

**Bernstein Network for Computational Neuroscience**

# Bernstein Newsletter



## **Recent Publications**

Shopping Subconsciously – Flexible while Growing – Time Course of Reach Planning



## **Meet the Scientist**

Jochen Triesch



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Bernstein Centers in the Second Funding Period – Bremen University Invests in Neurotechnology – Bernstein Center Freiburg Founded



# Shopping subconsciously

We stand at a busy street and watch a scene on the other side of the road. How much do we perceive of the passing cars? Is there maybe a corner in the brain that unconsciously ponders whether or not we would be inclined to buy the passing models? On the basis of magnetic resonance imaging studies, scientists around John-Dylan Haynes now answer this question with „Yes“. Even if we are not giving the inspection of a product our full attention, processes take place in the brain that prepare possible purchase decisions. Haynes works at the Bernstein Center Berlin, the Charité and the Max Planck Institute for Human Cognitive and Brain Sciences Leipzig.

It was already known from previous studies that purchase decisions can be predicted from brain activity measured during the inspection of a product. The role of attention in this process, however, had so far not been investigated. Does the brain process purchase-relevant information only consciously, if we are giving the product full attention? Or can we also predict the purchase decision if subjects see the object, but direct their attention to something else?

To investigate this, the researchers used functional magnetic resonance imaging (fMRI) to scan the brain activity of experimental subjects while they were shown pictures of a variety of cars. One group was asked to indicate how much they liked each of the cars shown. A second group was distracted during the presentation by a task in which they were to respond quickly to visual changes in a small square—the pictures of the cars were only presented in the background. After the experiment, the subjects were asked to indicate which of the cars shown they would buy. The scientists then studied how well they could predict the purchase decisions from the fMRI data.

In both groups, purchase decisions could be predicted with an accuracy of about 80%, based on the measured neural activity of two brain regions: the medial prefrontal cortex and the insular cortex. Both regions are known to be involved in the preparation of purchase decisions. The novelty of this study is that this preparation also happens when the object, although it is seen, is not the focus of attention.

If a car appeals to someone, that does not necessarily mean that he or she would want to buy it—perhaps it is too expensive or it consumes too much gasoline. Every purchase decision is based on complex trade-offs. Also in the brain, „appeal“ and „purchase considerations“ are processed in different regions. As the scientists showed, the brain activity measured in their experiment reflected these complex purchase considerations—even in the group of subjects that paid little attention to the cars.

[Tusche, A. Bode, S & Haynes, J.-D. \(2010\) The Journal of Neuroscience, 30\(23\):8024–8031](#)





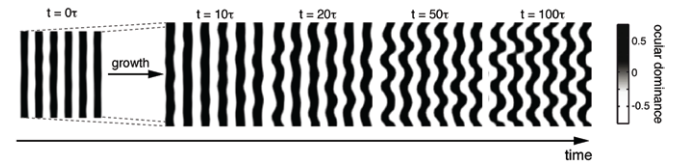
## RECENT PUBLICATIONS

### Flexible while growing

Science has long puzzled over why a baby's brain is particularly flexible and why it easily changes. Is it because babies have to learn a lot? Researchers from the Bernstein Network have now put forward a new explanation: Maybe it is because the brain still has to grow. In a recent study they showed that neuronal connections in the visual cortex of cats are restructured during the growth phase and that this restructuring can be explained by self-organizational processes. The study was headed by Matthias Kaschube, former researcher at the Max Planck Institute for Dynamics and Self-Organization in Göttingen and now at Princeton University (USA). Also participating in the study was Siegrid Löwel, professor at the University Jena (now in Göttingen) and scientist in the Bernstein Network.

The brain is continuously changing. Neuronal structures are modified with every learning step and every experience. Certain areas of the brain of a newborn baby are particularly flexible, however. In animal experiments, the development of the visual cortex can be strongly influenced in the first months of life, for example, by different visual stimuli.

Nerve cells in the visual cortex of fully-grown animals divide up the processing of information from the eyes: Some “see” only the left eye, others only the right. Cells of right or left specialisation each lie close to one another in small groups, called columns. The researchers showed that during growth, these structures are not simply inflated—columns do not become larger, but their number increases. Neither are new columns formed from new nerve cells. The number of nerve cells remains almost unchanged, a large part of the growth of the visual cortex can be attributed to an increase in the number of non-neuronal cells. These changes can be explained by the fact that existing neurons change their preference for the right or the left eye. In addition, another of the



Computer simulation of the development of ocular dominance columns. Black / white: preference for the left / right eye.

researchers' observations also points to such a restructuring: The arrangement of the columns changes. While the pattern initially looks stripy, it becomes more irregular over time.

“This is an enormous achievement by the brain—undertaking such a restructuring while continuing to function,” says Wolfgang Keil, scientist at the Max Planck Institute for Dynamics and Self-Organization and first author of the study. The researchers used mathematical models and computer simulations to investigate how the brain could proceed to achieve this restructuring. On the one hand, the brain tries to keep the neighbourhood relations in the visual cortex as uniform as possible. On the other hand, the development of the visual cortex is determined by the visual process itself—cells which have once been stimulated more strongly by the left or right eye try to maintain this particular calling. The researchers' model explains the formation of columns by taking both these tendencies into account. The scientists showed that when the tissue grows and the size of the columns is kept constant, the columns in the computer model change exactly as they had observed in their experimental studies on the visual cortex of the cat: The stripes dissolve into a zigzag pattern and thus become more irregular. In this way, the researchers provide a mathematical basis which realistically describes how the visual cortex could restructure during the growth phase.

Keil, W., Schmidt, K.-F., Löwel, S. & Kaschube, M. (2010). *Proc Natl Acad Sci USA*: 107(27):12293-8.

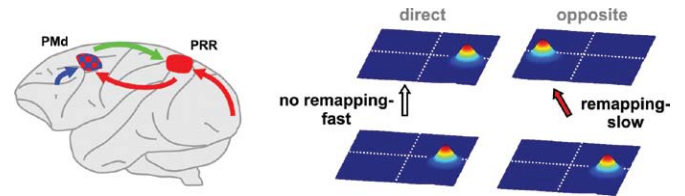


### Time course of reach planning

In most cases, our movements are precisely adjusted to our visual perception. For example, we see a glass of water and reach out for it. However, previous knowledge and decisions also play a role in motor planning. We know that drinking satisfies our thirst and therefore reach out for the glass in case we are thirsty. Two strongly interconnected brain regions in the parietal and premotor cortex are known to be involved in combining visual sensations and learned rules to a movement plan. In a current study, Stephanie Westendorff, Christian Klaes and Alexander Gail, researchers at the German Primate Center and the Bernstein Center Göttingen, have analyzed information processing in these regions in more detail. By measuring the precise timing of neuronal activity, they have shown that information flow not only strictly occurs from parietal to premotor areas—as conventional models assume—but that there also must be a feedback projection active.

Immediately before a reach movement begins, the movement goal is represented by neuronal activity in both brain regions: Some neurons, for example, are always active when reaching upwards, others during downward movements. Classical models of motor planning assume that the motor goal is first determined in the parietal cortex, and then transmitted to the premotor cortex in a next transformation step. This contrasts with models in which the motor goal is defined in the premotor cortex by an integration of spatial information and learned rules. The premotor cortex, or more precisely, the dorsal premotor cortex (PMd), would then feed this information back to the parietal reach region (PRR) in the parietal cortex.

To distinguish between these models, the scientists have measured the activity of many individual neurons in PRR and PMd of macaque monkeys that carried out a reaching task in which

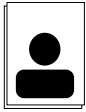


*Information flow for the planning of reaching movements in the brain. Red: visual information, blue: learned rules, green: motor plan. In reaching movements towards a visual signal, no remapping of neural activity takes place in PRR. Remapping is required for movements in the opposite direction.*

they combined visual information and learned rules about spatial relationships. The researchers showed that the movement plan was present in PMd prior to PRR whenever the monkey was required not to directly reach out for the visual signal, but rather to move in the opposite direction. This contradicts models in which the information about the movement plan is generally sent from PRR to PMd.

If the monkey reaches in the direction opposite of the visual signal, the spatial representation in the parietal cortex needs to be remapped. This remapping takes time. The scientists suggest that the time delay between PMd and PRR is due to the fact that PRR requires information from PMd via neuronal feedback connections for this remapping to occur. In a task in which no realignment of spatial activity is necessary, no time lag occurs between the two regions as was also shown in the study. The scientists assume that the feedback projections are needed during the planning and execution of a movement in order to continuously predict the sensory consequences of a reaching movement, allowing the subject to swiftly react to potential deviations from the expectations.

[Westendorff, S., Klaes, Ch., & Gail, A. \(2010\) The Journal of Neuroscience, 30\(15\):5426 –5436](#)



## MEET THE SCIENTIST

# Jochen Triesch

### The diversity of seeing

How does the brain process visual information? This problem can be decomposed into a hundred different sub-questions, because in order for us to see, the brain must cope with many different tasks. How does it analyze edges, contours, shadows and colors? How does it retrieve forms, discriminate objects and detect motion? “Human vision only works so well because the brain tackles all these aspects of vision simultaneously and partial solutions from one area influence solutions found in another area,” says Jochen Triesch, since 2007 Johanna Quandt Professor at the Frankfurt Institute for Advanced Studies (FIAS) and co-coordinator of the Bernstein Focus Neurotechnology in Frankfurt. “And because the brain is characterized exactly by this interplay of different strategies, it can only be understood by jointly analyzing its different skills.”

For this task, Jochen Triesch brings in the best qualifications. During the course of his research career, he has dealt with various aspects of vision, applying a diversity of research approaches, including neuroinformatics, psychophysics, developmental psychology, and robotics. According to Triesch, the best way to understand vision is to try and rebuild it in a computer. “In this way, you get a feeling of the kinds of problems that the brain has to solve when it analyzes image information,” he says.

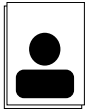
Triesch studied physics in Bochum, and while there, also completed a PhD in the field of computer vision. However, in order to come up with the topic of his doctoral thesis, he had to go to Sussex as part of a study abroad program. There, Triesch discovered his interest in neural networks and in the question of how brain functions can be simulated in a computer. When reading a text book, he noted with astonishment that one of the



great pioneers in this field, Christoph von der Malsburg, was working at his home university, of all places. Back in Bochum, he attended a seminar with von der Malsburg, and since that time, he has devoted himself to this research field.

In his doctoral thesis, Triesch investigated how robots can see objects, or more precisely, he taught them to recognize gestures. This is a particular challenge for an artificial visual system, because every person performs a gesture in a slightly different way, and the lighting conditions and spatial environments may vary. Gesture recognition is only possible if the robot bases its analysis of the scene on multiple features, such as movement, color or shape, and integrates them into an overall picture. Which piece of information proves most reliable for this task may vary from case to case. Therefore, Triesch based feature analysis on a strategy called “democratic integration”. In this strategy, the feature that the robot should primarily use for image analysis is not predetermined. Rather, multiple feature analysis systems interact with each other and in the end jointly come to a conclusion. “Whoever is outvoted shuts his mouth and thinks about what he could do better next time,” Triesch states when explaining the principle.

Triesch attended post-doctoral studies at the University of Rochester (USA), and in 2001 accepted an appointment as professor at the University of California at San Diego. Also in Rochester, he worked on feature integration and showed that, also in humans, this process may be based on “democratic” principles. Various predictions of the “democratic integration” could be confirmed in experimental subjects performing a perceptual task.



## MEET THE SCIENTIST

Which features of an object are most relevant for certain kinds of tasks under certain conditions? In examining this question, Triesch observed how amazingly little we are aware of what we see. In a perceptual experiment performed in a virtual reality environment, Triesch had subjects sort blocks by features—color or shape—that underwent sudden changes in exactly these properties. The changes went largely unnoticed by the subjects, even though they happened right before their eyes. Experts call this phenomenon “change blindness”. “These experiments put the very nature of perception into question,” says Triesch. “What we perceive has quite frequently rather little to do with what we actually see.”

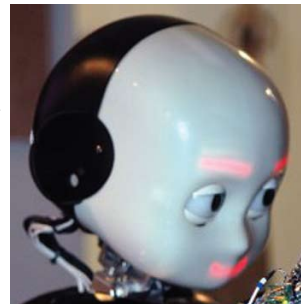
Why is that? Why do we seem to forget, from one moment to the other, that the block we are manipulating should actually be red? In later studies, already at FIAS, Triesch discovered a possible answer. He showed that visual processing is slowed down considerably when we engage our short-term memory. We have, for example, problems in telling faces apart if we simultaneously try to hold a face in memory. In order to be able to quickly grasp our visual environment, it seems that we switch off our visual short-term memory, at least in cases where we expect no change anyway, as in the case of the colored blocks. “Our brain seems to know quite well what to pay attention to,” says Triesch.

Not only does the brain have the ability to create a coherent picture from the variety of information that it collects about its environment, but it also learns this skill all by itself. How do neural structures acquire the ability to see? This is also a question in the focus of Triesch’s research interests. Also in this case, the same principles of his research approach apply—namely investigating different aspects of learning not separately, but in conjunction.

All learning is based on the fact that neurons change. On the one hand, they change the strength of their contacts to

neighboring nerve cells. This is referred to as “synaptic plasticity”. On the other hand, they also change their sensitivity to react to signals from neighboring cells. This process is called “intrinsic plasticity”. Previous studies on learning in neural networks have mostly considered only one form of plasticity. Triesch has now shown that network models that take into account both forms of plasticity can achieve things that the standard models are unable to do. For example, during vision, the image information is broken down into individual components that are analyzed independently from each other. Triesch was able to demonstrate how, based on synaptic and intrinsic plasticity, a network can learn this ability in an unsupervised fashion.

“Many problems cannot be solved in isolation. One has to try to understand how different aspects are related,” says Triesch. This insight probably most clearly characterizes Triesch’s scientific career. The Bernstein Focus Neurotechnology in Frankfurt is also characterized by the interaction of different approaches. Many different aspects of vision are investigated here, all of which are ultimately integrated into three different robot systems in order to equip them with the ability of learning to see.



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*In the framework of the Bernstein Focus Neurotechnology Frankfurt, the head of the robot “iCub” is being used to test computer models of vision.*

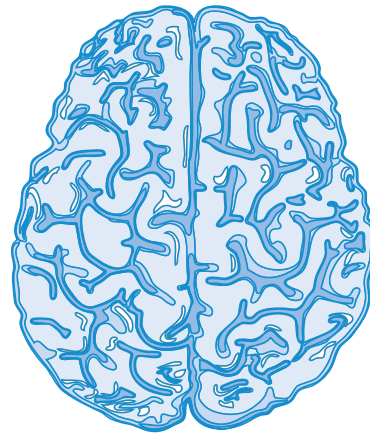


# Bernstein Centers in the second funding period

With 43 Million Euro, the German Ministry of Education and Research (BMBF) supports the establishment and continuation of five “Bernstein Centers for Computational Neuroscience” as part of the federal “Bernstein Network Computational Neuroscience”. The funding will contribute to further strengthen computational neuroscience in Germany. Two new Bernstein Centers will be established in Heidelberg-Mannheim and Tübingen, and existing centers in Berlin, Göttingen and Munich will receive renewed support over the coming five years.

Research topics of the Bernstein Centers are derived from the expertise present at the respective locations. The Bernstein Center Heidelberg-Mannheim will investigate the genetic basis of psychiatric diseases and the Center in Tübingen will focus on the question how the brain combines information and prior knowledge to a coherent perception. Research topics of the existing centers in Berlin, Göttingen and Munich are “Precision and Variability”, “Cooperative Dynamics and Adaptivity in Neuronal Systems” and “Neuronal Representations of Space-Time”.

With the new granting of the five Bernstein Centers, the total funding volume of the Bernstein Network now amounts to approximately 150 million €. This major investment of the BMBF within the framework of the “Hightech Strategy” of the Federal Ministry has turned Germany into one of the leading nations in the field of computational neuroscience. The Bernstein Network now grows to comprise approximately 200 research groups at 24 different locations in Germany. With this latest extension, seven new permanent professorships are being created in the newly funded Centers, adding up to a total of 21 professorships created within the whole Bernstein Network. The Bernstein Network is

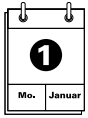


one of the largest funding initiatives in the field of Computational Neuroscience worldwide.

The Bernstein Network involves researchers from German universities, from institutes of the Max Planck and Fraunhofer Society, of the Leibniz and Helmholtz Association and includes 23 companies. The funding initiatives “Bernstein Focus: Neurotechnology” and “Bernstein Focus: Neuronal Basis of Learning” contribute to bridging the gap to applied sciences by translating insights from computational neuroscience into marketable products. To make sure that this stream of innovation will continue flowing, the scientific fundament of computational neuroscience needs to be strengthened. This will be ensured through the funding and further development of the Bernstein Centers for Computational Neuroscience. With their focus on basic research – though oriented towards application – they can be regarded as the core of the Bernstein Network.



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## NEWS AND EVENTS

### **Berlin – Precision and Variability**

**Coordinator: Prof. Michael Brecht,  
Humboldt-Universität zu Berlin**

**Funding volume: ca. 8,6 Millionen Euro**

The brain works very accurately and reliably. However, as in an electronic system, also in the brain the building blocks—the neurons—produce a background noise. How does the brain reliably encode information, in the face of such variability? Which neural signals are important, which are ignored?

### **Göttingen – Cooperative Dynamics and Adaptivity**

**Coordinator: Prof. Theo Geisel,  
Max-Planck-Institut für Dynamik und Selbstorganisation and  
Georg-August Universität Göttingen**

**Funding volume: ca. 8,5 Millionen Euro**

The brain is extremely adaptive, it changes with every experience. How do different spatially separated structures, such as brain areas, nerve cells and molecules, work together to produce certain functions of the brain? How does the adaptivity of the brain result from the cooperative interaction of its parts?

### **Heidelberg-Mannheim –**

**Genetic Determinants of Neuronal Information Processing**

**Coordinator: Dr. Daniel Durstewitz,  
Zentralinstitut für Seelische Gesundheit, Mannheim**

**Funding volume: ca. 9,6 Millionen Euro**

Recent years have seen a tremendous progress in identifying risk genes for a number of psychiatric conditions. Scientists at the Bernstein Center Heidelberg-Mannheim investigate the relationship between genetically determined neuronal properties and their impact on behavior and cognition.

### **Munich – Neuronal Representations of Space-Time**

**Coordinator: Prof. Andreas Herz,  
Ludwig-Maximilians-Universität**

**Funding volume: ca. 8,5 Millionen Euro**

During every sensory perception, a representation of the environment is generated in the brain in which space and time are tightly linked. We hear, where a sound comes from or observe, how an object moves through space. What are the neuronal principles that underlie these abilities of the brain?

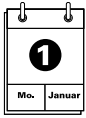
### **Tübingen – Neural Mechanisms of Perceptual Inference**

**Coordinator: Prof. Matthias Bethge,  
Max-Planck-Institut für Biologische Kybernetik**

**Funding volume: ca. 8 Millionen Euro**

Perceptual inference is the ability of the brain to combine sensory information and prior knowledge to form a coherent percept. Researchers at the Bernstein Center in Tübingen investigate how the complex interplay of neurons can accomplish this.





### Personalia

**Niels Birbaumer** (BFNT Freiburg-Tübingen) received no less than three major honors in 2010 for his plentiful groundbreaking contributions to clinical psychology and the neurobiology of learning. He was elected as a Fellow of the „American Association for the Advancement of Science (AAAS)“, received an honorary doctorate degree from the University of Jena and the Helmholtz Medal of the Berlin-Brandenburg Academy of Sciences and Humanities. Sources: [www.aaas.org/aboutaaas/fellows/new\\_fellows.shtml](http://www.aaas.org/aboutaaas/fellows/new_fellows.shtml); [www.idw-online.de/pages/de/news367606](http://www.idw-online.de/pages/de/news367606) (in German); [www.idw-online.de/pages/de/news375607](http://www.idw-online.de/pages/de/news375607)(in German)

**Benedikt Grothe** (BCCN Munich) was decorated by the Bavarian State Minister of Science, Research and the Arts, Dr. Wolfgang Heubisch, with the Cross of Merit on ribbon of the Order of Merit of the Federal Republic of Germany. The Order honors his achievements in the neurosciences, which he developed at the LMU Munich into an extremely successful focus of research and education. Source: [www.uni-muenchen.de/aktuelles/news/newsarchiv/2010/grothe\\_goetz.html](http://www.uni-muenchen.de/aktuelles/news/newsarchiv/2010/grothe_goetz.html) (in German)

**Onur Güntürkün** (BFNL Sequence Learning) joined the Wilhelm Wundt Society. The Society accepts maximally 30 members and aims at the support and development of basic research in psychology. [www.nncn.de/nachrichten-en/guentuerkuenwundtgesellschaft/](http://www.nncn.de/nachrichten-en/guentuerkuenwundtgesellschaft/)

### Bremen University invests in neurotechnology

After an intensive evaluation, the University of Bremen decided to promote the research area of neurotechnology on a long term basis by establishing an interdisciplinary research focus. The Bernstein Group Bremen took a significant part in

initiating this research direction. Over a funding period of three years, 470,000 € will be provided for the expansion of this line of research. The focus combines experience and knowledge from the fields of theoretical electrical engineering and microelectronics, radio frequency and microwave engineering, microsystems technology, automation technology, psychology and cognitive science, neurophysics and neurobiology. The support aims at creating a sustainable interdisciplinary network for research towards neurotechnologies. Speaker of the initiative is Prof. Axel Gräser (Institute of Automation, University of Bremen).

Source: [www.idw-online.de/de/news376480](http://www.idw-online.de/de/news376480) (in German)

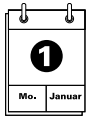
### Bernstein Center Freiburg founded

In the beginning of 2010, the Bernstein Center Freiburg (BCF) was founded as a Research Center of the University of Freiburg. It provides a new platform to consolidate Computational Neuroscience and Neurotechnology in Freiburg. The new institution combines the BMBF funded joint projects “Bernstein Center for Computational Neuroscience Freiburg” and “Bernstein Focus Neurotechnology Freiburg-Tübingen” with associated third-party funded projects. Moreover, it comprises national and international training and advanced training programs. With this Center, an important step towards sustaining the scientific activity—beyond the initial BMBF funding—has been made.

[www.bcf.uni-freiburg.de](http://www.bcf.uni-freiburg.de)



BCF building



### New call for proposals: Bernstein Award 2011

Starting 2011, the German Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF) intends, to initiate a new series of annual Bernstein Awards for excellent young scientists with out-standing research ideas in the field of Computational Neuroscience. The “Bernstein Award for Computational Neuroscience” is equipped with up to 1.25 Mio € for a period of five years, and allows young scientists from all nations to establish an independent research group at a German university or research institution. Application deadline for the year 2011 is May 20, 2011.

[Official BMBF announcement \(in German\):](#)

[www.gesundheitsforschung-bmbf.de/de/2476.php](http://www.gesundheitsforschung-bmbf.de/de/2476.php)

### International doctorates in Germany

With the funding program “International doctorates in Germany” (International promovieren in Deutschland, IPID) the German Academic Exchange Service (Deutscher Akademischer Austauschdienst, DAAD) supports, with funds from the German Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF), the establishment of internationally oriented PhD programs. The application deadline for the second IPID call for proposals is October 31, 2010. The program comprises two program lines: (1) “Internationalization of doctoral studies at German universities” and (2) “Bi-national PhD program networks”. Proposals for preparatory measures such as workshops, autumn schools and preparatory trips, can be submitted at any time, also until October 31, 2010.

Further information: [www.daad.de/ipid](http://www.daad.de/ipid)

## Upcoming Events

Termin / Date	Titel / Title	Organizers / Organisation	URL
September 27- October 1, 2010, Berlin	Bernstein Conference on Computational Neuroscience	K.R. Müller, M.L. Jügel, I. Weitkamp (BFNT Berlin)	<a href="http://www.bccn2010.de/">www.bccn2010.de/</a>
October 4-8, 2010, Trento, Italien	G-Node Autumn School: Advanced Scientific Programming in Python	P. Avesani (Center for Mind/Brain Sciences and Fondazione Bruno Kessler (Trento, Italy)), Zbigniew Jedrzejewscy-Szmek and Tiziano Zito (G-Node)	<a href="http://www.g-node.org/python-autumnschool">www.g-node.org/python-autumnschool</a>
October 10-15, 2010, Freiburg	BCCN/NWG Course: Analysis and Models in Neurophysiology	S. Rotter (BCCN Freiburg / BFNT Freiburg-Tübingen), S. Gruen (RIKEN, Japan and BCCN Berlin), U. Egert, A. Aertsen / J. Kirsch (BCCN Freiburg / BFNT Freiburg-Tübingen)	<a href="http://www.bcf.uni-freiburg.de/events/conferences/101010-nwgcourse">www.bcf.uni-freiburg.de/events/conferences/101010-nwgcourse</a>
October 26-27, 2010, Dresden	Workshop: Spike-Frequency Adaptation in Neural Systems	J. Benda (BPCN and BCCN München), B. Lindner, M. Lochar (MPIPKS, Dresden)	<a href="http://www.mpipks-dresden.mpg.de/~spaneu10/">www.mpipks-dresden.mpg.de/~spaneu10/</a>
November 13-17, 2010, San Diego, USA	Bernstein booth no. 3931 at SfN	Society for Neuroscience	<a href="http://www.nncn.de/termine-en/sfn2010/">www.nncn.de/termine-en/sfn2010/</a>
March 30- April 2, 2011, Delmenhorst	Workshop: Computational Aspects of Learning	Klaus Pawelzik (BGCN Bremen, BFNL sequence learning), Udo Ernst (BGCN Bremen)	<a href="http://www.nncn.de/termine-en/workshopdelmenhorst/">www.nncn.de/termine-en/workshopdelmenhorst/</a>

## The Bernstein Network

Bernstein Centers for Computational Neuroscience (BCCN)

Berlin – Coordinators: Prof. Dr. Michael Brecht

Freiburg – Coordinator: Prof. Dr. Ad Aertsen

Göttingen – Coordinator: Prof. Dr. Theo Geisel

Heidelberg / Mannheim: Dr. Daniel Durstewitz

Munich – Coordinator: Prof. Dr. Andreas Herz

Tübingen: Prof. Dr. Matthias Bethge

Bernstein Focus: Neurotechnology (BFNT)

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 Eget

Göttingen – Coordinator: Prof. Dr. Florentin Wörgötter

Bernstein Focus: Neuronal Basis of Learning

Visual Learning – Coordinator: Prof. Dr. Siegrid Löwel

Plasticity of Neural Dynamics – Coordinator: Prof. Dr. Christian Leibold

Memory in Decision Making – Coordinator: Prof. Dr. Dorothea Eisenhardt

Sequence Learning – Coordinator: Prof. Dr. Onur Güntürkün

Ephemeral Memory – Coordinator: Dr. Hiromu Tanimoto

Complex Human Learning – Coordinator: Prof. Dr. Christian Büchel

State Dependencies of Learning – Coordinators: PD Dr. Petra Ritter, Prof. Dr. Richard Kempter

Learning Behavioral Models – Coordinator: Dr. Ioannis Iossifidis

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-Erlangen-Nürnberg-Magdeburg, Berlin-Gießen-

Tübingen, Berlin-Constance, Berlin-Aachen, Freiburg-Rostock, Freiburg-

Tübingen, Göttingen-Jena-Bochum, Göttingen-Kassel-Ilmenau, Munich-

Göttingen, Munich-Heidelberg

Bernstein Award for Computational Neuroscience (BPCN)

Dr. Matthias Bethge (Tübingen), Dr. Jan Benda (Munich), Dr. Susanne Schreiber (Berlin), Dr. Jan Gläscher (Hamburg)

Project Committee

Vorsitzender des Bernstein Projektkomitees / Chairman of the Bernstein Project Committee: Prof. Dr. Andreas Herz

Stellvertretender Vorsitzender des Bernstein Projektkomitees / Deputy Chairman of the Project Committee: Prof. Dr. Theo Geisel

## Imprint

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*Title Image: To buy or not to buy a car? Scientists show that shopping decisions are prepared subconsciously in the brain (See article p. 3).*

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