Bernstein Network for Computational Neuroscience

Bernstein Newsletter

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10/2008

Tinnitus in a mathematical model

Tinnitus, i.e. the perception of phantom sounds in the absence of an acoustic stimulus, can be caused by hearing loss. Under which circumstances does this occur? Which mechanisms are involved? Roland Schaette and Richard Kempter from the Bernstein Center for Computational Neuroscience and the Humboldt University in Berlin found answers to these questions using computer simulations.

Tinnitus arises in the auditory pathway of the central nervous system. In animal studies, tinnitus-like activity of neurons – so-called hyperactivity – has been found in the dorsal cochlear nucleus (DCN), the first processing stage for acoustic information in the brain. Neurons of the DCN receive input directly from the auditory nerve and react to it with neuronal discharges – one says, they 'fire'. Even without any acoustic signals, however, cells of the auditory nerve and the auditory pathway are still active and fire spontaneously at a certain rate, the 'spontaneous firing rate' – comparable to the background noise produced by electrical devices. Various studies suggest that hearing loss can increase the spontaneous firing rate of nerve cells in the DCN and that animals perceive this as a kind of tinnitus. In a theoretical model, Schaette and Kempter explain the link between tinnitus and hearing loss for the first time.

After hearing loss, auditory nerve fibers and neurons along the auditory pathway only react to loud sounds. For soft sounds below the increased hearing threshold, the neurons fire spontaneously. Many neurons thus show an overall reduced activity. This could trigger a mechanism called 'homeostatic plasticity', which ensures that neuronal activity is neither too high nor too low. If the average activity of the neurons is too low, homeostasis enhances their sensitivity. As the scientists could show in their model, neurons then react more strongly to the activity of the auditory nerve; in particular the spontaneous firing rate increases.

Moreover, Schaette and Kempter also demonstrated in their model that this mechanism only applies to certain types of neurons – for example to type III neurons of the DCN. These neurons are primarily activated by sound. Therefore, their average activity initially drops after hearing loss and the mechanism described above is initiated: homeostasis has to counteract this loss in activity and elevate firing rates, which then also leads to an increased spontaneous firing rate. In contrast, type IV neurons are either activated or inhibited by sound, depending on sound intensity. Hearing loss only has a minor effect on their average activity. Accordingly, these neurons are less susceptible to hyperactivity. This prediction of the Berlin scientists' model corresponds with experimental findings: In rodents type III neurons dominate in the DCN. Here, tinnitus-like hyperactivity has been observed. In contrast, such an activity has not yet been found in cats, whose DCN mainly holds type IV neurons.

'Our studies have corroborated the association between hearing loss and tinnitus, which could provide a foundation for new treatment strategies,' Kempter states. 'Our hope would be that a tailored exposure to acoustic signals over an appropriate frequency range could help to drive back the hyperactivity caused by hearing loss'.

Source: Schaette R, Kempter R: Europ J Neurosci 2006; 23:3124-38.
Schaette R, Kempter R: Hear Res 2008; 240:57-72.

New cells in the brain

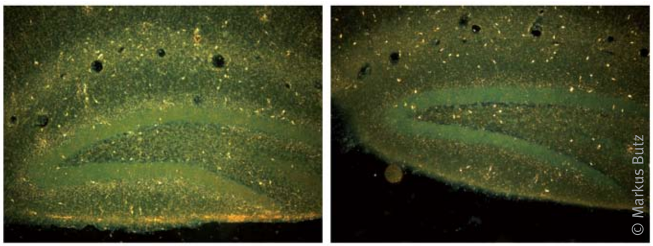
The brain changes continuously throughout life. If we remember something this is due to the fact that the event in question has left traces in the brain. The connections between the cells are continuously reorganized and newly created cells integrated into the network. The role played by the generation of new nerve cells in the brain in the reorganization of neuronal structures has been investigated by Markus Butz of the BCCN and the University of Göttingen together with Arjen van Ooyen from Amsterdam and other colleagues from Bielefeld. These scientists have shown that additional brain cells not necessarily increase the ability to learn. On the contrary, too many new cells might even hinder the creation of new connections within the brain.

Many cognitive processes depend on the brain‘s continuous creation of new cells. For that reason, scientists have hitherto assumed that new cells basically increase the reorganization capacity of the brain and thus the ability to learn. This positive influence of new cells on the restructuring of the brain, however, apparently seems to have limitations. As the scientists working with Butz have now shown for the first time ever, too many new brain cells can even hamper the generation of new connections. The team examined the connection between cell division and the generation of neuronal connections in the hippocampus of gerbils. The hippocampus is responsible for the transfer of information into the long-term memory. It stands out as a site of high cell division and neuronal reorganization throughout life.

Gerbils raised in isolation and with very little outside stimuli develop behavioural disorders: they are fearful and exhibit stereotypical behavioural patterns. This is associated with anatomical anomalies in the structure of the brain; not enough new connections are being created. This lack of structural reorganization is caused by too much cell division. As the scientists have shown, the structural reorganization in the brains of these animals can be increased to an almost normal level if cell division is artificially decreased. They investigated the mechanism which causes this impairment to neuronal reorganization caused by excessive neuronal cells by using a computer model.

Free neuronal contacts are a precondition for the neuronal network to reorganize. New cells only recently generated by cell division produce so-called „neurotrophic factors“ which attract such contacts. In this way, the new cells are integrated into the network. However, if there are too many new cells, all available contacts are occupied – that is hampering a subsequent reorganization between existing cells. This results in a faulty organization of the network. The scientists speculate that such a fault in the organization could also be a possible cause of epilepsy.

Source: Butz, M., Teuchert-Noodt, G., Grafen, K., van Ooyen, A. Hippocampus, Online-Publikation , 14. Mai 2008



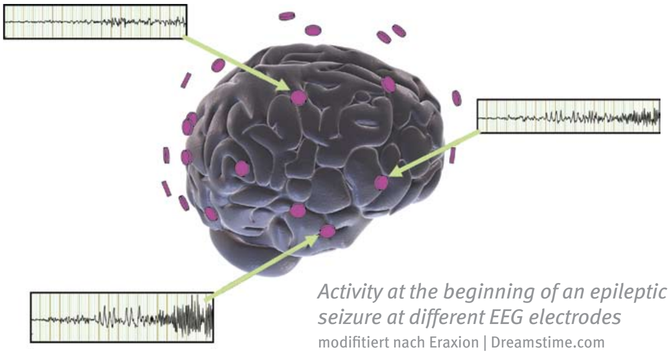
Brain section of the hippocampus after silver staining in dark-field microscopy. If the animal is raisen in an enclosure, strong reorganization takes place (light-colored grains, left image), as opposed to caged animals (right image).

Automatically recognizing impending epileptic seizures

Epileptic patients suffer from the sudden occurrence of seizures, which are brought on by the simultaneous discharge of a large number of nerve cells in the brain. Each seizure occurs out of the blue – when a storm of neural activity is seen to brew within the brain, the individual who is affected will not even notice it.

Scientists associated with Ralph Meier and Ad Aertsen, at the BCCN and the University of Freiburg, have now developed a method with which brainwaves of patients can automatically be measured and evaluated simultaneously. Since changes in neural activity generally appear some seconds before the first external indication of a seizure, this method would allow patients and clinic personnel to be forewarned of upcoming attacks. In the future, one additionally hopes to develop implants which may influence the brainwaves and serve to counteract the beginning phases of an attack. For such systems, a mandatory prerequisite is the accurately timed recognition of these upcoming convulsions.

The Freiburg data evaluation procedure is based on electroencephalography (EEG). With the help of electrodes placed on the scalp, voltage changes of the brain are measured. In the event of an epileptic seizure – and depending on the particular type of convulsion – there may be intensified discharges in certain frequency ranges or unusual discharge patterns may occur. In an EEG from a healthy individual, oscillations also occur within different frequency ranges, which reflect specific brain states like sleeping, dozing or excitement. The goal of the scientists from Freiburg is to reliably differentiate healthy oscillatory patterns from discharges associated with epilepsy.



Activity at the beginning of an epileptic seizure at different EEG electrodes
modifitiert nach Eraxion | Dreamstime.com

To date, with the help of mathematical algorithms, attempts have already been made to evaluate an EEG automatically. However, not every procedure is suitable for each form of convulsion. To guarantee an optimal recording of all types of seizures, the scientists associated with Meier have made use of various mathematical evaluation procedures in parallel. 'Our method requires no individual adjustment, but is instead suitable for all types of seizures,' explains Meier.

Meier and his colleagues made use of approximately 1400 hours long-term of EEG recordings, including 91 verified seizures, in order to examine the efficiency of this procedure. Almost all of these seizures were recognized in time by the procedure. Only about once every two hours their system resulted in a faulty prediction of a seizure which did not subsequently occur. Consequently, the process reveals a better recognition accuracy than other currently available methods. In addition, the system can differentiate between the course of various types of seizures and thereby contributes to the diagnosis of epilepsy. 'In principle, the programme is ready for clinical application. There are only a couple of technical hurdles to be cleared for applying the procedure in routine clinical data acquisition systems,' says Meier.

Source: Meier, R., Dittrich, H., Schulze-Bonhage, A. & Aertsen, A. (2008). J Clin Neurophysiol. 2008 Jun;25(3):119-31.

Eye movements in a computer model

If we follow a moving object with our eyes, the brain calculates the speed of the object and the eye movement is adjusted accordingly. This alone is already an enormous achievement, but the brain can still do even more. When a car rushes past, it will speed up or slow down more quickly than a pedestrian. Accordingly, our eye movement control reacts to speed changes of fast objects more sensitively than it does to slow moving objects. This is referred to as 'Gain control' amongst the experts. The location within the brain in which this gain control is calculated and the neural connections underlying it have been postulated in a mathematical model and experimentally checked by scientists around Ulrich Nuding, Stefan Glasauer and Ulrich Büttner of the Bernstein Center for Computational Neuroscience and the Ludwig-Maximilians-University Munich. Their results are also relevant for the diagnosis of eye movement disorders.

Both from behavioral experiments on humans and neurophysiological studies a great deal is already known about the control of eye movements. It is known, for example, that different cortical brain regions participate in the origin of eye pursuit movement: the MST area in the parieto-temporal cortex and the frontal eye fields (FEFs). Nerve cells in the MST area primarily reflect the speed of eye or target movement, while cells in the FEF mainly react to speed changes. The objective of the Munich scientists was to summarize these findings in a computer model that could explain eye movement control.

The model of the scientists simulates the most important circuits required for the control of visual pursuit. In the MST area the speed of the target is calculated in order to compare it and adapt the current eye movement to it. The FEFs represent the

Transcranial Magnetic Stimulation

postulated location for gain control: here, the sensitivity of eye movement is set for speed changes. The faster an object moves, the greater is the adaptability. 'With these studies we were able to explain for the first time the potential use of the parallel anatomical pathways in processing,' says Glasauer.

In order to check the model, the scientists, together with colleagues from University College London, instructed subjects to pursue a point on a screen with their eyes. In this experiment, the activity of the FEFs was transiently disrupted by transcranial magnetic stimulation, a technology with which specific brain regions can be purposefully influenced for a few seconds. These experiments confirmed the predictions of the model. As long as the observed object moved at a constant speed, a perturbance of the FEFs barely affected eye movement control. The sensitivity of eye movement to speed changes, however, did not increase adequately at higher speeds with a disrupted FEF. In conclusion, gain control is determined in the FEFs depending on the speed of the eye or the target. This change in sensitivity shows interesting parallels with visual attention control in which FEFs also seem to play an important role, and can therefore be considered as an attentional mechanism within the visual pursuit system.

Source: Nuding, U., Ono, S., Mustari, M.J., Büttner, U. & Glasauer, S. J Neurophysiol. 2008; 99(6):2798-808.
Nuding, U., Kalla, R., Muggleton, N.G., Büttner, U., Walsh, V. & Glasauer, S. Cerebral Cortex. 2008; published online Oct 1st.
See also: Nuding et al., Prog Brain Res. 2008;171:261-4.

Predicting hand movements from non-invasive brain signals

The subject is moving a joystick in one of four directions, while brain activity is recorded by MEG (sensors under the white cap) and EEG (not visible in this figure).

‚Brain machine interfaces' (BMI) are technologies that allow controlling computers or prostheses with signals recorded from the brain. Scientists hope that in the future severely paralyzed patients will be able to use this method to control artificial limbs with their thoughts. There are two basic types of BMI-technologies: invasive and non-invasive BMIs. In invasive BMIs, neuronal activity is recorded from electrodes that have to be implanted into the brain. Non-invasive BMIs work with sensors that are externally attached to the skull. Obviously, non-invasive technologies have the advantage to be much easier to handle and are virtually risk-free. But they carry the decisive disadvantage of a much lower spatial resolution. Carsten Mehring (BCCN and University Freiburg) and his colleagues from Freiburg and Tübingen, however, have succeeded in non-invasively recording a movement control signal from the brain, which, up to that time, had only been achieved by invasive BMIs.

Invasive and non-invasive BMIs differ not only in their technical approach, but also in where the neuronal signals for movement control are recorded. In non-invasive methods, brain activity is measured through the skull, resulting in a blurred picture, like when looking through a frosted glass. Therefore, this technology exploits brain signals that are produced by large groups of neurons. Patients or experimental subjects usually have to learn in an intensive training how to voluntarily induce certain electrical voltage changes that can be used for controlling a computer cursor. Invasive technologies that use implanted electrodes, in contrast, allow recording the activity of single neurons or small neuron groups from within the motor cortex – the brain region that is of primary importance for voluntary movements.

Scientists from Freiburg and Tübingen have now for the first time succeeded in extracting specific movement control signals from the motor cortex using non-invasive methods. Using magneto-encephalography (MEG) or electro-encephalography (EEG), they could tell from brain activity alone in which direction the subject was moving its hand. In EEG, the voltage changes that are induced by currents flowing through electrically active neurons are measured at the skull surface. MEG records magnetic signals that are induced by these currents. Compared to previous non-invasive methods, the approach of Mehring's goup has one decisive advantage: with it, controlling a prosthesis or a cursor would be possible in a completely intuitive way, just like in natural hand movements, and would therefore require much less training than previous non-invasive approaches.

In a follow-up study, the scientists are now testing whether healthy subjects can use this approach to control a computer with non-invasive brain signals. They concede that the precision of such a system will probably not quite reach the one of invasive systems. Based on their new results, however, one could make use of the advantages of this direct and natural approach for control of prostheses and cursors without running the high risks tied to sensor implantation.

Source: Waldert, S., Preissl, H., Demandt, E., Braun, C., Birbaumer, N., Aertsen, A. & Mehring, C. (2008). J Neurosci. 28(4):1000-8.

Stefan Rotter

Structure and function of neuronal networks

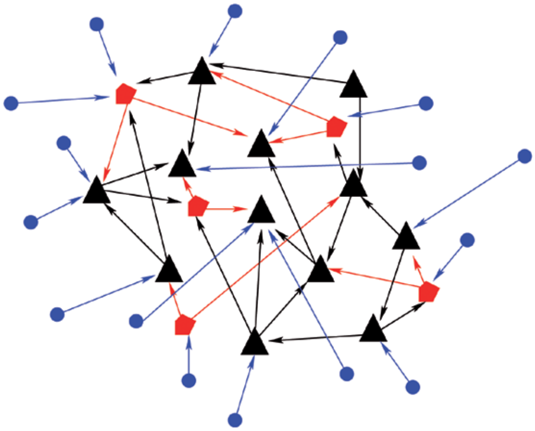
'Like an entomologist', as the renowned neuroanatomist Santiago Ramón y Cajal (1852-1934) once said, he was hunting for the cells of the brain, those 'mysterious butterflies of the soul, the beating of whose wings may some day – who knows – reveal the secret of mental life'. He described brain structure, neuronal form and neuronal connections with such meticulous precision, that future generations of scientists continue to use his findings to understand the functioning of the brain.

Stefan Rotter, Bernstein professor at the BCCN Freiburg since April 2008, has made it his task to understand the relationship between the structure and function of the brain, or as he explains more precisely, 'the association between network structure and neuronal dynamics'. When the brain processes sensory inputs, controls movements or recalls memory content, it encodes information as a spatio-temporal pattern of neuronal impulses. One cubic millimeter of neocortex contains about 100,000 nerve cells, and each of them connects to about 10,000 other nerve cells. The question as to how the structure of the vast resulting neuronal network and its activity dynamics are related, can currently only be analyzed using sophisticated computer simulations.

Rotter is using various mathematical methods to synthesize 'wiring diagrams' of biological brains and to explore the electrical phenomena that occur within them. Specifically, Rotter's research group has recently been investigating applications of stochastic graph theory to neuronal networks. These methods can be used both in the analysis of networks where only summary statistical information is available. The nervous system is just such a case: 'Not every synaptic connection between cells is known. In the near future, neuroanatomy will only be able to provide us with statistical information about the presence of synapses between different types of neurons,' says Rotter.

The analysis of networks using mathematics and computers is only one part of the story. As Rotter explains, 'It is important to use experimental data to adapt our neuronal models to reality'. In close cooperation with a number of experimental scientists, notably Ulrich Egert, Clemens Boucsein, and other colleagues at the BCCN Freiburg, Rotter uses various statistical methods for analysis in order to infer rules and structures from experimental data. Such methods may be known from other contexts, such as for the analysis of stock market prices or of the topology of the internet. Rotter is applying these techniques for analyzing the brain and its function.

Rotter studied mathematics and physics before seeking out new challenges in the field of neurosciences. 'One tends to work as a recluse in many areas of mathematics. So, it was a very refreshing experience for me to see how brain researchers and colleagues from a large variety of disciplines and schools of thought collaborate together. Although I was having to learn from scratch how to communicate science with others,' Rotter reveals. Ultimately he enjoyed it so much that he did his PhD in Valentino Braitenberg's group at the Max Planck Institute for Biological Cybernetics in Tübingen. He then went on to coordinate a theoretical group with Ad Aertsen at the University of Freiburg and has remained in this field of research until today. In the meantime Rotter's enthusiasm for research across the



Modell eines cortikalen Netzwerks mit erregenden (schwarz) und hemmenden (rot) Neuronen. Externe Eingänge (blau) wirken wie ein Wärmebad

Model of a cortical network with excitatory (black) and inhibitory (red) neurons. External inputs (blue) act like a heat bath.

traditional borders of disciplines has now infected several other mathematicians with the same passion. 'The number of people in my team who want to apply mathematics to study the brain is growing', he says.

In his quest to understand the relationship between structure and dynamics in the brain, Rotter is particularly concentrating on large neuronal networks, since these have special properties that are not necessarily shared by smaller networks, and not at all by individual neurons. The properties of nerve cells can, for example, change when they receive many input signals simultaneously. This is is especially the case in the cerebral cortex, where cells are interconnected through massive feedback pathways. Taking this into account, as Rotter and his colleagues have shown, a sufficiently large network remains active once it is stimulated, even without any additional input from the external environment. It is presumed that this kind of activity forms the basis of thought and short-term memory in the brain, as not every activation is caused by a direct sensory stimulus.

The analysis of large networks is a complex task. It becomes even more complicated when one considers that these networks change continuously. When we experience, see or hear something, this is not only reflected in the activity of nerve cells. Ultimately, it also entails consequences for the structure of the network. Precisely these growth processes are presumed to be the basis for learning and persistent memory. 'Neuronal activity governs the formation of new synaptic connections, and these connections, in turn, lead to altered neuronal dynamics', explains Rotter. In a collaborative project with Markus Diesmann of the RIKEN Brain Science Institute in Japan and other scientists he is studying the influence of such complex interactions on the structure of networks.

Practical applications of Rotter's work can be found mainly in biomedicine, e.g. in neuroprosthetics. The known properties of signals from the motor cortex, the brain region responsible for planning and controlling movements, can in principle be exploited to operate artificial limbs or a computer cursor 'with the power of one's thoughts'. Paralyzed individuals could benefit enormously from such brain-computer interfaces. Rotter and his colleagues have been particularly interested in determining the type of information which can be read out directly from the brain using various measurement and decoding procedures. 'Although, in principle, we are doing basic research, this can sometimes prove to be very application-relevant', Rotter observes.

Randolf Menzel

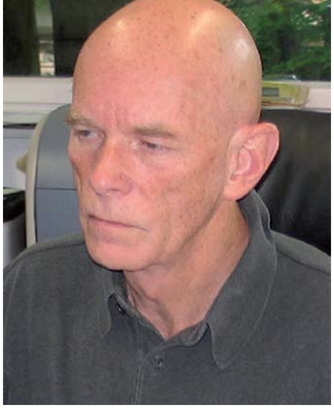
Research on the cognition of bees

"'Because bees have so small brains, it was believed for a long time that their behavior could be explained by a limited amount of very simple operations,' says Randolf Menzel, Professor for Neurobiology at the Free University Berlin and at the Bernstein Center for Computational Neuroscience, Berlin. With ingenious experiments and modern technologies, Menzel and his co-workers revolutionized our view of the cognitive abilities of small brains. 'We showed that such a simplistic approach is insufficient to explain the complex social behavior and the navigation and learning skills of the bee. Rather, these animals have astonishing cognitive abilities.'

On March 27, 2008 Menzel was awarded with the international research prize of the Fyssen Foundation for his groundbreaking work on the cognitive abilities of the honey bee. The Prize was conferred in a ceremony in Paris. The Fondation Fyssen supports research on the neuronal basis of cognitive mechanisms like thinking, learning or sensing. Menzel studied Biology, Chemistry and Physics in Tübingen and Frankfurt (Main). In 1972, he became Professor at the Institute of Zoology at the Technical University of Darmstadt, before accepting an appointment at the Institute for Neurobiology at the Free University Berlin. He already received a number of awards for his work about the cognitive abilities of the honey bee, among others in 1991 the Gottfried Wilhelm Leibniz Prize of the German Research Foundation (DFG), in 2000 the Körber European Science Award and in 2004 the Karl Ritter von Frisch Medal of the German Zoological Society. In 2007, Menzel received the honorary doctorate of the University of Toulouse. Menzel is also a founding member of the Berlin-Brandenburg Academy of Sciences and Humanities.

Despite their quite small nervous systems, bees learn very fast. They memorize features in the landscape to orient themselves in their environment; they communicate with and learn from each other. Their 'waggle dance' with which they inform each other about new food sources is arguably the most complex form of communication among invertebrates.

But what exactly happens within the brain of the bee while it navigates, searches for food or extracts information from the dance of its mates? As Menzel could show, bees have complex maps inside their heads, in which they store the information about direction and distance extracted from the waggle dance. Using these maps, they find their way to the indicated food source, not only directly from the bee hive where they watched the dance, but they also with detours or shortcuts. What's more, bees take decisions. They compare new information with previous ones and try out different options in their exploratory flights. In new experiments, Menzel and his colleagues look for the neuronal correlates of such learning and decision processes. 'The bee is very cooperative and is well suited for such experiments. Even under laboratory conditions it shows complex forms of learning that we can investigate physiologically,' explains Menzel.



Michael Frotscher

Hertie Senior Professorship 2007

Having enough time to concentrate on research is the dream of many scientists. Thanks to the Hertie Senior Professorship for Neuroscience, this dream has now become true for Michael Frotscher (BCCN Freiburg), towards the end of his scientific career. The award of the Hertie Foundation aims at maintaining the immense research potential of older scientists. The awardees are released from administrative tasks for five years and can remain in science beyond the age of 65.

Michael Frotscher studied medicine and started his scientific career at the Humboldt-Universität zu Berlin (at that time located within the German Democratic Republic). After his escape to the Federal Republic of Germany in 1979, he started a new career at the Max Planck Institute for Brain Research in Frankfurt. Since 1989, he is Director at the Institute for Anatomy and Cell Biology at the Albert-Ludwigs University Freiburg. The focus of Frotscher's research is the question, how a structure as complex as the nervous system arises during development and how certain structural characteristics influence the function of the brain.

Millions of cells are generated during the development of the brain. In order to ensure the formation of a functional structure, their migration into different brain regions as well as their wiring into a network has to be tightly coordinated. To achieve this, cells communicate with each other via molecular signals. Frotscher and his colleagues have investigated the role that particular signalling molecules play in this process.

Frotscher's specific interest in this context is the hippocampus, a highly structured brain region consisting of various layers of neurons with different functions. Frotscher and his colleagues have found that a protein called "reelin" plays a key role in building the cell- and fiber layers of the hippocampus. In addition to that, reelin helps glia cells to build a scaffold that can be used by other cells as a migratory guide. Disruptions of these migration processes can lead to epileptic seizures and other neuronal disorders.

It is possible to draw conclusions about the function of the nervous system by looking at its structure – just like exploring the design of a complex machine can shed light on its function. One of the structures investigated by Frotscher and his colleagues are the synapses, the connections between neuronal cells. With a modern electron microscopic technology – shock freezing the tissue under high pressure – they aim at understanding how the structure of synapses changes through their utilization.

Frotscher has obtained numerous awards for his scientific achievements, amongst others the Leibniz Award in the year 1993. He is one of the leading researchers in the field of hippocampus development and function worldwide.

Grants for participation at Sloan Centers annual meeting

For the first time, the Swartz foundation awarded this year fellowships to ten doctoral students and post docs of the Bernstein Network Computational Neuroscience to allow their participation at the annual meeting of the Sloan-Swartz Centers in Princeton (New Jersey) from July, 19-22, 2008. In return, fellowships will be awarded to American doctoral students and post docs for the participation at the coming Bernstein Symposium in October 2008 in Munich. This first step towards a transatlantic exchange program between the Bernstein Network and the Sloan-Swartz Centers, the leading research institutes in the field of computational Neuroscience in the USA, was initiated by Hirsh Cohen (Scientific Director of the Swartz Foundation) and Andreas Herz (Coordinator of the Bernstein Center Munich).

Teilnehmer der Sloan-Swartz Tagung
Participants of the Sloan- Swartz Meeting

Personalia

Jan Benda, winner of the Bernstein Award 2007, moved from Berlin to the LMU Munich in August 2008. In his junior research group he studies the principles of neuronal signal processing using the electrosensory system of weakly electric fish and the auditory system of grasshoppers and crickets as models.

Since 2007, **Martin Buss** and **Kolja Kühnlenz** have been affiliated to the BCCN Munich. Buss is head of the ‘Institute of Automatic Control and Engineering’ at the Technical University Munich, where also Kühnlenz is leading a research group.

Susanne Kunkel and **Alexander Hanuschkin (BCCN Freiburg)** have been awarded the ‘CNS Poster Award’ of the Organization for Computational Neuroscience. The award was granted at the CNS Meeting from July 19-24, 2008 in Portland/Oregon, USA.

Call for proposals

With the ‘National Bernstein Network Computational Neuroscience’, the Federal Ministry of Education and Research (BMBF) has provided a framework to establish the research area computational neuroscience with high international visibility in Germany. The network was initiated in the year 2004 with the ‘Bernstein Centers for Computational Neuroscience’, a format, which now will be pursued and extended. Within the framework of a new call for proposals, up to five regionally organized Bernstein Centers for Computational Neuroscience will be funded. In the first step of a two-tiered funding procedure, project outlines are to be submitted to the the project management agency DLR until December 31, 2008.
http://www.bmbf.de/foerderungen/12572.php

With the new funding measure ‘Bernstein Focus: Neuronal Basis of Learning’, research results from this area are to be linked to technological applications at an early stage. Project outlines are to be submitted to the project management agency DLR until Sept 30, 2008.
http://www.bmbf.de/foerderungen/12434.php

Events

The internationally renowned summer school **'Advanced Course in Computational Neuroscience'** (ACCN) took place from **August 4 to August 29, 2008** at the **BCCN Freiburg**. Since 1996, the ACCN provides 30 carefully selected PhD students and post docs from all over the world with a four-week advanced training in neuroscience, comprising lectures, tutorials and an own research project under the guidance of leading international scientists. The course aims at introducing experimentally working neuroscientists and medical scientists together with theoreticians from mathematics and physics as well as engineers and computer scientists into the interdisciplinary field of computational neuroscience.
http://www.neuroinf.org/courses/EUCOURSE/F08

The workshop **'Aspects of Adaptive Cortex Dynamics'** took place at the Hanse-Wissenschaftskolleg Delmenhorst from **September 4-9, 2008**. The workshop was organized by Klaus Pawelzik and Udo Ernst from the **Bernstein Group Bremen**.
http://www.h-w-k.de/555.html?&L=1

From **September 4-17, 2008** the **3rd International Summer School in Biomedical Engineering** took place in Weimar and Illmenau in collaboration with the **Bernstein Group Jena**. The main focus of the course is the reconstruction of brain activity based on electroencephalographic and magnetoencephalographic measurements of electrical and magnetic fields.
http://wcms1.rz.tu-ilmenau.de/fakia/?id=6825

This year, the annual Göttingen **'Fall Course on Computational Neuroscience'** will take place from **September 22-26, 2008 at the BCCN Göttingen**. The course is addressed at students from all fields of neuroscience and provides them with an introduction in theoretical and computer based methods. It is organized by Hecke Schrobsdorff and J. Michael Herrmann.
http://www.bccn-goettingen.de/events-1/cns-course

From **October 13-17, 2008** the course of the German Neuroscience Society **'Analysis and Models in Neurophysiology'** for advanced master students and PhD students will take place at the **BCCN Freiburg**. The course is organized by Stefan Rotter.
http://www.brainworks.uni-freiburg.de/teaching-and-training/nwg-course

The **second PhD symposium of the BCCN Berlin**, organized by Robert Martin, took place from **August 7-9, 2008** at the Werbellinsee, a lake located close to Berlin. Two invited speakers escorted the symposium „Collaborative aspects of Computational Neuroscience" scientifically. At the campfire in the evenings and during the canoeing exercise on Saturday the participants could strengthen their team spirit.

After the positive feedback towards the exhibitions of the Bernstein Network at the FENS Forum 2008 in Geneva (Switzerland), the CNS Meeting 2008 in Portland (USA) and the INCF Neuroinformatics 2008 in Stockholm (Sweden), the network will also be present with an information booth organized by the **Bernstein Coordination Site** at the Neuroscience 2008 from **November 15-19, 2008** in Washington, DC (USA). Scientists from all over the world are invited to catch up on research projects, open positions, study as well as visiting scientists programs of the network.
http://www.nncn.de/termine-en/sfn2008

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Title Image: Scientists from Munich investigate how we follow objects with our eyes (see page 9).

The Bernstein Network

Bernstein Centers for Computational Neuroscience (BCCN)
Berlin – Coordinators: Prof. Dr. Michael Brecht, Prof. Dr. Laurenz Wiskott
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Berlin – Coordinator: Prof. Dr. Klaus-Robert Müller
Frankfurt – Coordinators: Prof. Dr. Christoph von der Malsburg, Prof. Dr. Jochen Triesch, Prof. Dr. Rudolf Mester
Freiburg/Tübingen – Coordinator: Prof. Dr. Ulrich Egert
Göttingen – Coordinator: Prof. Dr. Florentin Wörgötter

Bernstein Groups for Computational Neuroscience (BGCN)
Bochum – Coordinator: Prof. Dr. Gregor Schöner
Bremen – Coordinator: Prof. Dr. Klaus Pawelzik
Heidelberg – Coordinator: Prof. Dr. Gabriel Wittum
Jena – Coordinator: Prof. Dr. Herbert Witte
Magdeburg – Coordinator: Prof. Dr. Jochen Braun

Bernstein Collaborations for Computational Neuroscience (BCOL)
Berlin-Tübingen, Berlin-Cologne, Berlin-Erlangen-Nürnberg-Magdeburg, Berlin-Gießen-Frankfurt, Berlin-Konstanz, Berlin-Aachen, Freiburg-Rostock, Freiburg-Tübingen, Göttingen-Jena-Bochum, Göttingen-Kassel-Ilmenau, Munich-Stuttgart

Bernstein Award for Computational Neuroscience (BPCN)
Dr. Matthias Bethge (Tübingen), Dr. Jan Benda (Munich)

Chairman of the Bernstein Project Committee: Prof. Dr. Ad Aertsen
Deputy Chairman of the Project Committee: Prof. Dr. Theo Geisel

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