bernstein Centers in Berlin and Munich, respectively.
www.nncn.de/nachrichten-en/emmynoetherrolfs/
www.nncn.de/nachrichten-en/klauswunderlich/

Hermann Wagner (BCOL Temporal precision, RWTH Aachen University) received the Ornithologists Award of the German Ornithologists' Society (DO-G).
www.nncn.de/nachrichten-en/ornithologenpreis/

Bernstein Conference 2012

The 8th Bernstein Conference took place from September 12-14, 2012 in Munich. The conference was held directly after the INCF Congress "Neuroinformatics 2012" and was organized by the Bernstein Center Munich under the direction of Andreas Herz. With approximately 550 registrations, it drew the largest number of participants so far. Conference abstracts were published in Frontiers in Computational Neuroscience.
www.frontiersin.org/events/Bernstein_Conference_2012/1661

Bernstein Award 2012

As in previous years, the first highlight of the conference was the prize giving ceremony of the Bernstein Award. Dr. Christiane Buchholz (German Federal Ministry of Education and Research) presented the award to Tim Vogels (École Polytechnique Fédérale Lausanne, Switzerland). With the prize money of up to 1.25 Mio €, he will establish his own research group at the Humboldt-Universität and Bernstein Center Berlin.

1st Braitenberg Award - the Golden Neuron

Subsequent to the Bernstein Award prize giving ceremony, the first Valentino Braitenberg Award was presented to Moshe Abeles (Bar Ilan University, Israel). The award is conferred in memory of the Tübingen brain scientist Valentino Braitenberg, who passed away in 2011, and recognizes outstanding researchers who have contributed significantly to the understanding of brain function and which have or will profoundly influence brain research.

1st Braitenberg Award.
F. l. t. r.: Ad Aertsen (head of the award comitee), Carla Braitenberg (daughter of V. Braitenberg), Moshe Abeles, Simone Cardoso (Bernstein Coordination Site).

Lecture for the general public

In order to inform scientists as well as interested laymen about latest neuroscience findings, Onur Güntürkün (BFNL Sequence Learning, Ruhr-Universität Bochum) gave a talk in German language about the topic: "Intelligence without cerebral cortex? How birds found their own way to cognitive top performances."

Brains for Brains Awards

For the third time, the Bernstein Association for Computational Neuroscience awarded Brains for Brains Young Researchers' Computational Neuroscience Awards. This year's awardees were Jeffrey S. Seely (Columbia University, New York, USA) and Michael Eickenberg (Saclay, INRIA, France). The awards were made possible by donations by the companies Multi Channel Systems MCS GmbH, Brain Products GmbH and neuroConn.

Travel Fellows from the US-American Sloan Swartz Centers

Within the exchange program between the Bernstein Network and the Sloan-Swartz Centers for Theoretical Neurobiology, the Bernstein Center Munich funded the participation of three American PhD students / postdocs—Robbe Goris (Postdoc, NYU), Marjena Popovic (PhD student, Brandeis University) und Haim Jonathan Dar (PhD student, Brandeis University)—in the Bernstein Conference 2012.

NeuroVision Film Contest

For the second time, a short film competition was held during the Bernstein Conference. Candidate films covered themes from brain research in a generally understandable form. Winner of the jury award for the most creative handling of a neuroscientific topic and the audience award was the film by Guillaume Dumas and Luc Halard. The second jury award for the film of greatest informational value went to Anna Stöckl.
www.nncn.de/nachrichten-en/bernsteinconference2012/

Bernstein Facility Simulation and Database Technology inaugurated

The Bernstein Facility is part of the “Simulation Laboratory Neuroscience” at Forschungszentrum Jülich, which was inaugurated with a workshop on January 14-15, 2013, and is funded by the Helmholtz Society within the framework of the Helmholtz portfolio theme “Supercomputing and Modelling for the Human Brain (SMHB)” and the Jülich Aachen Research Alliance (JARA).

Under the direction of Abigail Morrison, neuroscientists, physicians, computer scientists, mathematicians and physicists work intensively together in order to optimize the use of computer simulations of the brain for supercomputers.

Upon a proposal by the Forschungszentrum Jülich and by decision of the Bernstein Project Committee, the new facility is integrated into the Bernstein Network. The facility offers the network expertise, assistance and consulting services in developing software for supercomputing, integrating new data into large-scale models and in applying for computing times at Forschungszentrum Jülich.

“In this way, Computational Neuroscience in Germany is brought even further towards supercomputing,” said Sebastian M. Schmidt, member of the board of directors of the Forschungszentrum Jülich, at the opening ceremony.
www.nncn.de/nachrichten-en/bfsderoeffnung/

Leibniz Prize for Onur Güntürkün

Onur Güntürkün (BFNL Sequence Learning, Ruhr-Universität Bochum) was selected by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) as one of eleven Gottfried Wilhelm Leibniz Prize Winners 2013.

He receives the Leibniz Prize as one of the pioneers and most important representatives of a biology-based psychology. His fundamental objective is to explore how perception, thinking and acting are mediated by the brain. His spectrum of research topics comprises such diverse topics like motor learning, anxiety and decision-making processes, or risk-taking behavior and kissing. Güntürkün’s work is characterized by a combination of psychological, biological and neuroanatomical issues with concepts and findings from comparative behavioral- and neurosciences.

The Gottfried Wilhelm Leibniz Prize is annually awarded by the DFG since 1986. With up to 2.5 million €, it is the most highly remunerated German research award.
www.nncn.de/nachrichten-en/leibnizpreis2013/

Third round of D-USA Collaborations in CNS granted

In 2009, the funding measure "Germany-USA Collaborations in Computational Neuroscience" was jointly established by the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, the National Science Foundation (NSF) and the National Institutes of Health (NIH) in order to support transnational collaborative projects. On the American side, it is part of the "Collaborative Research in Computational Neuroscience (CRCNS)" program, on the German side, it is a component of the Bernstein Network. From 2012, the following five projects will be supported as part of the third funding round:

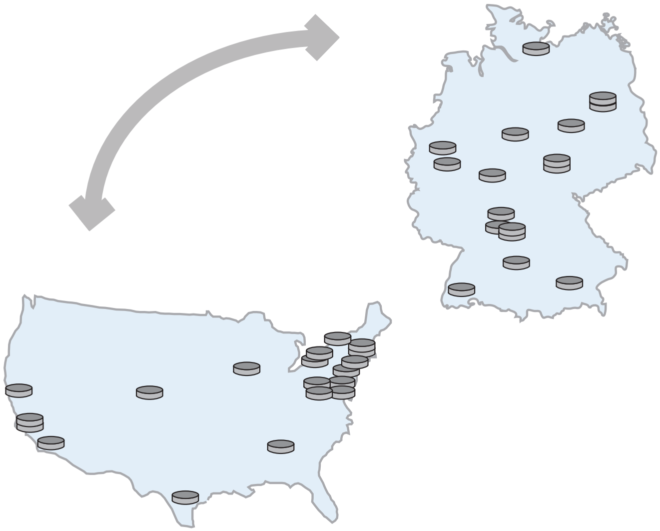
- **Effects of activity-dependent changes of chloride concentration on cerebellar function**, Peter Jedlicka (Frankfurt), Fidel Santamaria (San Antonio)
- **Exploring large scale functional connectivity in the human brain: From bench to bedside**, Lutz Leistritz (Jena), Axel W. E. Wismueller (Rochester)
- **Unravel CNS regeneration—from fact extraction to experimental design**, Barbara Grimpe (Düsseldorf), Lawrence Hunter (Aurora)
- **Computational and neural mechanisms of inference over decision-structure**, Stefan Kiebel (Jena), John O'Doherty (Pasadena)
- **Somatic sodium channels and temporal precision of action potentials**, Andreas Neef (Göttingen), Matthew Xu-Friedman (Buffalo)

www.nncn.de/nachrichten-en/dusacollaborations2012/

8th call for proposals: Bernstein Award 2013

In 2013, the German Federal Ministry of Education and Research intends to confer the eighth annual Bernstein Award to an excellent young scientist with outstanding research ideas in the field of Computational Neuroscience. The "Bernstein Award for Computational Neuroscience" is endowed with up to 1.25 Mio. € for a period of five years, and allows young scientists of any nationality to establish an independent research group at a German university or research institution. Application deadline for the year 2013 is April 15, 2013.

www.nncn.de/nachrichten-en/bpcn2013/



Upcoming Events

Date	Title	Organizers	URL
Mar. 6-10, 2013, Delmenhorst	1st Bernstein Sparks Workshop “Cortical Neurointerfaces“	K. Pawelzik (BGCN Bremen, BFNL Sequence Learning), A. Kreiter (BGCN Bremen), S. Paul, W. Lang, D. Rotermund, A. Janssen	www.nncn.de/termine-en/nwg2013
Mar. 11-15, 2013, Berlin	Brain Awareness Week in Berlin	M. Franke (BCCN Berlin), I. Dose (Berlin School of Mind and Brain)	www.baw-berlin.de
Mar. 13-16, 2013, Göttingen	NWG 2013 with Bernstein Network Contributions	German Neuroscience Society	www.nncn.de/termine-en/nwg2013
Aug. 3-4, 2013, Bejing, China	Workshop: “Intelligence Science“	R. A. Koene, X. Tang, J-D Zucker, U. Ernst (BPCN 2010, BGCN Bremen) as programm chair	www.nncn.de/termine-en/intelligencescience
Aug. 25-29, 2013, Bremen	European Conference on Visual Perception	U. Ernst (BPCN 2010, BGCN Bremen), C. Grimsen, D. Wegener, A. Janssen	www.nncn.de/termine-en/ecvp2013
Sept. 1-6, 2013, Zürich, Switzerland	G-Node Summer School: Advanced Scientific Programming in Python	N. Chiapolini, Z. Jedrzejewscy-Szmek (G-Node), T. Zito (BCCN Berlin, G-Node)	www.python.g-node.org/wiki
Sept. 24-27, 2013, Tübingen	Bernstein Conference 2013 Workshops: Sept. 24-25, 2013 Main Conference: Sept. 25-27, 2013	M. Bethge (BPCN 2006, BCCN Tübingen), J. Macke, J. Lam, F. Wichmann (all three BCCN Tübingen)	www.bernstein-conference.de
Oct. 6-11, 2013, Freiburg	BCF/NWG Course: Analysis and Models in Neurophysiology	S. Rotter, U. Egert, A. Aertsen, J. Kirsch (all Bernstein Center Freiburg), S. Grün (BCCN Berlin, D-J Collaboration)	www.bcf.uni-freiburg.de/events/conferences-workshops/20131006-nwgcourse

The Bernstein Network

Chairman of the Bernstein Project Comittee: Andreas Herz

The National Bernstein Network Computational Neuroscience (NNCN) is a funding initiative of the Federal Ministry of Education and Research (BMBF). Established in 2004, it has the aim of structurally interconnecting and developing German capacities in the new scientific discipline of computational neuroscience and, to date, consists of more than 200 research groups. The network is named after the German physiologist Julius Bernstein (1835–1917).

Imprint

Published by:
Coordination Site of the
National Bernstein Network Computational Neuroscience
www.nncn.de, info@bcos.uni-freiburg.de

Text, Layout:
Mareike Kardinal, Simone Cardoso de Oliveira, Kerstin Schwarzwälder (News and Events)

Editorial Support:
Coordination assistants in the Bernstein Network

Design: newmediamen, Berlin

Print: Elch Graphics, Berlin

Title image: A glass of milk is knocked over by a hand. The causality judgment arises from fundamental visual processes *(see article p. 5).*

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