



**Bernstein Centers for Computational Neuroscience**

# BCCN Newsletter



## **Recent Publications**

How thoughts arise – ‘RunBot’ goes mountaineering – The emergence of a sense of orientation – Psychological models – The role of single neurons – The brain on the edge of chaos



## **Meet the Scientist**

Werner Hemmert, Susanne Schreiber, Petra Ritter



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02/2008



# How thoughts arise

## The fundamental components of memory and thought

What makes up a thought? First of all, it is a firework of neuronal activity, produced by neurons, the building blocks of the brain, which encode and transmit information in the form of electrical impulses. Brain scientists hope to explain, for example, how a goal keeper uses his arms and legs, and his intuition to block a penalty by the opponent. But not always when we think or remember is there a direct input from the environment. A team of scientists at the Bernstein Center for Computational Neuroscience of the University of Freiburg, led by Stefan Rotter from the Institute for Frontier Areas in Psychology and Mental Health, found by means of elaborate computer simulations, that under certain conditions very large neuronal networks can show sustained activity even without external input. The researchers hypothesize that it is this sustained activity that provides the fundamental components of memory and thought.

Neurons receive inputs from other cells that can be either excitatory or inhibitory. Mathematical models of neuronal networks generally assume that nerve cells integrate the incoming signals and, as soon as a threshold is reached, elicit an electrical impulse themselves. But a number of experiments show that neurons behave in a more complex way, if intense input impinges on them within a short period of time. This is due to the fact that the biophysical properties of the cells temporarily undergo a dramatic change under these circumstances.

In their doctoral theses, Arvind Kumar and Sven Schrader have simulated large neuronal networks that, for the first time, take this neuronal feature into account. Especially in the

neocortex, neurons are intensely interconnected, i.e. they receive many input signals that can modify the integration of subsequent signals. Taking the special features of such highly interconnected networks into consideration yields simulations that are in excellent agreement with recordings from biological nerve cells in the intact brain. The new virtual network thus reflects reality better than previous models.

A special feature in which Rotter's and colleagues' network differs from other models is its self-sustained activity. If the network is large enough, it suffices to trigger it once – from then on it remains active even without external input. 'Networks built from simpler model neurons would literally 'fall asleep' within a short time,' says Rotter. This finding obtained in artificial systems allows to draw conclusions about the function of the real brain – after all, for thinking or remembering no external input seems to be necessary.

'But it does not suffice that the brain is just active', adds Rotter. 'The activity pattern must somehow be connected to a meaning.' When we remember, our brain has to make associations and has to produce meaningful behavior. How meaningful patterns arise in the ocean of neuronal network activity will be subject of new investigations by Rotter and his colleagues at the Bernstein Center. Their network model now provides a promising starting point for this.

Source: Kumar, A., Schrader, S., Aertsen, A. & Rotter, S. (2008). [The High-Conductance State of Cortical Networks](#). *Neural Computation*, 20(1): 1-43



# A walking robot goes mountaineering

**Scientists from Göttingen have developed a walking robot that can adapt its gait to the steepness of a slope**

The human gait is a marvel of coordination. All aspects of movement control – from the angle of the knee joints to the momentum of the hip up to the balance point of the torso - need to be meticulously adjusted. In addition, the gait is adaptable to different environments. Walking on ice is different from walking on solid ground, walking uphill is different from downhill.

Scientists around Florentin Wörgötter, Bernstein Center for Computational Neuroscience at the University of Göttingen, have simulated the neuronal principles that form the basis of this adaptivity in a walking robot. 'RunBot', as it is called, lives up to its name – it holds the world record in speed walking for dynamic machines. Now its inventors have expanded its repertoire. With an infrared eye it can detect a slope on its path and adjust its gait on the spot. Just as a human, it leans forwards slightly and uses shorter steps. It can learn this behavior using only a few trials.

The robot's ability to abruptly switch from one gait to the other is due to the hierarchical organization of the movement control. In this respect, its control strategy resembles that of a human and can hold as a human model. On the lower hierarchical levels, movement is based on reflexes driven by peripheral sensors. Control circuits ensure that the joints are not overstretched or that the next step is initiated as soon as the foot touches the ground. Only when the gait needs to be adapted, higher centers of organization step in - a process triggered by the human brain or, in case of the robot, by its infrared eye leading on to a simpler neural network. Because of the hierarchical organization,

adjustment of the gait can be achieved by changing only a few parameters. Other factors will be automatically tuned through the regular circuits.

At its first attempt to climb a slope, RunBot falls over backwards, as it has not yet learned to react to its visual input with a change in gait. But just like children, RunBot learns from its failures, leading to a strengthening of the contact between the eye and the sites of movement control. Only once these connections are established, step length and body posture are controllable by the visually induced signal. The steeper the slope, the stronger RunBot will adapt its gait.

**Source: Manoonpong, P., Geng, T., Kulvicius, T., Porr, B. & Wörgötter, F. (2007). Adaptive, Fast Walking in a Biped Robot under Neuronal Control and Learning. *PloS Computational Biology*, 3(7):e134**

*For movies of RunBot view:*

[www.nld.ds.mpg.de/~poramate/RUNBOT/ManoonpongMovieS1.mpeg](http://www.nld.ds.mpg.de/~poramate/RUNBOT/ManoonpongMovieS1.mpeg)

[www.nld.ds.mpg.de/~poramate/RUNBOT/ManoonpongMovieS2.mpeg](http://www.nld.ds.mpg.de/~poramate/RUNBOT/ManoonpongMovieS2.mpeg)

*RunBot, the world record holder in speed walking for dynamic machines, can now also climb slopes.*

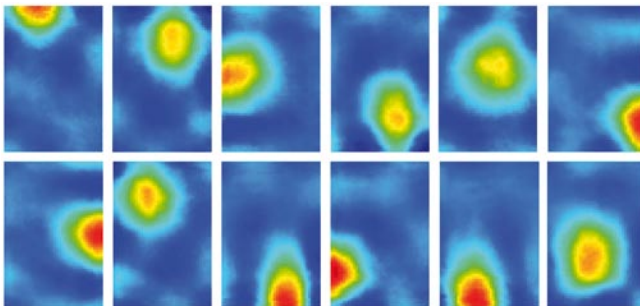




# The emergence of a sense of orientation

**Scientists from Berlin have developed a theoretical model that shows how an orientation map develops in the brain**

To orient ourselves, we mainly need two pieces of information: where am I and in which direction am I heading? Experiments in the rat have shown, that these types of information are directly accessible and independently coded in the brain. When the rat explores a new territory, so-called place cells and head direction cells form within only a few minutes. Place cells are active when the rat visits a particular area, no matter which direction it is facing. In contrast, head direction cells code the direction into which the rat is heading, independent of where it is. Also humans presumably have these and other types of cells which specifically instruct their sense of orientation. Mathias Franzius, Henning Sprekeler and Laurenz Wiskott, scientists at the Humboldt-University and at the BCCN Berlin, have now developed a theoretical model that can explain the emergence of all orientation specific cells that are known in rats and primates to date.



*From images of the visual impression perceived when exploring a new environment, a computer model derives „place cells“ (color coded), which are active only in defined regions of the cage (blue squares).*

The model of the researchers analyzes realistic image data that reflect the visual input a rat would perceive when exploring a new environment. The core of their model is a mathematical algorithm called ‘slow feature analysis’, which extracts information relevant to orientation from the image data. On the basis of this algorithm, the model generates place cells and head direction cells – without this being an a priori requirement.

Every receptor in the eye only captures a very small section of the perceived image. When shifting the gaze just a little, the information that every single receptor transmits will be quite different than before. While sensors deliver constantly changing data, the information important for orientation varies far more slowly – the overall impression in the example above remains almost constant. Features that vary slowly can be obtained from image data by slow feature analysis.

With their model, the scientists could show that slow feature analysis allows the emergence of what one could call a ‘cognitive map’ from the linear sequence of visual data a rat receives when moving through a new environment. In this map, positions are coded by place cells, whereas a directional reference frame is given by head direction cells. It is only after this learning process that disparate visual impressions can activate the same set of place or head direction cells. If, for example, the rat is located in the northern corner of its cage, the same place cells will show activity, no matter if it is heading east or west.

Source: Franzius, M., Sprekeler, H. & Wiskott, L. (2007). Slowness and sparseness lead to place, head-direction and spatial-view cells. *PLoS Computational Biology*, 3(8):e166.



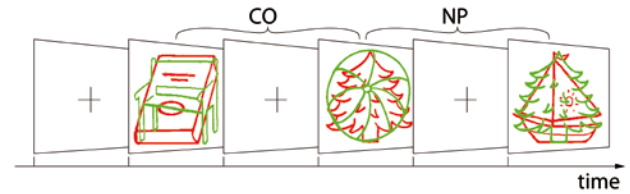
# Psychological models in mathematical formulas

## Computer model of unconscious image processing in the brain

Not all visual information that our eye detects is consciously perceived. While concentrating on road traffic, things happening on the sides of the road escape our notice although we ‘see’ them. Various psychological experiments prove that such visual input is nonetheless processed and saved in the brain’s memory. To achieve a better understanding of the neuronal mechanisms underlying this phenomenon, a team around Hecke Schrobsdorff and Michael Herrmann at the BCCN and the University of Göttingen have simulated unconscious image processing in the computer. Having achieved this, psychological models can now be approached quantitatively.

We are able to recognize objects more easily if we have seen them shortly before. This phenomenon is called positive priming. The opposite effect is called negative priming: Image information which we have previously ignored is less quickly recognized – indicating that it has been processed by the brain without consciously being perceived. With the help of psychological experiments it is possible to measure negative priming. To this end, subjects are shown two overlapping line drawings, one in red and one in green. The subjects must describe what the green picture shows, while they ignore the red drawing which serves as a distraction. This procedure is then repeated with more drawings. If the green drawing in the second run displays the figure which was previously represented in red and was thus ignored, the subject’s reaction is slowed down by a few milliseconds.

What is the cause of this differing stimulus processing? Is an ignored impulse actively suppressed for a longer period of time



*Typical stimulus sequence in a negative priming experiment. CO: control; NP: Negative Priming*

and therefore not recognized? Or is the object stamped as ‘to be ignored’, causing a conflict when the observer is required to react? ‘Psychologists formulate their models using language – they do not draw any quantitative conclusions,’ Hecke Schrobsdorff explains. In order to quantify the results of psychological tests, the researchers in Göttingen have developed a mathematical basis. It is based on the idea that the red and green stimuli are processed simultaneously, however the processing of relevant stimuli is willingly advanced.

For the green image to be recognized it is required that the green stimulus exceed a threshold level which has not been reached by the red stimulus. The threshold limit increases together with the processing of stimuli. If the observer is confronted with a green image previously shown in red, stimulus processing is impeded due to the clash of incongruent representations, and therefore slows down. With their computer model, the researchers could yield an exact reproduction of the recorded experimental data. ‘With our computer-based simulation we are able to explain both positive and negative priming,’ says Schrobsdorff. The aim of the project is to integrate further aspects of other psychological models into the computer model in order to derive testable specific prognoses.

Source: [Schrobsdorff, H., Ihrke, M., Kabisch, B., Behrendt, J., Hasselhorn, M. & Herrmann, J.M. \(2007\). A computational approach to negative priming. \*Connection Science\* 19 \(3\), 203-221.](#)



# How many neurons are needed to evoke a sensation?

### Even the activity of a single neuron can be consciously perceived

An estimated two million neurons are contained in the rat somatosensory cortex – the brain region that processes tactile perceptions. Arthur Houweling and Michael Brecht from the Humboldt University and the Bernstein Center for Computational Neuroscience Berlin have now found out that, despite this enormous multitude, the activity of a single neuron can evoke a sensation. ‘Given the great number of neurons in the cortex, it has so far been widely assumed that only the interaction of large groups of neurons can create a conscious perception. We have shown that single neuron activity is of much more significance than previously assumed,’ Brecht comments on his results.

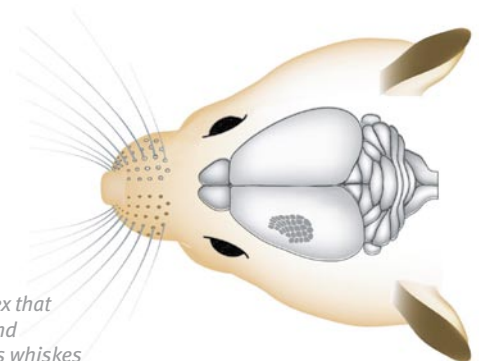
Seeing, hearing, touching – each sensory impression is processed in the brain and can be attributed to the transmission of electric impulses by nerve cells. So far, however, only little is known about the principle according to which such neuronal information coding works. Does each processing step involve whole populations of neurons so that small errors of single cells can be compensated for? Or are there only a few neurons involved, which consequently have to work very precisely? Already in 2004, Brecht had shown that the activity of single neurons is sufficient to move the vibrissae of a rat by an angle of a few degrees. The next question he addresses in his current study is whether single neurons play a similarly central role with regard to perception.

It is already known that the stimulation of larger groups of neurons in the human somatosensory cortex evokes a tactile sensation, and also animals react to such stimulation. By using

tiny currents in the range of some nanoamperes, the scientists around Brecht stimulated single neurons that are involved in the rat’s sense of touch. Each of these tiny currents evoked approx. 15 neuronal impulses. The scientists examined the rat’s perception by means of a behavioural test – the rats were trained to respond to sensations of touch with a licking motion. Thus, the scientists were able to show that these few impulses of a single neuron can be perceived by the rat.

This does not mean, however, that each neuron’s activity reaches consciousness – this would overstrain the brain. How good the rat responds to the increased activity of a neuron, and whether the rat perceives it at all, depends on various factors – firstly, on the type of neuron and, secondly, on the response threshold of downstream neurons which pass on the signal. Nevertheless, the experiments have clearly shown that the brain works much less redundantly than previously assumed. ‘We assume that neuronal activity in the cortex is considerably lower than anticipated so far. The cortex works very precisely and a sensation is not – at least not in all cases – only evoked by the interaction of large cell populations,’ says Brecht.

Source: Houweling, A.R. & Brecht, M. (2007). Behavioural report of single neuron stimulation in somatosensory cortex. *Nature* 451, 65-68



*Region of the cortex that controls moving and sensing of the rat's whiskers*



## RECENT PUBLICATIONS

# The brain on the edge of chaos

### How avalanches of neuronal discharge occur in the brain

Many natural systems automatically head for a critical state which can be characterized as an extremely instable equilibrium. For example, if sand slowly trickles onto a surface, it will pile up until the slope of the sand pile is so steep that avalanches of sand occur and tumble down the slope. In doing so there is no typical avalanche size. In a defined period of time, many small avalanches or, in other cases, just a few big ones may occur in a random sequence. In 2002, a staff of researchers including Michael Herrmann had already proposed, based on theoretical calculations, that the transmission of signals in the nervous system also follows this principle of 'self-organized criticality'. In the following years this assumption was supported by experimental observations. With a new study, Anna Levina, Michael Herrmann and Theo Geisel, researchers at the Bernstein Center for Computational Science, the Max Planck Institute for Dynamics and Self-Organization and the University of Göttingen, have now successfully identified the neuronal mechanisms underlying this phenomenon.

Avalanches can also occur in the nervous system – not sand avalanches, but avalanches of neuronal discharge. When a neuron transmits an electric impulse, this can release an impulse in a downstream neuron. When the transmission is repeated a number of times, this results in a chain of neuronal discharges, which can respectively vary in the number of neurons it comprises. 'In this way, the nervous system can make use of the full potential of all possible reactions – sometimes it reacts strongly, other times less strongly,' Herrmann explains. To date, it has been successful in only a few exceptional cases to yield a neuronal network in such a critical state in a computer simulation. In their latest study, the researchers from Göttingen

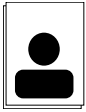


*If sand or rice slowly trickles onto a surface, the slope will become so steep that any new grain may cause an avalanche. The occurrence of neuronal discharges in the brain follows these same principles of 'self-organized criticality'*

were able to realistically model and explain the self-organized criticality in a computer-simulated network by taking into account the attenuation of the connection strength between the neurons resulting from repeated neuronal activity.

Neurons transmit information in the form of electric signals. However, where two neurons connect, at the synapse, the transfer of information is interrupted and the signal is transmitted to the next neuron with the help of chemical substances. 'The supply of these neurotransmitters is reduced by the activity of the synapses so that the strength of the signal transmission deteriorates. The efficiency of the synapse can only be recovered after the reserves are replenished,' Levina explains. Only in the past few years was this mechanism – the so-called synaptic depression – seen to play a significant role for the function of the brain. Geisel and his co-workers have for the first time been able to show that this synaptic adaptation pushes the neuronal network into the state of self-organized criticality, on the border of chaos.

Source: Levina, A., Herrmann, J.M. & Geisel, T. (2007). Dynamical Synapses Causing Self-Organized Criticality in Neural Networks. *Nature Physics* 3, 857 - 860



## MEET THE SCIENTIST

# Werner Hemmert

### Understanding language

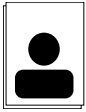
Of all the five senses, the hearing sense excels through its enormous precision in temporal processing. For example, when locating sounds, the brain determines the temporal difference by which a sound wave reaches the ear facing the speaker before the ear on the averted side. This measurement requires microsecond precision. Similarly, the understanding of language depends on the nervous system's high temporal resolution. 'Language has a very distinct temporal structure, which needs to be scrutinized in great detail,' Werner Hemmert says. Since September 2007, Hemmert is professor for 'Bio-Inspired Information Processing' at the Technical University and the Bernstein Center for Computational Neuroscience in Munich. Every sound wave that reaches the ear contains information, which is translated into neuronal signals that can then be processed by the brain. Thereby, short electrical impulses, or 'spikes', are transmitted from neuron to neuron. Hemmert examines what kind of information is encoded in these rapid spike trains. He then uses his insight to improve automatic speech recognition systems and inner-ear implants.

Automatic speech recognition systems have many applications, including enabling physically challenged people to operate a technical device or entering commands into a portable computer without the need of a keyboard, like a navigation system in a car. However, current systems quickly reach their limits when it comes to understanding language that is speaker-independent and where background noise is present. The human ear still by far outperforms any current automatic speech recognition system.



Various studies have shown that the ear dissects the frequency composition of an acoustical signal to analyze its frequency spectrum. Defined sensory cells in the cochlea respond to high frequencies, while others preferentially react to those that are low. Automatic speech recognition systems operate according to the same principle. However, their temporal resolution is considerably lower than that of the ear. Every 10 milliseconds, automatic speech recognition systems determine changes in the frequency spectrum, whereas the neurons of the hearing system also code temporal information with a precision of 20 microseconds or better. Hemmert examined in detail whether the significantly better temporal resolution of the ear is also the reason for its superiority in speech recognition. 'We are the first laboratory to address speech recognition using realistic spike trains of model neurons in the auditory system,' says Hemmert. He demonstrated that in the presence of distracting noises, the spectral information alone is not sufficient for explaining the achievements of the ear. This work has already triggered new approaches for improving current speech recognition systems.

How the human ear goes about resolving the temporal structure of speech is also within the scope of Hemmert's research interests. So called 'onset neurons', which specifically respond to the initiation of an acoustical signal, play a crucial role in this context. As Hemmert explains, 'If one would turn on a pure tone at a frequency above 1000 Hz, such neurons send exactly one impulse, namely at the signal onset.' In addition, statistical noise is barely registered by these neurons. The

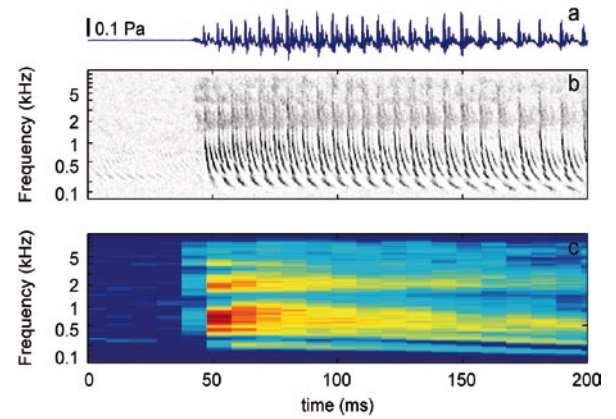


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human language, in contrast, is characterized by vocal chord impulses and vibrations at a frequency of 100 to 800 Hz, the fundamental frequency of speech. Onset neurons are optimized to pick up this rapid sequence of impulses and they send their signals in the rhythm of the speech signal. In this way, they enable the human hearing system to elevate language above background noise. In addition, they help discriminate between different speakers by analyzing their fundamental frequencies. ‘Our articulation and hearing systems have adjusted to each other in the course of evolution so that the transmission of information between speaker and listener has become optimized. From the chirping of a cricket to animal noises and on to human language, different communication signals have one thing in common: a distinct temporal structure,’ Hemmert explains.

Hemmert has studied electrical engineering and computer science and has been investigating the hearing process since the beginning of his ‘diploma’ project. During his doctoral thesis at the Tübingen Hearing Research Center, he conducted a detailed analysis of inner ear mechanisms to obtain a better understanding of how the ear transforms sound waves into neuronal impulses. He developed an apparatus to characterize the sound-induced vibrations of the different structural elements of the hearing organ by means of optical measurements. For this work, in 1996, he received the Helmholtz-Prize of the Physikalisch-Technischen Bundesanstalt.

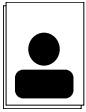
These measurements formed the basis of Hemmert’s subsequent research activities at the Massachusetts Institute of Technology, the IBM research laboratory in Zurich and the research laboratory of the technology enterprise Infineon in Munich. At IBM, Hemmert successfully implemented the first functional hydrodynamic life-sized model of the inner ear. At Infineon, he developed a detailed computer model of the inner ear and



*Response of the whole auditory nerve to speech signals. a) Time course of the sound pressure of the vocal ‘ay’, b) modeled response of 600 neurons covering the whole frequency spectrum of the inner ear. Neuronal impulses are triggered synchronously to the maxima of the pressure wave. c) Extraction of features with reduced temporal resolution, which can be processed by an automatic speech recognition system.*

subsequent neuronal circuits. Based on current findings from physiological measurements, the model calculates the neuronal spike pattern that would result from a given acoustical signal, thereby simulating the function of the ear. ‘The model can accurately predict the neuronal signal that is triggered by an acoustic stimulus and transmitted through the acoustic nerve. This allows for a better understanding of not only the processing mechanisms of the intact inner ear, but also of impairments in cases of inner ear deafness,’ explains Hemmert. Patients with a complete loss of inner ear function can recover an acoustic sensation with the help of cochlear implants, which directly stimulate the acoustic nerve.

Since his time at Infineon, Hemmert has been a principal investigator at the Bernstein Center in Munich. Although he has had multiple offers for professorships at different universities, he has decided to remain at the Bernstein Center. ‘Of course, this has to do with the desire to stay “at home” after living abroad for a long period,’ says Hemmert. To a large extent though, this decision was based on the good research environment and opportunities for scientific cooperations that Munich and the Bernstein Center for Computational Neuroscience offer.



## MEET THE SCIENTIST

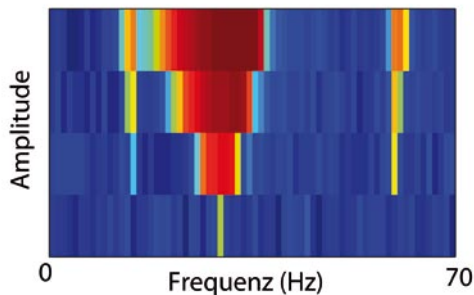
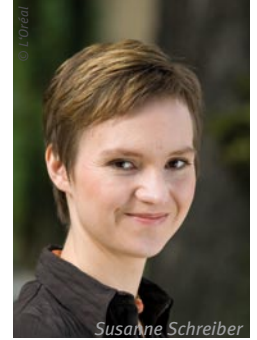
# Susanne Schreiber and Petra Ritter

### UNESCO-L'Oréal scholarship for women in science with children

In the year 2007, for the first time, three scholarships were awarded by the German UNESCO Commission and L'Oréal Germany in partnership with the Christiane Nüsslein-Volhard Foundation, for the promotion of women who excel in research. By providing aid for household and child care, the support programme shall enable outstanding young female scientists to combine family and research. Two of the scholarship recipients – Susanne Schreiber and Petra Ritter – are scientists at the Bernstein Center for Computational Neuroscience Berlin.

#### Susanne Schreiber

Susanne Schreiber is interested in how the properties of single neurons influence the function of larger neuronal networks in the brain. Each thinking process and each sensory processing in the brain is based on the activity of nerve cells, which pass on signals in the form of electric impulses – it is said that neurons ‘fire’. Often, larger groups of neurons send out impulses in a common rhythm; they influence each other, thus entering into a collective oscillation. Such rhythmic behaviour is essential for many functions of the nervous system – e.g. for the storage of information or



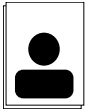
*Every neuron has a 'favourite frequency', at which it operates most precisely. The image shows the precision (color coded) as a function of the frequency and the amplitude of the input signal.*

the function of the short-term memory when exploring a new environment. Susanne Schreiber examines what enables single neurons within a synchronically firing network to keep the rhythm reproducibly and precisely.

Each neuron has a self-resonance – a kind of ‘favourite frequency’ at which it works especially precisely. The oscillation frequency of the whole network also depends on this frequency preference of single neurons. Which processes determine this frequency preference? How reliably do neurons respond to stimuli at this frequency? By selectively stimulating neurons with different signals, Susanne Schreiber was able to distinguish between different mechanisms that determine the response properties of the neurons.

Neurons maintain a voltage difference across their membrane, which they use to send neuronal impulses. When they receive signals from other cells, this membrane voltage changes; if a given threshold value is exceeded, the neuron itself sends a signal. Ion channels in the membrane serve to precisely regulate the permeability of the membrane for electric charges and thus the membrane voltage. Schreiber was able to show that the precise properties of certain ion channels determine how reliably neurons respond to signals.

Susanne Schreiber studied biophysics at the Humboldt University Berlin and completed her degree dissertation under Simon Laughlin's supervision at the University of Cambridge in Great Britain. With a scholarship, she wrote the first part of



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her doctoral thesis in Terrence Sejnowski's group at the Sloan-Schwartz Center of the Salk Institute for Biological Studies in California. For the second part of her doctoral thesis, she did research in Andreas Herz's group at the Institute for Theoretical Biology at the Humboldt University Berlin, where she completed her doctoral thesis in 2004. Currently, Susanne Schreiber – by now mother of a two-year old daughter – works at the Bernstein Center and at the Charité in Berlin, in close collaboration with scientists from the Humboldt University.

### Petra Ritter

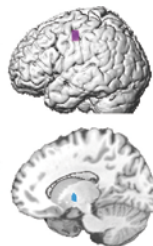
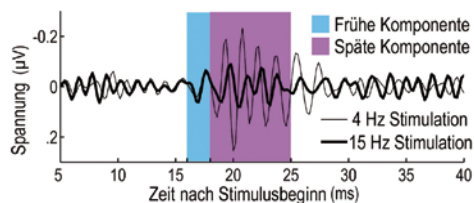
Understanding the human brain is a great challenge – it is highly complex and very difficult to access experimentally. Electroencephalography (EEG) and Magnetic Resonance Imaging (MRI) allow scientists to watch the brain at work. However, both of these methods have their limits; each method examines only certain aspects of the brain function. Petra Ritter's work aims at combining these two techniques so that they complement each other in a reasonable way. Even though both methods have already been used for decades, their simultaneous application is still in its infancy. This is mainly due to technical difficulties: the switching of magnetic fields for MRI measurement interferes with the EEG Signal. These problems must now be overcome.

By means of MRI, scientists examine which brain areas are involved in certain functions, e.g. in the processing of visual

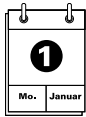
and acoustic information. However, the temporal resolution of MRI is very low – the rapid repetitions of electric impulses used by nerve cells to process information cannot be resolved. The temporal resolution of EEG is considerably higher. Electrical voltage changes in the brain are measured by electrodes that are attached to the scalp. Only when many neurons synchronize their electric discharges, their activities add up and can be perceived by EEG. Such rhythmic 'network oscillations' reflect specific conditions and functions of the brain.

Petra Ritter combines the two methods in order to use the better spatial resolution of MRI and, at the same time, the better temporal resolution of EEG. By doing so, she was able to show in which brain regions the so-called 'alpha rhythm' originates and how this rhythm influences the activation level of that region. When eyes are closed, neurons oscillate in the 'alpha rhythm', which is suppressed during visual stimulation.

Petra Ritter studied medicine at the Humboldt University Berlin. She spent a large part of her clinical traineeships and practical year abroad: at the universities UCLA and UCSD in Los Angeles and San Diego, the Mount Sinai School of Medicine in New York and the Harvard Medical School in Boston. She completed her period as 'Ärztin im Praktikum' (physician in training) in the neurology department of the Charité and, in 2002, she received her license to practise medicine. In 2004, she completed her doctoral thesis, which she also wrote at the Charité, under the supervision of Arno Villringer. Since 2001, Petra Ritter has been in charge of a study group at the Berlin Neuroimaging Center. She has two children, born in the years 2001 and 2007.



*Combining EEG and MRT allows localizing electric oscillations of neurons (left) to defined regions of the brain (right). Here, early reactions (cyan) and late reactions (purple) to a stimulus taking place within a few milliseconds are distinguished.*



## NEWS AND EVENTS

# The Bernstein Network and the Excellence Initiative

‘The Excellence Initiative makes history of science,’ said Annette Schavan, federal research minister, following the decision of the second call of the program in Bonn on October 19, 2007. All in all, after two selection calls, nine universities have been elected ‘Excellence University’; five of them are located at the four sites of the Bernstein Centers, another three at further locations of the network. 40 Graduate Schools and 37 Clusters of Excellence have been established by the Initiative, five and seven respectively with the participation of researchers of the Bernstein Network. The outcome of the Excellence Initiative thus impressively demonstrates the significance of Computational Neuroscience in the German research community. It therefore seem fair to say that as the Excellence Initiative is making history of science, the Bernstein scientists are having their share in this process.

## Life Sciences at the Humboldt-University Berlin

An interdisciplinary research approach gets a new home. Together with the Charité, the Humboldt University Berlin will establish an ‘Institute of Integrative Life Sciences’ (IILS) on its future Campus of Life Sciences, where also the Bernstein Center for Computational Neuroscience is located. At the IILS, renowned researchers from diverse disciplines will, in collaborative projects, jointly tackle burning questions of life sciences at the boundary between humanities and natural sciences. Co-founder of the project is Andreas Herz, Coordinator of the Bernstein Center Berlin.

Measures funded by the Excellence Initiative with contribution of Bernstein scientists

### Excellence Universities

- Ludwig-Maximilians-Universität München 2006
- Technische Universität München 2006
- Freie Universität Berlin 2007
- Georg-August-Universität Göttingen 2007
- Albert-Ludwigs-Universität Freiburg 2007
- Universität Konstanz 2007
- RWTH Aachen 2007
- Universität Heidelberg 2007

### Graduate Schools

- Berlin School of Mind and Brain (Humboldt Universität Berlin) 2006
- Spemann Graduate School of Biology and Medicine (Freiburg) 2006
- Graduate School of Systemic Neurosciences (LMU München) 2006
- Graduate School for Neurosciences and Molecular Biosciences (Göttingen) 2007
- The Hartmut Hoffmann-Berling International Graduate School of Molecular and Cellular Biology (Heidelberg) 2007

### Clusters of Excellence

- Microscopy at the Nanometer Range (Göttingen) 2006
- Cellular Networks (Heidelberg) 2006
- Cognition for Technical Systems (TU München) 2006
- NeuroCure: Towards a better outcome of Neurological Disorders (Berlin) 2007
- Centre for Biological Signalling Studies (bioss) - from Analysis to Synthesis (Freiburg) 2007
- Interdisciplinary Centre for Integrative Neuroscience (Tübingen) 2007
- Simulation Technology (Stuttgart) 2007

## Personalia

**Genela Morris** has received a Minerva fellowship of the Max Planck Society. The grant offers her the possibility of a two year research stay at the BCCN Berlin.

**Michael Frotscher** is the 2007 laureate of the „Senior Forschungsprofessur Neurowissenschaften“ (Senior Research Professorship) of the Hertie Foundation. The Senior Research Professorship aims at preserving the capacity and experience of scientists after the age of retirement.

## Upcoming Events

The inaugural symposium of the ‘Computational Vision and Neuroscience Group’, led by the recipient of the Bernstein Award 2006, Mathias Bethge, will take place in Tübingen on April 7-8.

View: <http://www.kyb.mpg.de/bethgegrou/symposium>

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*Title Image: In order to improve automatic speech recognition systems and inner-ear implants, Werner Hemmert investigates how the ear translates sound waves into neuronal signals (see p. 15).*

GEFÖRDERT VOM



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