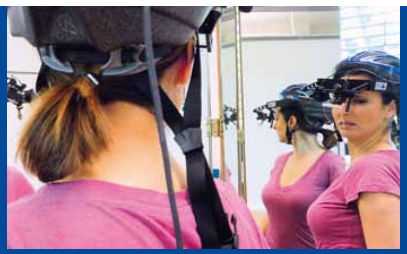
uni wissen 01 2012

The research magazine of the University of Freiburg | www.wissen.uni-freiburg.de

Light and Lasers

Self-reconstructing Bessel beams lead to better microscopic images

Text and Tradition:
Which verses of the *Iliad* Homer penned himself



Mirror Image and Self-Image:
How women with eating disorders perceive their body

Sacralization and Secularization:
Why we need to rethink our theories on faith

UNI FREIBURG

Signalhaus Freiburg: A New Home for Top-Level Research

Photo: Herzog

The University of Freiburg's Centre for Biological Signalling Studies (BIOSS) unites signaling research and synthetic biology – not just from a scientific perspective, but now also in a spatial sense: The research cluster opened its own building on 11 June 2012. It now brings the cluster's scientists and administration together under a single roof, as well as the so-called Toolbox, which provides biological materials and methodological competence for research.

Biological signaling processes form the basis of life for all of an organism's cells. Signaling research investigates how cells react to external signals and how signals are passed on within or between them. Synthetic biology reconstructs molecules or develops molecules with new functions. BIOSS builds a bridge between the these two fields of research by reconstructing biological signaling processes in the laboratory. The goal is to understand signaling paths and control signals.

The architecture and technical equipment of Signalhaus Freiburg are tailored to the needs of the research groups. The BIOSS scientists will form an even more closely knit network in the new building on Schänzlestraße across from the Faculty of Biology. Signalhaus Freiburg is thus an important component of the University of Freiburg's aim to further advance fundamental research in biology.

www.bioss.uni-freiburg.de

Contents

To always number among the best and to outshine others": This is the line from the Iliad *inscribed on Homer's seat at the entrance to Collegiate Building I of the University of Freiburg. Homer is regarded as the author of the* Iliad *– but the extent of his own contribution to the poem is a point of contention among scholars. Photo: Traenkle*

Back to the Old Verse

A New Research Method Developed by Indo-European Linguist Eva Tichy Has the Potential to Answer Unsolved Questions about Homer's *Iliad*

by Nicolas Scherger

"Homer or one of his predecessors adopted passages written in the older 15-syllable verse and converted them into Ionic hexameters"

Departure of a warrior: Typical scenes like this were used in the oral tradition of ancient poetry again and again. The picture shows the fragment of an amphora made around 460 BC in Athens, Greece, or in the immediate surroundings of the city.
Photo: Zahn/Archaeological Collection

The language of the *Iliad* is a mixed bag. The epic poem about the Trojan War contains older and newer forms, often within one and the same line. "Linguistic phenomena of the 8th century before Christ are interspersed so evenly throughout the text that you can hardly find a passage of 30 lines or more that could have been written in the 10th century or earlier in its entirety," says Eva Tichy, professor of Indo-European linguistics at the University of Freiburg. Philologists have been trying to determine how older and newer passages are distributed throughout the text of the *Iliad* for a long time – not least in order to establish the extent of Homer's own contribution to the poem. After four years analyzing the text, Eva Tichy is certain she has found the answers.

Tichy's approach combines two major research traditions. The analytical tradition views Homer as the author of an original version of the *Iliad* that drew on verse from oral tradition and was later expanded upon by others. The unitary tradition, on the other hand, sees him as the author of the final written version, which was based on material but not actual verse from earlier centuries. Tichy adopts the view of the unitary tradition that the entire poem was written by Homer but also delivers an analysis of the text that shows how he combined his own new material with traditional verse material in the poem. "In this way the text

Old helmet, old verses: The description of a boar's tooth helmet in the Iliad *provides a good example of how the poet integrated passages from the oral tradition into a new textual environment.*
Photo: Wikipedia Commons

becomes transparent, like a sheet of glass over an archaeological excavation: You can walk over it and still see what lies below."

Reconstructing the Original Verse Form

The Norwegian Greek philologist Nils Berg set the stage for Tichy's work in 1978 with his hypothesis on the origin of the hexameter. The hexameter, the meter of the *Iliad*, is made up of 14 to 17 syllables arranged in sequences of long and short in accordance with strict rules. Berg views the hexameter as an innovation and attributes it to the Ionic dialect of Homer. He argues that it developed out of a 15-syllable, metrically freer verse from the Aeolic phase of the early Greek epic poem, which preceded the Ionic phase. Tichy applies this hypothesis to the *Iliad*: "Homer or one of his predecessors adopted passages written in the older 15-syllable verse and converted them into Ionic hexameters." It thus follows that linguistically old lines of the *Iliad* that can still be read as epic 15-syllable verses or that can be brought into this form with only minor changes can or must be old. On the other hand, all lines that cannot be converted back into the older verse form are probably newer lines that were written in hexameters from the beginning and were penned by Homer himself.

In order to test her hypothesis, Tichy is trying to reconstruct the older verses in the text with as few changes as possible. In other words, she is undoing the metric adjustments to the verses that she believes Homer to have once made himself in order to make them into hexameters. For example, she shortens syllables from metrically elongated word forms and eliminates particles or pronouns if they don't contribute anything to the content or are maybe even located at the wrong position in the sentence. Or she exchanges metrical variants and replaces newer Ionic forms or non-grammatical forms by their older, regular counterparts. She searches for parallels in unchanged verses in each individual case in order to ensure that her changes remain within the bounds of the traditional poetic language. This would not have been such an easy task before the Digital Age: "I have the advantage of being able to search through Homer's text electronically."

Linguistic Breaks Explained by Content

However, the argumentation is only convincing when the linguistic breaks between the old and new passages can be justified by the content. In addition, she has to make sure the results of her work do not contradict the findings of reliable methods of dating text, for instance archaeological finds. Her previous work has adhered to both of these criteria, says Tichy. One example is the boar's tooth helmet of Meriones in the tenth book of the *Iliad*: This type of helmet is Mycenaean. The most recent known copy was found in a grave from the 10th century before Christ. The description is so detailed that it is highly probable that the person who originally wrote it had seen such an object himself. Indeed, the lines including this description are easy to convert back into epic 15-syllable verses and may thus be classified as old – whereas the preceding and following lines are not. "This is thus an old passage that was integrated into a new textual environment." A counterexample is

"All of a sudden it becomes clear how Homer treats the orally transmitted material, how closely attached to the epic tradition he is and where he transcends it"

Achilles' speech in the ninth book, which consists primarily of old verses. The city of Thebes is mentioned – along with the city of Orchomenos, both located in the Greek region of Boetia. In the following three lines, however, it is explained that it is the Egyptian Thebes that is meant, a city regarded as being especially rich in Ionic times, and these lines cannot be converted into epic 15-syllable verses. "A more recent insertion in an older textual environment," concludes Tichy.

A Risk of Error of Less than Ten Percent

Tichy has analyzed five books of the *Iliad* so far. The result: Between two-thirds and three-fourths of two of them consist of old verses. In the tenth book, however, almost 80 percent of the verses are more recent. That fits the picture: It is regarded as certain that this book, probably the work of another poet, was added later – because it makes references to other parts of the *Iliad*, but there are no references to it in the rest of the work. In addition, Tichy has conducted a provisional appraisal of around 500 reconstructed 15-syllable verses. Just under a quarter of them remained unchanged from the original text. "Half of them needed minor changes, often amounting to a mere linguistic regularization. These are the most telling cases," says Tichy. She had to risk more radical changes in the other third. "However, my changes often lead to advantages in that they solve long-known textual problems." She estimates the risk of error at less than ten percent.

On the whole, it is possible to identify two textual layers. The older one was written between the 11th and the 9th century before Christ. It includes material that was available to be used again and again in the oral tradition and that has been handed down to us exactly for that reason: speeches, battle scenes, other typical scenes like those depicting a departure, an arrival, or a visit, but also popular songs and short epic poems. The newer layer, that consisting of Homer's own verses, is characterized by sections that move the plot forward and structure the work by referring to preceding or following passages. "All of a sudden it becomes clear how Homer treats the orally transmitted material, how closely attached to the epic tradition he is and where he transcends it," says Tichy.

The Indo-European linguist has been working on her analysis of the *Iliad* since 2008. "In the beginning I could hardly believe that the experiment could be successful myself and that one could then just see which passages are old and which are more recent." Her results have the potential to become a sensation in philological circles. However, until now she has been viewed as an outsider: She conducted her research alone, applications for third-party funding "would have certainly been turned down," reactions from colleagues have been cautious. But Eva Tichy is convinced that she is on the right track. For the present, she is unwilling to make any predictions concerning the other 19 books: "It will be exciting to see what the rest of the project will show or bear out. It will no doubt be my last big research project."

Prof. Dr. Eva Tichy *studied Indo-European linguistics, Indo-Iranian linguistics, Latin, and Greek in Erlangen and earned her habilitation in 1989 in Marburg. Following stations in Basel, Switzerland, and Frankfurt am Main she accepted a chair in comparative linguistics at the University of Freiburg in 1993. From this time on, she has taught Indo-European linguistics in Freiburg; until a minor field program in general linguistics was established, she was also responsible for this field. From 1995 to 1997 she served as dean of the then Faculty of Humanities II. Her research initially concentrated on Greek, later on Indo-Iranian, particularly Vedic Sanskrit. She is currently working primarily on a linguistic analysis of the* Iliad. *Photo: S.K.U.B.*

Further Reading

Tichy, Eva (2011): Ilias diachronica Iota (9). www.freidok.uni-freiburg.de/volltexte/8282

Tichy, Eva (2010): Älter als der Hexameter? Schiffskatalog, Troerkatalog und vier Einzelszenen der Ilias. Bremen.

Tichy, Eva (2009³): Indogermanistisches Grundwissen für Studierende sprachwissenschaftlicher Disziplinen. Bremen.

Ready for the Defense

Scientists at the Center for Chronic Immunodeficiency of the Freiburg University Medical Center Are Studying Defective Immune Cells of the Human Body

by Eva Opitz

The four letters SCID might not sound harmful, but as a diagnosis they mean terrifying news for the parents of an afflicted child. Doctors use this acronym to refer to “severe combined immunodeficiency,” a disorder that leads to death in the first year of life if the cause is not identified in time. This form of immunodeficiency is very rare: Only one to three of every 100,000 children suffer from it.

“The difficult research on rare diseases is especially useful for learning about how the immune system works in general”

In Germany, patients diagnosed with SCID are treated at the Center for Chronic Immunodeficiency (CCI) of the Freiburg University Medical Center, the largest reference center for the disorder in the country. “It is not possible to specify the clinical picture in the beginning,” says the clinical director of the center, Prof. Dr. Stephan Ehl. “These people are vulnerable to infections in general. Due to an impairment in their immune system, the infections accumulate and their course is much more severe than in other people with the same infection.” The disorder also leads to an impairment of the immune regulation, which can manifest itself in eczema, chronic diarrhea, an enlarged spleen, or enlarged lymph nodes. The doctor must work out the precise profile of the infection and establish a connection with the impaired regulation in order to determine which of the around 200 genetically defined immune defects the patient is afflicted with. “It is important for the pediatrician to be attentive early on and determine whether an infection with a pathological course is present.”

The three-year-old boy Tim suffers from an immunodeficiency. He has thus received a bone marrow transplant at the Freiburg University Children’s Hospital. Dr. Thomas Vraetz examines him after the intervention. Photo: Kunz

The smaller, green-bordered T cell attaches itself to the larger infected target cell in order to destroy it. Freiburg scientists are studying why this defensive reaction no longer functions in some patients.

As with many genetic diseases, SCID occurs more frequently in children who are the product of marriages between relatives. In such cases, genetically based immunodeficiencies are transmitted twice. “It can also happen with parents who are not related, but the probability is lower,” says Ehl. In general, lymphocytes play the main role in the immune system’s answer to a germ. They include the so-called T cells, precursor cells from the bone marrow that penetrate into the thymus gland, where they are shaped further and prepared for their task. As soon as the body gives the signal that it is ready, the T cells begin circulating in the blood and are ready to destroy invaders that can cause an illness. The B cells have the same task. They also develop out of precursor cells in the bone marrow and are prepared for their function in the immune defense. In the case of SCID, it can happen that only very few of these two types of immune cell are available or that the cells are formed but cannot be activated due to a defect in function. Freiburg doctors were among the first to conduct research into the causes for this failure.

Immune Cells Do Not Work as Planned

“Cellular processes play an important role,” says Ehl. The T cell receives an activation signal from a T cell receptor, which sits on the cell like a tentacle. A calcium channel in the membrane surrounding the cell is then opened, allowing positively charged ions to flow into the cell. The calcium ions function as a second messenger that activates the switching points in the cell. The cell divides and forms messengers to destroy tumor cells and cells infected by the virus. For example, it punctures holes in the membrane of such target cells, thus demonstrating its cytotoxicity. In one form of SCID the problem stems from a calcium channel. A mutated gene prevents the channel from functioning as it is supposed to and the T cell from being activated. “We have succeeded in understanding why the immune cells, although they are there, do not work as the are supposed to,” says Ehl. “The difficult research on rare diseases is especially useful for learning about how the immune system works in general.” Whereas the identification of the calcium channel goes back to research in Freiburg in the 1990s, up until now only little was known about the role of the channel for cytotoxicity. “We developed tests a while back in order to measure this toxicity in a quick and simple way. In examining the patients, we found out that the cytotoxicity does not function without the calcium channel and that this prevents viral infections from being controlled.” The diagnostic methods derived from these experiments can be transferred to other groups of immune defects. The scientists are considering the prospect of using their new findings for therapies. In the case that the T cells exhibit overactive behavior and threaten to lead to the rejection of a transplant, an obstruction of the calcium influx could slow down the activation signal. “It could be advantageous to block the T cells in certain cases instead of using imprecise medicines that suppress an immune response, for instance in autoimmune diseases like multiple sclerosis,” says Ehl.

Learning to Understand the Disturbed Development

As head of the Section for Pediatric Immunology at the CCI’s Center for Pediatrics and Adolescent Medicine, Ehl founded a reference center for defects of the immune system that is now recognized throughout Europe. His focus is on studying the immune response of the T cells. In addition to conducting important research on this topic, he has initiated a study on the treatment of combined immunodeficiencies at the center. “We want to improve the treatment of patients by learning to better understand the

"As difficult as the disease and its correct diagnosis may be, the therapy is actually relatively simple"

causes of the disturbed development and regulation of the immune system." Since immune defects appear early, most of the patients are children. However, there are also long, drawn-out cases extending even into old age, for instance when repeated bouts of pneumonia are not identified as a problem originating in the patient's immune defense. Ehl sees the advantage of the CCI as lying in the cooperation between infectiologists, hematologists, internists, transplanters, and pediatricians. "We combine fundamental research with patient care at the clinic and can share our results with each other." Using their insight into the cellular processes of the immune system, the scientists of the CCI succeeded in implementing the correct therapy for SCID. "As difficult as the disease and its correct diagnosis may be, the therapy is actually relatively simple," says Ehl. The T cells of the hemopoietic system cannot be activated in SCID patients since the necessary influx of calcium into the cell is disrupted. However, research has shown that the formation of messengers is essential for the activation and the cytotoxicity of the immune response.

The scientists found an obvious solution to the problem: counteracting the genetic defect by introducing healthy cells. "In the case of many genetic diseases the doctor can't do much, but when the hemopoietic system is affected, he can exchange it," says Ehl. The non-functioning immune cells are killed off by means of chemotherapy, thus preventing an immune reaction and the rejection of foreign cells. If the patient's own bone marrow is destroyed, the doctors introduce healthy bone marrow cells from a donor through the veins via blood transfusion, and the cells then find the right place all on their own. "We don't even have to operate," says Ehl. Thanks to medical progress it is now possible in some cases to repair the bone marrow cells of a diseased child in a test tube by introducing a healthy gene. The child develops a healthy immune system following the transfusion. The youngest patient at CCI is an eight-month-old child who has just received a bone marrow cell transplant. There had already been a similar case in the patient's family, so the pediatrician was more alert from the beginning. However, it wasn't until the baby had undergone several bouts of pneumonia that the severity of the illness was identified. "Now he is doing better again."

Prof. Dr. Stephan Ehl *worked as a postdoc under Nobel laureate Prof. Dr. Rolf Zinkernagel in Zurich, Switzerland, after studying medicine in Aachen, Erlangen, and Munich. After completing his training as a pediatrician in Freiburg, he earned his habilitation in 2003. Since 2008 Ehl has served as medical director of the Center for Chronic Immunodeficiency (CCI). He has dedicated himself to treating and researching immunodeficiencies for the past 15 years and has made important contributions to the improvement of diagnostics and the study of the symptoms of immunodeficiencies.*

Further Reading

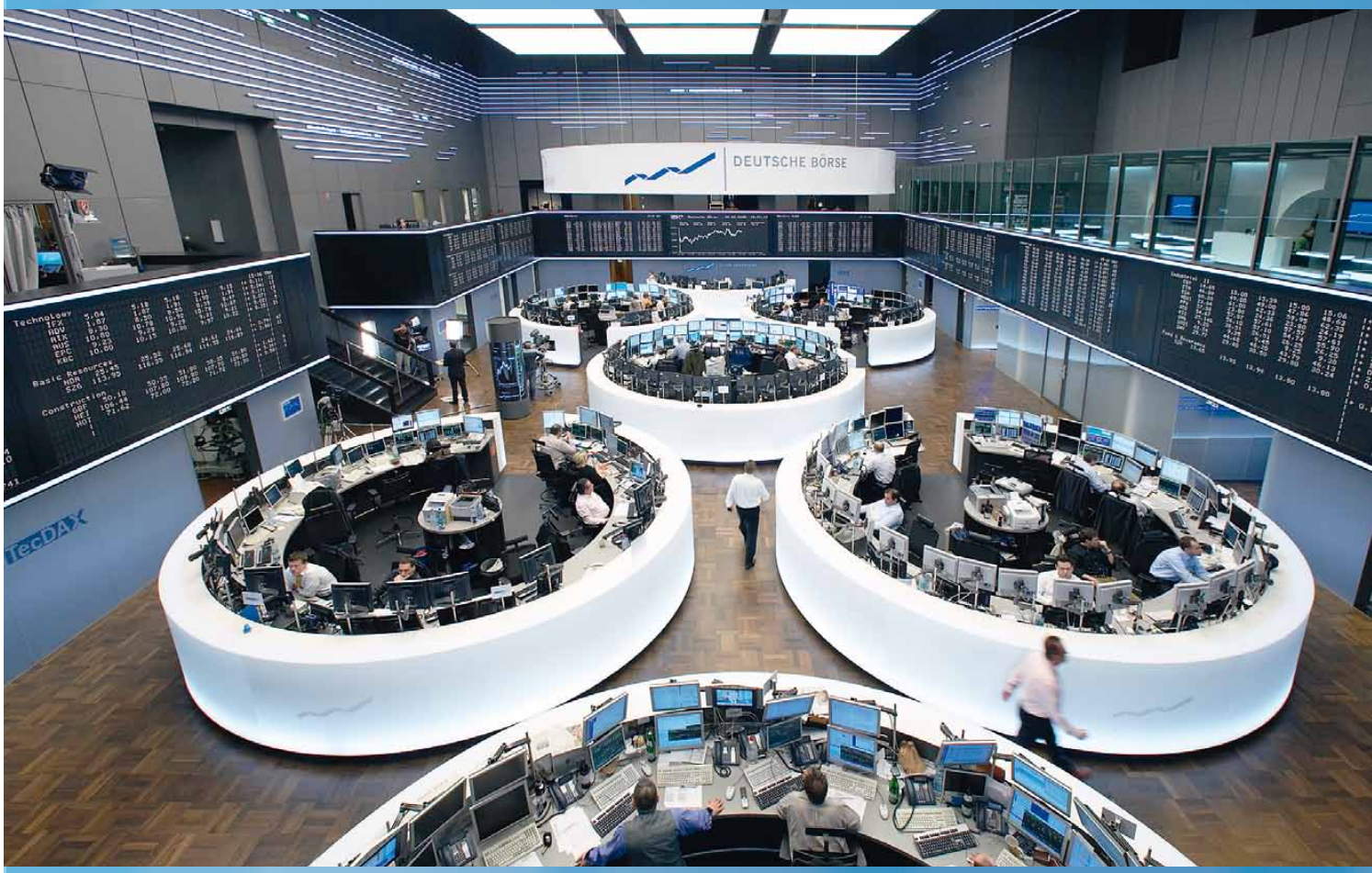
Bryceson, Y. T./Pende, D./Maul-Pavicic, A./Gilmour, K. C./Ufheil, H./Vraetz, T./Chiang, S. C./Marcenaro, S./Meazza, R./Bondzio, I./Walshe, D./Janka, G./Lehmberg, K./Beutel, K./zur Stadt, U./Binder, N./Arico, M./Moretta, L./Henter, J. I./Ehl, S. (2012): A prospective evaluation of degranulation assays in the rapid diagnosis of familial hemophagocytic syndromes. In: Blood 119/12, pp. 2754 – 2763.

Maul-Pavicic, A./Chiang, S. C./Rensing-Ehl, A./Jessen, B./Fauriat, C./Wood, S. M./Sjöqvist, S./Hufnagel, M./Schulze, I./Bass, T./Schamel, W. W./Fuchs, S./Pircher, H./McCarl, C. A./Mikoshiba, K./Schwarz, K./Feske, S./Bryceson, Y. T./Ehl, S. (2011): ORAI1-mediated calcium influx is required for human cytotoxic lymphocyte degranulation and target cell lysis. In: Proceedings of the National Academy of Sciences of the United States of America 108/8, pp. 3324 – 3329.

Making Sense of Dilemmas

Public Finance Expert Wolfgang Eggert Studies Mechanisms that Get Societies into Difficult Situations

by Katharina Wetzel



Ruinous competition: When countries lower their capital tax, the investors they are trying to attract are the winners (left: the trading floor of the Frankfurt Stock Exchange). But since this results in less tax revenue, the countries have less money to fund public goods like education and equal opportunity (right: Freiburg students at the education strike in 2010). Photos: Deutsche Börse AG, Kunz

What do a cuckolded husband and a German Minister of Finance have in common? Both of them are in an awkward situation. Both of them have to make a decision. And neither of them know whether their decision will lead to success. The husband has to decide whether to leave his wife or to forgive her. The finance minister has to decide whether to burden the citizens with more taxes or not. Neither of them know how their respective audience – in the one case the wife, in the other the voter and taxpayer – will react, because they might be concealing their true opinion in their own self-interest.

Only one thing is for certain in this complicated situation, says the Freiburg economist Prof. Dr. Wolfgang Eggert: "However private and public actors decide, the results will often be painful." Difficult situations like these, in which everyone wants the best result for him or her self and one or the other party is thus bound to come out disappointed, are referred to in game

"However private and public actors decide, the results will often be painful"

theory as dilemmas. Dilemmas can lurk everywhere: in private life just as in politics and the business world. Eggert loves to find the best solution to such problems – even in cases in which the situation actually seems hopeless. The public finance professor studies societal processes and their impact on the tax and financial sectors. What tax policy leads to the broadest level of satisfaction in the populace? And what effect does tax competition have? These are the kind of questions that pervade his work.

Where do decisions lead? Game theory describes situations in which the success of the individual is not only dependent on his or her own action but rather also on the behavior of others.
Photo: Mellimage/Fotalia

Das Dilemma des Steuerwettbewerbs

	COUNTRY 1 cooperation	no cooperation
COUNTRY 2 cooperation	**A** 3 / 3 **(6)**	**B** 1 / 4 **(5)**
no cooperation	**B** 4 / 1 **(5)**	**C** 2 / 2 **(4)**

A simple thought model from game theory illustrates why sovereign states have difficulties harmonizing their tax rates. The colored numbers stand for the benefits the respective behavioral strategy has for the individual state. The numbers in parenthesis represent the sum of these benefits and thus the social value for the state. This number is largest when the two states cooperate by agreeing to harmonize their tax rates (A). However, the individual benefit for a country is greater when it signalizes a willingness to cooperate but then deviates from this course – assuming that the other country cooperates and thus incurs the most damage (B). No cooperation is thus also the predominant strategy when a country assumes that the other will not cooperate. But when no one cooperates, the social value is minimized (C). The result: Although all countries lose by competition in sum, they strive for it – a social dilemma.

Within the context of his most recent study – on framework conditions for negotiating tax reforms – Eggert was invited to the Brussels Tax Forum, at which the world's leading experts in public finance meet each year to discuss topics of public interest in taxation. The yearly conference serves to clarify issues and provide advice for policy makers. It also provides decision-making bodies of the European Union (EU), for example the European Commission, with valuable background information from current research. The EU currently has 27 member states, making tax harmonization a slow and difficult process. A common tax policy, let alone uniform tax rates, is but a distant goal.

A Thought Model Shows Why Cooperation Is Difficult

Eggert illustrates why cooperation between countries is so difficult with the help of a simple thought model: Two sovereign states are connected by a single capital market. The citizens of each state are free to consume private and public goods. The latter are goods which it is in the public interest to provide but which are normally not produced in sufficient quantity by private markets – for instance social justice, equal opportunity, information, or fundamental research. In order to provide public goods, both countries impose a capital tax. However, this leads to a conflict in interests: If taxes are raised, investors will be less willing to invest in the country. However, the state can finance more public goods with the additional tax revenue, and this benefits everyone. A tax cut, on the other hand, benefits the investors; their income increases. Since they will invest the additional capital now at their disposal, domestic production will increase as a consequence, and in the end so will private income. In return, however, the state receives less tax revenue. Funding for public goods must thus be cut, and public welfare sinks.

In situations like this, economists typically call for more competition. Competition, they argue, forces the state to be more economical. If the two states were to compete for investors, the optimal tax rate would set itself at the right level without any external help. In the model described above, however, tax competition would give rise to a ruinous race to attract investors, says Eggert: "It's a dilemma situation in which there can be no winners." If the countries

"From an academic perspective, it is a great achievement that the EU is a partially supranational confederation"

Prof. Dr. Wolfgang Eggert *studied economics in Constance, where he then went on to complete his PhD under the tutelage of Prof. Dr. Bernd Genser in 1999. Following stints in Japan, Norway, and Denmark, he earned his habilitation in Constance in 2003. He then accepted a post as a research professor at the Ifo Institute for Economic Research, where he is still employed today. From 2005 to 2010 Eggert lived and worked in Paderborn. Since 2010 he has taught and researched at the Institute of Public Finance and Monetary Economics in his adopted home Freiburg. His research focuses on public finance.*

descend into a spiral of tax-cutting, in the end they will hardly be able to provide any public goods at all. In theory, tax competition should bring about the most favorable result, but in reality it leads to the opposite.

Another possibility would be for the countries to cooperate by agreeing on a common tax rate, thus preventing investors from leaving. "But deviation is always worth it," says Eggert, because a county that lowers taxes more than agreed upon puts itself in a better position – at least as long as the other country abides by the agreement. The tragedy of the situation is that both countries thus have an incentive to deviate from cooperative behavior. "The politicians in both countries want the best for their own country and citizens and then find themselves in the worst situation for everyone," explains Eggert. What does this teach us about the EU? "From an academic perspective, it is a great achievement that the EU is a partially supranational confederation," says Eggert. "In any case it's not a bad sign that institutions like the European Parliament exist and are criticized for not acting in the national interest of the voters of individual member states alone."

Countries Should Abstain from Tax Competition

The public finance professor is looking for mechanisms that encourage countries to abstain from tax cuts and mutually detrimental competition of their own accord. An example of one of them could be: "Deviations will be punished." If a country that does not abide by agreements has to fear sanctions, it is usually more cost-effective to abide by the agreements. But a look at the debt-ridden countries of the eurozone shows that states often do not abide by rules that they have set up for themselves – and still do not have to reckon with sanctions. "Finding the right balance is difficult for economists and politicians alike," says Eggert. On the one hand, the threats must be made to seem credible. If they aren't, they will not be taken seriously. On the other hand, they should not be too strong, in order to not put off anybody. A system of sovereign states only functions when everyone pulls together.

The EU, at any rate, has not yet succeeded in installing an effective mechanism for sanctions. Countries that break the rules are generally in good company. In addition to Spain and Greece, for example, Germany has also breached the European Stability and Growth Pact multiple times in the past years and deregulated its financial markets. That makes it difficult to enforce sanctions. After all, who would want to punish himself? However, economists can stand by the side of policy makers as advisors in such dilemmas by explaining why countries abide by agreements or why they break them.

Further Reading

Eggert, W./Itaya, J.-I./Mino, K. (2011): A dynamic model of conflict and appropriation. In: Journal of Economic Behavior & Organization 78, pp. 167–182.

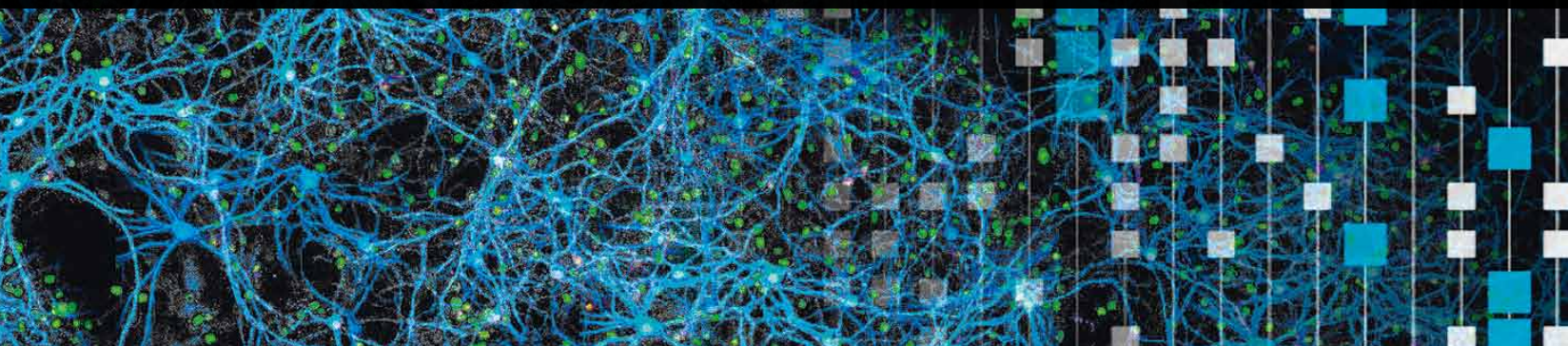
Eggert, W./Itaya, J.-I. (2011): Tax rate harmonization, renegotiation and asymmetric tax competition for profits with repeated interaction. (= CESifo Working Paper 3437).

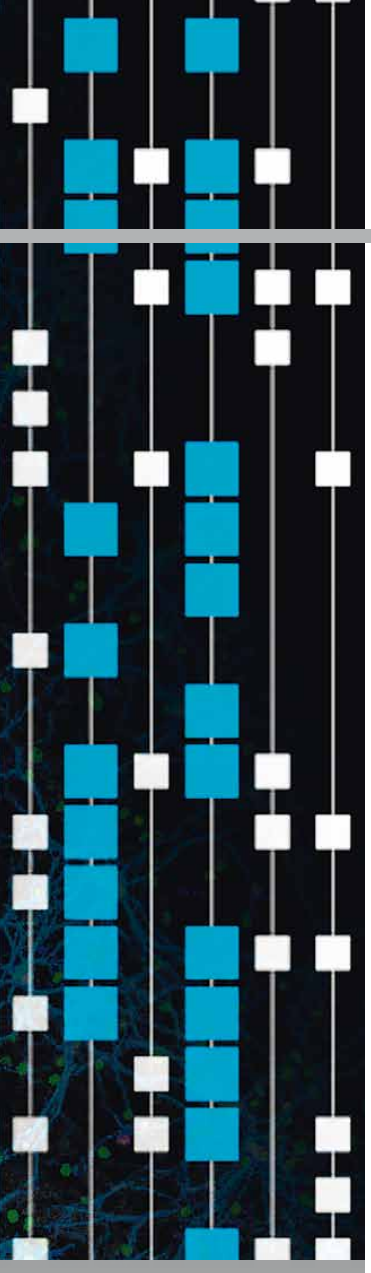
Eggert, W. (2010): Frameworks for negotiating tax reforms: What can we learn from the economic literature. Brussels Tax Forum 2010.

Making Deep Brain Stimulation Greener

Scientists at the Bernstein Center Freiburg Are Studying the Emergence of Parkinson's Disease – and Are Developing an Energy-Saving Treatment Method

by Stephanie Heyl





Biological networks of nerve cells (left) and a schema of the network (right) that can serve as the basis for computer simulations: Computational neuroscience uses equations and models to determine how the human brain functions.

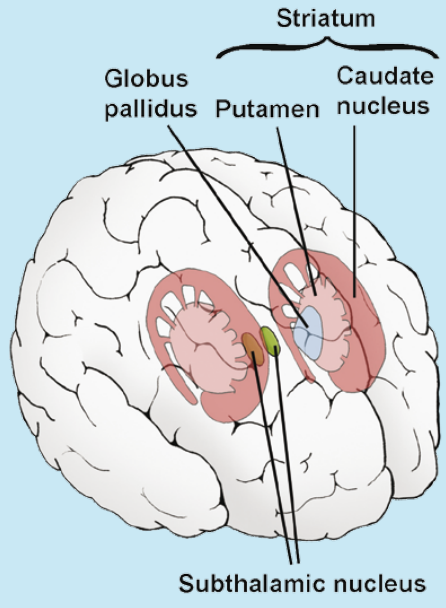
"When something is so microscopically small that I don't see it and at the same time so complex that I don't understand it, I have to simplify it"

Guiding a cup to one's mouth is a simple process, and yet it involves the joint action of millions of nerve cells. For the 300,000 million people in Germany suffering from Parkinson's disease, it thus presents a real problem. Particularly in the later stages of the disease, patients can only carry out deliberate movements with great effort, if at all.

The disease originates in the basal ganglia, a group of structures in the brain that are among other things responsible for selecting and controlling movements. In Parkinson's patients, nerve cells in these structures that produce and store the chemical messenger dopamine die off for reasons that are as yet unclear. The shortage of dopamine disrupts the balance between inhibiting and stimulating substances in the processing and transmitting of impulses. By the time the first disturbances in motion sequences appear, more than half of the cells producing dopamine have already died off. "Since the outward signs aren't visible until so late, we don't know exactly where the disease originates," says Dr. Arvind Kumar from the Bernstein Center Freiburg and the Faculty of Biology of the University of Freiburg. The engineer and theoretical neuroscientist is thus working with hypotheses: A computer model he has developed proposes an explanation of how Parkinson's disease emerges – and of how deep brain stimulation (DBS) counteracts the symptoms.

A Parkinson's therapy begins with drugs that compensate for the lack of dopamine. But in the course of time the drug's duration of effect decreases and phases of good movement can end abruptly – the so-called on-off phenomenon. The use of DBS, a neurosurgical procedure that can alleviate the symptoms, was approved in 1998. The patient receives a so-called neurostimulator as an implant: Electrodes are placed at certain positions in the brain through a tiny hole in the cranium. An impulse generator connected to the electrodes sends weak electrical impulses, causing a permanent electrical stimulation to act on abnormally overactive nerve cells. The procedure does not destroy any brain tissue, and the intensity and voltage of the current can be adjusted at any time with a programming

"We can draw inferences about the behavior without having to work directly on the human brain"



The basal ganglia (colored) in the brain are among other things responsible for selecting and controlling movements. They include two networks of nerve cells that influence each other and whose activity periodically oscillates in Parkinson's patients: the subthalamic nucleus and the globus pallidus. In order to study the emergence of the disease, Arvind Kumar simulated this activity in a model, also taking account of the influence of the striatum, another brain structure. Graphic: Wrobel

device. DBS does not arrest the progress of the disease, but it does allow many patients to reduce the amount of drugs they have to take. Their quality of life improves.

Modeling Networks of Nerve Cells on the Computer

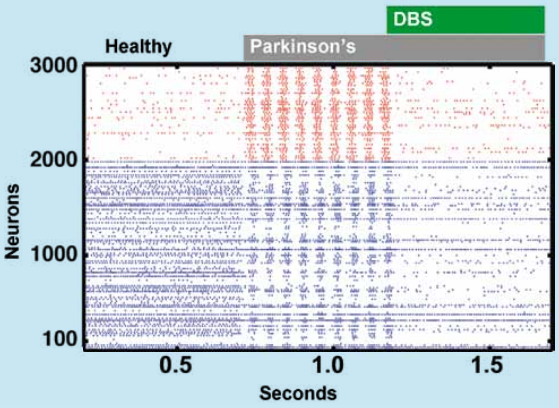
Kumar uses computer simulations to work out what exactly happens in the networks of the roughly hundred billion nerve cells in the human brain during this process. "When something is so microscopically small that I don't see it and at the same time so complex that I don't understand it, I have to simplify it." This field of research is known as computational neuroscience: Engineers, mathematicians, and biophysicists study the properties of the networks in the brain and develop models to gain new insight into the causes and therapies of neuronal dysfunctions. In order to accomplish this, they break down that which is known about nerve cells, their behavior, and the patterns of the connections between them into the simplest possible mathematical equations. "A lot of the details are lost, but it is an initial step toward solving this enormous task."

The computer can then use the equations to reconstruct the neuronal networks believed to be harbored by the brain – from the molecular interaction of individual cells to the communication between complex networks. The computer thus serves as a virtual mini laboratory in which scientists simulate and test hypotheses and make predictions. A computer program helps them to develop the models. To take an example: 3,000 nerve cells for one network, 2,000 for another, and a five percent degree of connections between them results in a model of two networks with over half a million connections. The scientists need only specify the electrical activity; the rest is done by the machine. The resulting raw data is evaluated and statistically analyzed just like data obtained from an experiment.

Kumar is observing groups of nerve cells in the basal ganglia in his research: "We have two networks that influence each other in their activity." The first region, the subthalamic nucleus, stimulates the second, the globus pallidus, which for its part inhibits the first. The electrical activity of these two networks is in a state of balance in healthy people, but in the sick it oscillates periodically. This prevents signals from being passed on – a consciously controlled command, like "reach for the cup," doesn't come through anymore. In order to determine the cause of the oscillations, Kumar and his colleagues are simulating the dynamics of these networks. "We can draw inferences about the behavior without having to work directly on the human brain."

Alleviating Symptoms with Half As Many Impulses

What is new is the research group's idea of including another brain structure, the striatum, in their simulations. This region receives its impulses directly from the cerebral cortex and is referred



The computer model simulates the pulse-like activity of each individual neuron. The red points belong to the nerve cells of the subthalamic nucleus, the blue points to those of the globus pallidus. In a healthy person, the activity follows no apparent pattern. In Parkinson's patients (gray bar) the cells of the two areas of the brain fall into rhythmic activity. The influence of deep brain stimulation (DBS, green bar) suppresses these oscillations.

to as the gateway to the basal ganglia. The scientists simulated an increased electrical activity in the striatum and, as a consequence, inhibited the globus pallidus more strongly. The result: The model shows the constant oscillation of electrical activity of the two nerve cell networks in the basal ganglia that is characteristic of Parkinsonian patients. The striatum is thus a potential starting point for further research on the emergence of Parkinson's disease. However, the simulation is a greatly reduced version of what actually happens in the brain. "In reality we have many more cells and a more complex network, but in principle, the model captures the main points of the brain's behavior."

Kumar and his colleagues are also studying ways of improving DBS. The simulation led them to the conclusion that this method might require less electrical impulses than before in order to achieve a positive effect. "If we send the impulses at irregular intervals, we can leave up to 50 percent of them out and still alleviate the symptoms." That would save a whole lot of energy: The batteries of a neurostimulator in the brain would last longer, and they would not need to be replaced – which of course involves another operation – for eight years instead of four.

Kumar stresses the importance of constant exchange with colleagues from medicine and the neurosciences, a collaboration which has also led to the joint proposal for the Cluster of Excellence BrainLinks – BrainTools in Freiburg. He sees himself in the role of a creative director: "The theoretician plays the ball to the clinicians and gives them hints about what they could do to reach a better understanding of Parkinson's disease." For example, he recommends for researchers at hospitals and in private companies to take up the idea of improving DBS – and start developing and testing neurostimulators with a random impulse frequency that could function with half of the energy. "A green solution for DBS would be just the thing for a green city like Freiburg."

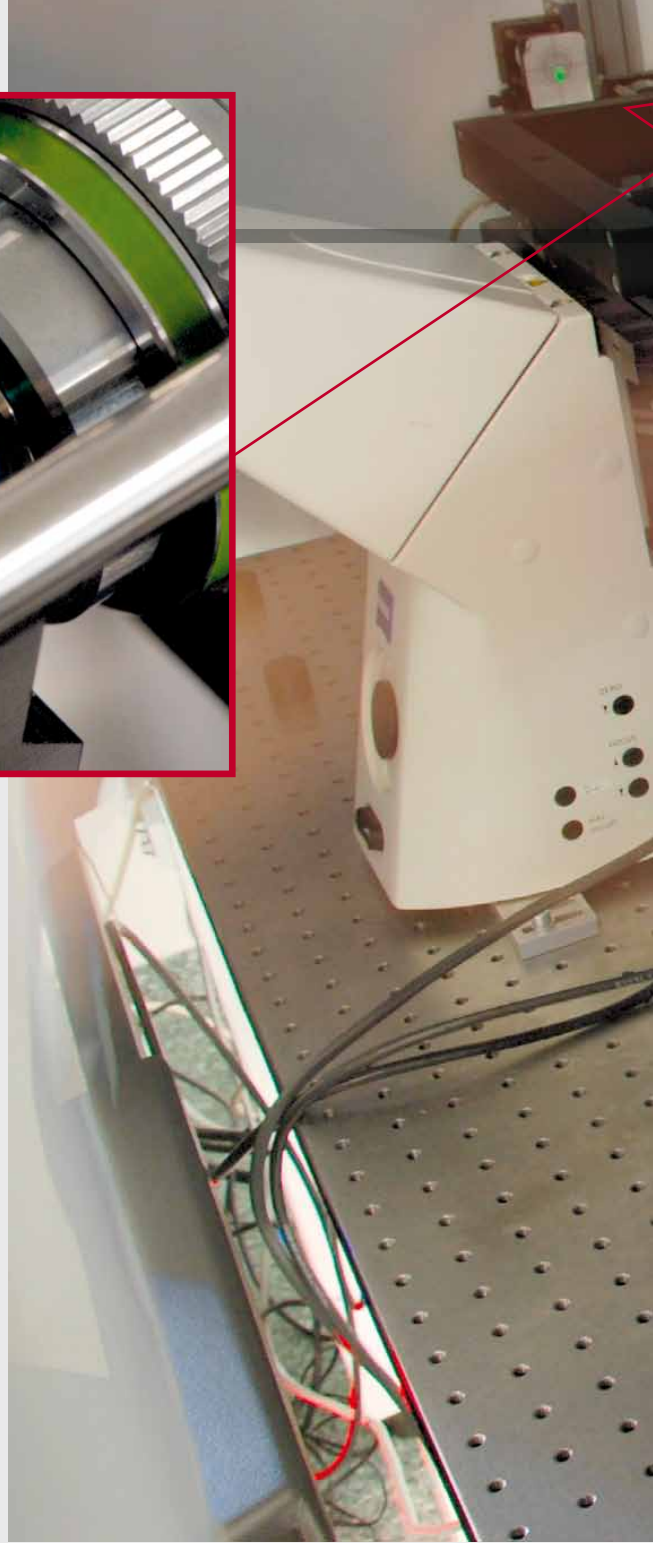
Further Reading

Kumar, A./Aertsen, A. (2011): The role of inhibition in generating and controlling Parkinson's disease oscillations in the basal ganglia. In: Frontiers in Systems Neuroscience 5/86. doi: 10.3389/fnsys.2011.00086

Moran, A./Stein, E./Tischler, H./Belelovsky, K./Bar-Gad, I. (2011): Dynamic stereotypic responses of basal ganglia neurons to subthalamic nucleus high-frequency stimulation in the Parkinsonian primate. In: Frontiers in Systems Neuroscience 5/21. doi:10.3389/fnsys.2011.00021

Amtage, F. (2008): Tremor-correlated neuronal activity in the subthalamic nucleus of Parkinsonian patients. In: Neuroscience Letters 442/3, pp. 195 – 199.

Dr. Arvind Kumar *studied engineering at the Birla Institute of Technology and Science in Pilani, India, and neurobiology, biophysics, and computational neuroscience at the University of Freiburg. After completing his PhD in Freiburg he worked from 2006 to 2008 as a research assistant at the Department of Neurosciences of Brown University in Rhode Island, USA. Since 2008 he has served as a research group leader at the Bernstein Center Freiburg within the context of the program EuroSPIN (European Study Programme in Neuroinformatics), which combines neuroscience with computer science in order to reach a better understanding of the structure and function of the brain. His research interests include the dynamics of neuronal networks and the analysis and modeling of nerve cell activity.*



Illuminating Remote Corners

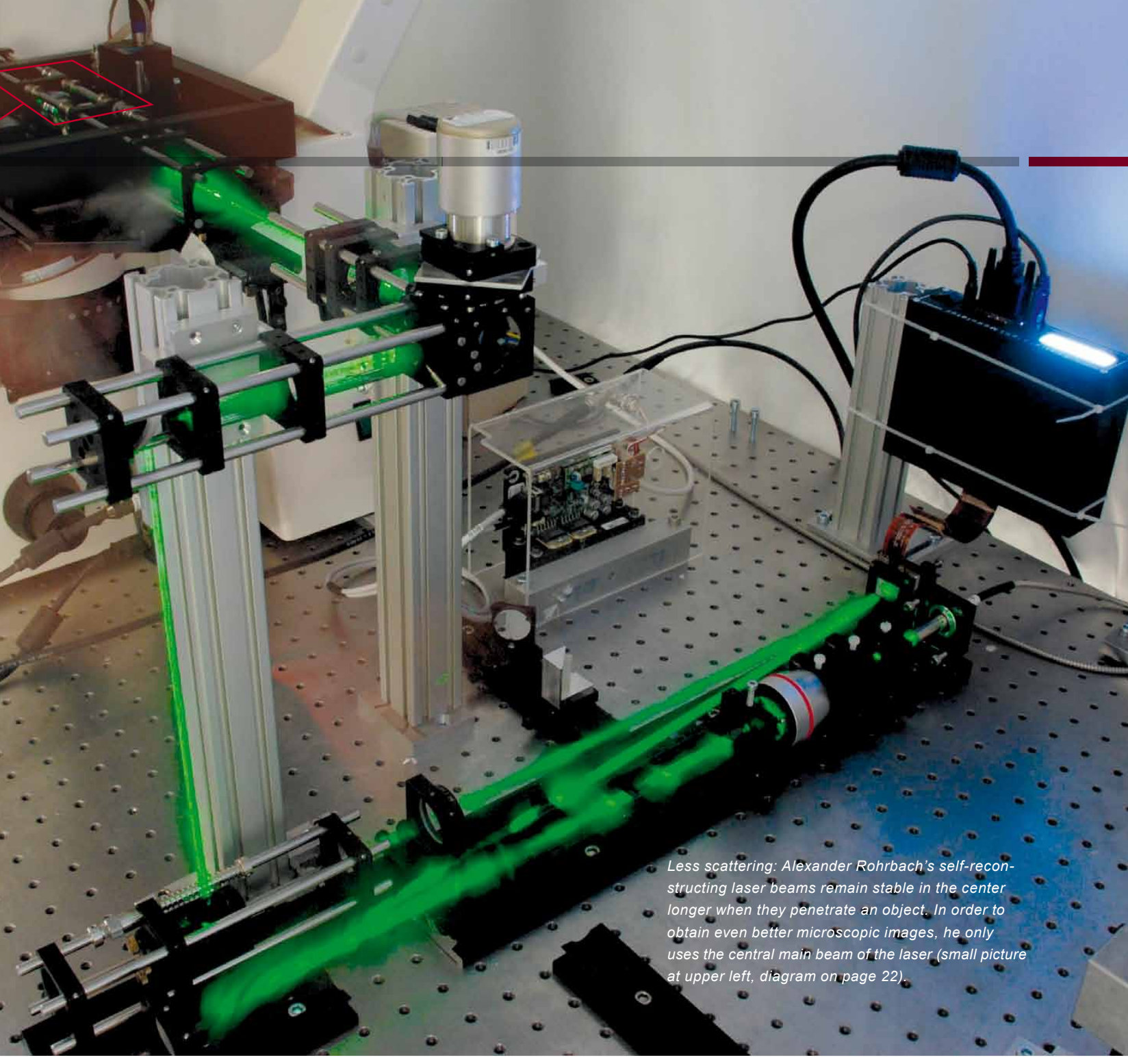
The Physicist Alexander Rohrbach Is Developing a New Type of Microscope with Self-Reconstructing Laser Beams That Enables Better Images

by Annette Kollefrath-Persch

What do driving a car in the fog and viewing thick objects through a microscope have in common? – The two situations both present the same problem: The light is scattered. In the first case, fog droplets prevent the car's headlights from penetrating through to obstacles and thus from sufficiently illuminating them. In the same way, thick collections of thousands of cells scatter the light from the illuminator of optical microscopes such as those used in modern cell biology. In fact, the scattering is so strong that cells of the object under observation located further from the light source are hardly visible at all.

Alexander Rohrbach, professor of bio- and nanophotonics, has succeeded in clearly reducing the undesired deflection and scattering of the light inside the object. Together with his research group at the Department of Microsystems Engineering of the University of Freiburg, he is developing a new and innovative microscopy method based on self-reconstructing laser beams.

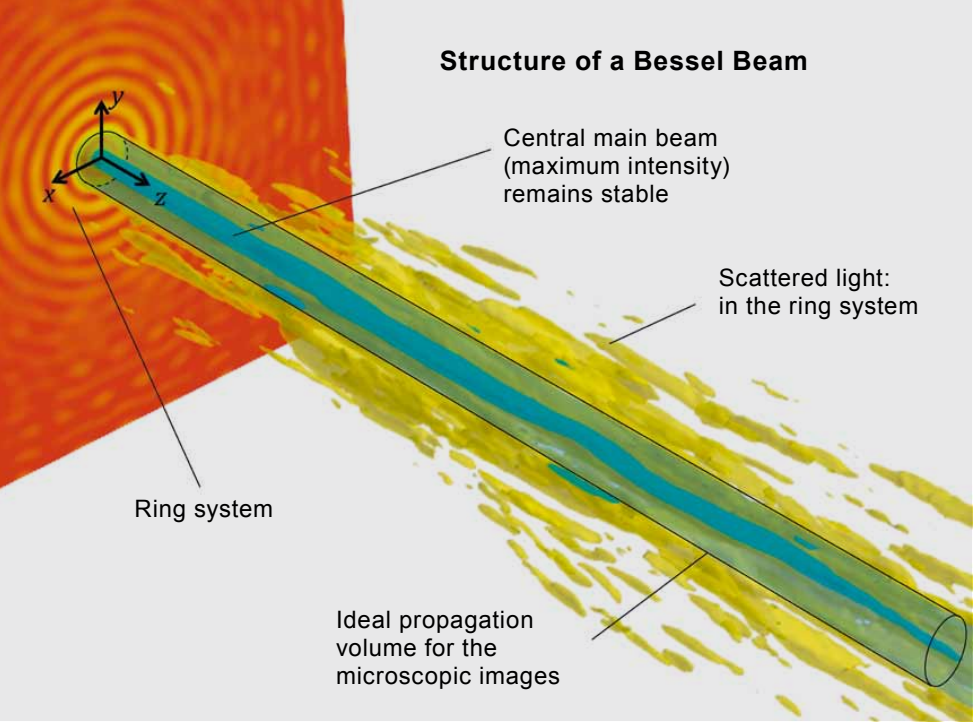
This development is a boon for scientists studying comparatively large specimens with a thickness of up to one millimeter. Up until now, microscopy has been unable to properly illumi-



Less scattering: Alexander Rohrbach's self-reconstructing laser beams remain stable in the center longer when they penetrate an object. In order to obtain even better microscopic images, he only uses the central main beam of the laser (small picture at upper left, diagram on page 22).

nate objects like cancer cell clusters, insulated skin, or animal embryos, which scatter the light too strongly due to their size. The laser beam loses its original concentrated form to scattering due to a multitude of tiny particles or is deflected, making it almost impossible for the microscope to illuminate anything at all on the far side of the object. Rohrbach, a trained physicist, has been investigating biological systems for many years but has not always had success in extracting all of the desired information from them. For example, it is not yet clear when and how various forms of energy are built up inside the cell. "We will need to develop new microscopy techniques, approaches, and analyses to find the answers to these questions," explains Rohrbach – and these prospects excite his passion for research again and again.

Like several earlier research groups, the Freiburg professor has taken up the over-a-century-old idea of ultramicroscopy. Ultramicroscopy, or light sheet microscopy as it is called today, only illuminates the objects at a particular level: the level to which the focus of the microscope's objective lens is set. This is made possible by a light sheet,



Better contrast, higher resolution: The central main beam of the laser illuminates the object line by line. At the same time, a camera also captures the object as through a single-slit diffraction. This masks the light from the ring system.

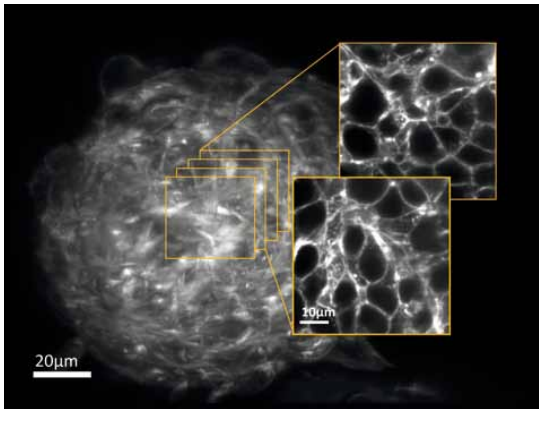
which is irradiated into the object from the side. All parts of the object outside of this level remain unlit and thus dark. In order to create the light sheet, it is possible to use a special cylinder lens alignment or to move a laser beam back and forth quickly at the level of focus in order to obtain an even thinner sheet. However, the light radiated from the side is scattered and deflected by numerous cells and boundary surfaces – in other words by the layers between the various materials. This is where Rohrbach's idea comes in: He wants to reduce the scattering by using new self-reconstructing beams.

Bessel Beams Penetrate Deeper

In a series of experiments, Rohrbach and his team demonstrated that specially formed laser beams can approximately reconstruct their original profile when various obstacles, such as light-scattering biological cells, repeatedly destroy the profile of the beam. This self-reconstruction works because scattered photons, i.e. quanta of light, are continuously replaced in the center of the beam by new ones coming from the side. "It is an astounding phenomenon that almost all of the photons coming from the side meet at the center almost simultaneously to form a new beam profile despite massive delays caused by the scattering cells."

In order to create these special laser beams, the Freiburg researchers converted conventional laser beams to so-called Bessel beams. The most flexible way of doing this is with a computer-controlled hologram that changes the trajectory of the photons depending on their position over the cross-section of the beam. It is known that the profile of Bessel beams in scatter-free space remains largely stable, but until recently it was completely unclear whether and to what extent they also can also revert to their original form in inhomogeneous material, i.e., where there is a lot of scattering. Rohrbach first succeeded in predicting this on a theoretical level with computer simulations and then verified it with experiments. He was thus able to demonstrate that holographically formed self-reconstructing laser beams are especially well suited for microscopy since they are more robust against disruptive scattering. The Bessel beams can penetrate more deeply into the objects under observation, such as pieces of skin or cancer cell clusters.

However, even the functioning of Bessel beams is not completely trouble-free, because only around 20 percent of the light particles are located in the central main beam; the rest are transported around the center in a ring system.



Sharper image: The new microscopes deliver a more detailed view of individual areas of cancer cell clusters.

"The future of modern microscopy lies in the use of lasers and computers to optimize the interaction between light and cell – and that goes for each individual beam position"

While this extensive ring system surrounding the main beam helps the beam to reconstruct itself, it also leads to poor image contrast in a microscope.

Higher Image Contrast, Higher Resolution

However, Rohrbach has also succeeded in solving this problem: He has developed a method for exploiting the stability of the beam in penetrating the object in which the latter is not illuminated all at once, but rather line by line – similar to the movement of a windshield wiper that travels over the entire surface of a windshield. At the same time, a camera also captures the object line by line as through a single-slit diffraction. This masks the light from the ring system. In comparison to traditional light sheet microscopy with conventional laser beams, this leads to a 50-percent increase in image contrast and an almost 100-percent improvement in the axial resolution – the smallest resolvable distance between consecutive image points – of the three-dimensional image.

In addition to providing new insight into the physically complex processes of light scattering, the optical microscopes developed by Rohrbach's group also enable researchers in biology and medicine to perform new analyses. For example, the beams can penetrate around one and a half times deeper into human skin samples than conventional laser beams. The new method also allows scientists to observe processes like the cell movements within various layers of skin following contact allergies or sunburns in four dimensions – with 3D images that change in time. "The new method is no magic bullet, but in light sheet microcopy it's the best we are currently capable of in physical terms."

Rohrbach is planning on teaming up with colleagues from the Freiburg research cluster BIOSS, Centre for Biological Signalling Studies, to conduct further research with his microscopes, among other things on the dynamics of cancer cell clusters. With an eye to such future projects, he and his team will continue to work on improving the image quality of microscopes with self-reconstructing laser beams and computer holograms: "The future of modern microscopy lies in the use of lasers and computers to optimize the interaction between light and cell – and that goes for each individual beam position."

Prof. Dr. Alexander Rohrbach
has served as professor of bio- and nanophotonics at the Department of Microsystems Engineering of the University of Freiburg since January 2006 and as a member of the Faculty of Physics and the research cluster BIOSS (Centre for Biological Signalling Studies) since November 2007. After graduating from the University of Erlangen-Nuremberg with a degree in physics in 1994, Rohrbach earned his PhD in Heidelberg in 1998. While writing his dissertation he conducted research on optical microscopy and cell biology at the Kirchhoff Institute of Physics and the Max Planck Institute of Medical Research in Heidelberg. After conducting various studies on optical forces and cytological applications, he completed his habilitation in physics at the University of Heidelberg. His research interests include optical traps with interferometric particle tracking, molecular motors, cytoskeletal mechanics, and new methods in laser microscopy.
Photo: Zahn

Further Reading

Fahrbach, F. O./Rohrbach, A. (2012): Contrast-enhanced imaging based on the propagation stability of self-reconstructing Bessel beams. In: Nature Communications 3, pp. 632.

Fahrbach, F. O./Simon, P./Rohrbach, A. (2010): Microscopy with self-reconstructing beams. In: Nature Photonics 4, pp. 780–785.

Rohrbach, A. (2009): Artifacts resulting from imaging in scattering media: a theoretical prediction. In: Optics Letters 34/19, pp. 3041 – 3043.

SURPRISING SCIENCE

Florian Fahrbach, a member of Prof. Dr. Alexander Rohrbach's team, shares multimedia content and shows how the microscopes illuminate remote corners.

www.surprising-science.de/einzelforschungsprojekte/mikroskopie

A New Way of Talking about Faith

The Sociologist Hans Joas Is Finishing Up His Study on “Sacralization and Secularization” at the Freiburg Institute for Advanced Studies

by Claudia Füßler

"Since we do not choose our values consciously but rather discover them for ourselves through various intensive and powerful experiences in the course of our lives, our memories of these experiences also help us to secure values"

Religion evidently remains a mass phenomenon in modern societies. In September 2011, for example, some 100,000 Catholics attended a worship service with Pope Benedict XVI in Freiburg.
Photo: Kunz

Prof. Dr. Hans Joas was recently invited to dinner in the USA. His American host engaged him in small talk in exemplary fashion, asking the sociologist, who had just published a book about human rights, whether he believed that human rights are guaranteed today. No they aren't, replied Joas and referred with all due discretion – after all, he was a guest – to the prison camp in Guantanamo and torture practices in Iraq. He wasn't surprised at all at the American's reaction: "I beg your pardon, but in Guantanamo and Abu Ghraib we are protecting the human rights of our citizens."

So all it takes is a threat to national security to render the principles referred to in the Universal Declaration of Human Rights adopted by the United Nations in 1948 null and void? "This shows very clearly that it's not enough to just make a law about something. The people must also stand behind the law and voice their disapproval when it is infringed upon," says Joas. In his new book *Die Sakralität der Person – Eine neue Genealogie der Menschenrechte* ("The Sacrality of the Person – A New Genealogy of Human Rights"), he proposes a triangle with the corners values, institutions, and practices as a way of illustrating this notion. Each of the three corners can serve to initiate or block change. Stated more directly: That which is written into law (institutions) can remain without consequences if it is not backed up by intellectual discourses (values) and behavior in daily life (practices). Non-acceptance of two of the corners can cause the third to stagger.

Researching the Origin of Values

Thus, stabilizing human rights also involves attending to the level of values. "Since we do not choose our values consciously but rather discover them for ourselves through various intensive and powerful experiences in the course of our lives, our memories of these experiences also help us to secure values," says Joas. In order to uphold a ban on torture in the long term, it is necessary for a country to keep the memories of torture practices in the past centuries and of how they were overcome alive in the citizenry. Among other things, Joas' book discusses historical events, such as the abolition of torture in Europe in the 18th century and the connected emergence of values.

This monograph is Joas' first project at the Freiburg Institute for Advanced Studies (FRIAS), where the sociologist is a permanent fellow of the School of History. Until March 2011 he served as director of the Max Weber Center for Advanced Cultural and Social Studies. As a fellow of FRIAS, he now has time to devote his undivided attention to the global theme "sacralization and

> "In the past 20 years the common assumption in the sociology and history of religion that modernization inevitably leads to secularization has practically imploded."

secularization." "I've been working on many projects for years, but as director of an institute I just didn't have the time to edit existing drafts for publication. There was a book on the debate I still wanted to read, and I needed the leisure to finish a chapter," explains Joas. The time at FRIAS now gives him an ideal opportunity to finally bring long slumbering projects to completion. I often suffer from being forced into the confines of a project schedule. Conducting research is sometimes a bit like cooking, he says: "Imagine you have several pots on the stove. You stir a little here and add some spices there; at the same time you have to make sure that nothing burns, but you can't force a dish to finish itself. You have to give everything the time it needs."

Dispensing With Apparent Certainties

Joas' next book, *Glaube als Option. Zukunftsmöglichkeiten des Christentums* ("Faith as Option. Possibilities for Christianity in the Future"), is set to appear in June 2012 – seemingly right after his last one, but actually long since in preparation. In it he illuminates the current state of religion by examining two pseudo-certainties that have long dominated debates on religious policy. The first has to do with the prophesy of nonbelievers since the 18th century that religious faith will disappear in the course of time and lead to a secularization. Not believing in God was not even imaginable in earlier centuries, but then it became possible to profess oneself to be an nonbeliever. This "secular option," as the Canadian philosopher Prof. Dr. Charles Taylor has called it, developed out of currents of thought in the Enlightenment. Taylor's work forms the starting point for Joas' deliberations. "In the past 20 years the common assumption in the sociology and history of religion that modernization inevitably leads to secularization has practically imploded," says Joas and asks the logical question: "If modernization isn't what leads to secularization, then what does?"

Laws alone are not enough: Human rights also need to be secured through intellectual discourse and everyday practice. This painting by Jean-Jacques-François Le Barbier shows the Declaration of the Rights of Man and of the Citizen and was painted in France in 1789. Photo: Wikimedia Commons.

The second aspect of the book also has to do with a prediction, this time one by the believers: They long thought and asserted that those who did not believe would end up being unhappy. They even predicted that societies without religion at all would descend into moral decay. "But the empirical evidence does not support this claim," says Joas and comes to the conclusion: "We need to speak about faith in a completely different way, because we can neither say that it will die out anyway nor that we will become unhappy or immoral if it disappears." The new book is an attempt to put this idea into practice.

A third, no less important part of the umbrella topic "sacralization and secularization" is Joas' work on the so-called Axial Age. A volume on this topic edited by Joas and the American sociologist Prof. Dr. Robert Bellah is set to be published by Harvard University Press in fall 2012. Coined by the philosopher Prof. Dr. Karl Jaspers in 1949, the term "Axial Age" refers to the time between 800 and 200 before Christ, in which the

Was Confucius a source for the desacralization of political power? Hans Joas collaborates with leading international experts in order to answer questions like these.
Photo: Increa/Fotolia

notion of transcendence developed and God or the gods were positioned outside of all worldly things. "That was a historical watershed," says Joas. "Up to this time, political power could be perceived as divine. But the idea of transcendence suddenly enabled one to think: The leader is only human like me. Maybe he was installed by the gods, but he can't be godly himself." Joas looked for other thinkers before Jaspers who thought that the point at which religion and politics began to separate was an important step for human development and examined the new alliances that appeared as a result.

Collaboration with Leading International Experts

Even more important than the historical classification of the idea, however, are the concrete cases themselves: When and in which societies did such transformations take place? Furthermore – and here is where one of the many ideas in Joas' work comes full circle – to what extent is our understanding of human dignity influenced by the changes witnessed during the Axial Age. In order to answer these questions, Joas and Bellah engaged the help of numerous experts. For example, in order to determine whether Confucius was a source for the desacralization of political power it would have been necessary to read many texts, most of which were written in Chinese. "And then we probably would have made ourselves look foolish anyway for overlooking important information or something that was lost in translation. It is thus wise to be on the lookout for the world's leading Confucius experts from the outset and get them on board," explains Joas on the genesis of the volume.

Joas still has a few other pots on the stove. What will be cooking in the next one or the one after that? At the moment he is preparing a series of six lectures on the relationship between the history and criticism of religion. "Sometimes I dig through a paper, a project, and realize that this mine is very rich. But in the process of digging I see that there is another tunnel leading away from it that promises to be very interesting. It take note of it and then go back there again later. In this way, I look back and see continuity of a kind I never would have been able to predict." Joas hardly ever knows what tunnels he will stumble upon beforehand and how promising they will turn out to be. But that is what the creative moment of surprise in scholarship – which he loves and attempted to define more closely in an earlier book on the creativity of human action – is all about.

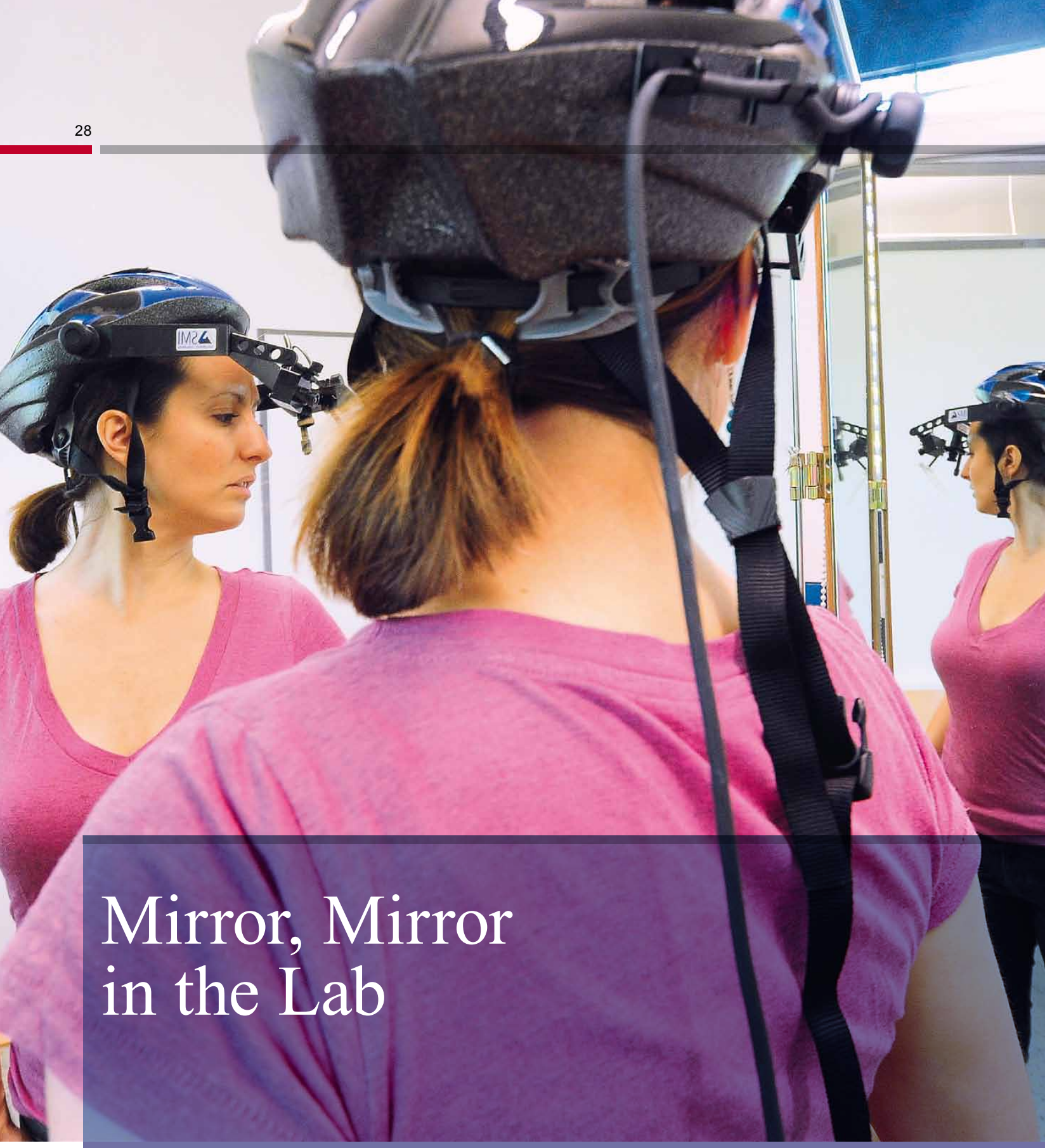
Further Reading

Bellah, R. N. (2011): Religion in human evolution. From the paleolithic to the axial Age. Cambridge/USA.

Taylor, Charles (2007): A secular age. Cambridge, MA.

Joas, Hans (2000): The genesis of values. Chicago, IL.

Prof. Dr. Hans Joas
Joas will be a permanent fellow at the Freiburg Institute for Advanced Studies (FRIAS) until the spring of 2014. The sociologist studied among other places at the Free University of Berlin, where he also completed his habilitation. From 1987 to 1990 he served as a professor at the University of Erlangen-Nuremberg. Then he was offered a chair at the John F. Kennedy Institute for North America Studies and the Institute of Sociology of the Free University of Berlin, where he remained until 2002. Afterwards he accepted a position as Max Weber Professor in Erfurt, where he headed the Max Weber Center for Advanced Cultural and Social Studies until March 2011. In addition to his work at FRIAS, he has held a visiting professorship at the University of Chicago, USA, since 2000. Joas' research interests include historically oriented sociology of religion, the sociology of war and violence, and social philosophy.



Mirror, Mirror in the Lab

The Psychologist Brunna Tuschen-Caffier Is Studying How Girls and Women with Eating Disorders Perceive Their Bodies

by Rimma Gerenstein

Anorexia patients and healthy women were asked to look at themselves in the mirror while an eye tracker attached to a helmet recorded their eye movements. The result: The former looked longer and more frequently at parts of their body they were not satisfied with (scene reenacted). Photo: Kunz

"Although there are clear criteria for distinguishing pathological from healthy behavior, the transitions are often difficult to pinpoint"

Vanilla ice cream, an entire family-sized carton. Ten wieners with globs of mustard. Fast. Hurriedly. Chocolate cookies, bread with liver pâté, bananas. It could also be oversalted oatmeal gruel – no matter what she stuffs in her mouth, the young lady doesn't like it. She wolfs down food unchewed, occasionally taking a gulp of milk so it's easier to heave it back up later. She was actually supposed to go out to the movies with two friends tonight, but she cancelled in order to be alone. Besides, the two have been asking uncomfortable questions lately: "I heard you retching in the bathroom earlier. Are you sick?" "You go to the toilet a lot. Everything alright?"

Going on two-hour eating binges without enjoying any of it, deliberate vomiting, gradually cutting oneself off from family and friends: These are typical symptoms of people who suffer from bulimia nervosa – also called binge-purge syndrome – explains Brunna Tuschen-Caffier. The professor of clinical psychology and psychotherapy at the University of Freiburg has been researching eating disorders for 20 years. She and her colleagues won the Christina Barz Prize in 2011 for their fundamental research on the topic. The team found out what mechanisms contribute to the development and perpetuation of eating disorders. The scientists collected and analyzed data in studies and projects for over a four-year period. Now the implementation phase is about to begin: They want to apply their findings to clinical practice, to improve therapies for eating disorders – a task that will occupy them for the next several years.

Women Are a Risk Group

In addition to bulimia nervosa, the most prominent forms of eating disorders are anorexia nervosa, characterized by the desire to lose weight by refusing to eat, and binge eating disorder, which has only been recognized as a distinct condition since the mid 1990s. People with this disorder suffer from attacks of compulsive overeating. "But in contrast to bulimia nervosa the countermeasures are missing, like vomiting or dieting," says Tuschen-Caffier. What all three eating disorders have in common is a deep-seated dissatisfaction with one's own body and the seemingly inseparable relationship between self-esteem, figure, and weight – a mechanism the psychologist says even healthy women can be susceptible to: "In Western culture women often tend to define their self-worth through physical appearance and slimness. They are a risk group for eating disorders." Over 90 percent of the one to three percent of Germany's population afflicted with eating disorders are female.

"Although there are clear criteria for distinguishing pathological from healthy behavior, the transitions are often difficult to pinpoint," says the expert. Even healthy women have a feeding

frenzy once in a while, exercise to burn off the calories again, go on diets, and feel bad when the scale reveals that they've put on a kilogram or two. "But healthy women get such feelings under control faster and don't let them influence their entire state of mind," underlines Tuschen-Caffier. "Women with eating disorders, on the other hand, have a fragile sense of self-worth that is highly dependent on the fluctuations in their weight. They don't find any other strategies to feel better again." In the case of some forms of anorexia, for instance, girls and young women have a distorted perception of themselves: They see themselves in the mirror with a chubby belly and flabby thighs – although even pants in children's sizes won't stay on their hips. Scientists call this condition body dysmorphic disorder.

No appetite: Patients with eating disorders are often afraid of eating a normal meal (scene reenacted). Nutritional training can help them to adopt good eating habits. Photo: Kunz

Bathing Suit and Eye Tracker

What do women with anorexia or bulimia actually see when they look at themselves in the mirror? How do they process this information about their body? These are a few of the questions that the psychologist posed in her research. Along with her team she has developed a new approach to studying body dysmorphic disorders. The group included both conscious and unconscious processes in their analysis. This approach enables a comprehensive strategy that takes into account human qualities at different levels – "even those that humans cannot provide an answer to because they are not subject to conscious control."

"Combining fundamental research with therapy research is a matter of great personal importance for me."

In one of their studies, for example, anorexia patients and healthy women were asked to put on a skin-colored bathing suit and look at themselves in the mirror. On their head they wore a helmet with an eye tracker attached to it, a device that records eye movements. While doing this, they were requested to say everything that came into their head – scientists refer to this method as "thinking out loud." The experiment lasted three minutes – taxing enough for a person with an eating disorder. The result: The healthy women's thinking out loud did not just revolve around their bodies. Rather, they also thought about everyday banalities: "This is boring." "I have to go shopping later." The thoughts of the anorexic test subjects, on the other hand, remained focused almost exclusively on their bodies: "How ugly I am." "My belly is so fat." The data recorded by the eye tracker also confirms this fixation with supposed external defects. "Women with eating disorders look longer and more frequently at parts of their body they are not satisfied with, particularly the classical problem zones stomach, thighs, buttocks," summarizes Tusche-Caffier. The healthy test subjects, on the other hand, spent the same amount of time looking at parts of their body they were satisfied with as at parts they were dissatisfied with. "That is a nice pattern; it's exactly what we are trying to achieve in therapy."

Learning how to stand oneself: Brunna Tuschen-Caffier describes this as a central goal of a therapeutic treatment. She does not want to get them to "put on rose-colored glasses," to suggest to them that they are beautiful although they do not feel that way themselves. Instead,

she instructs the women to “build up a conception of their bodies that allows for positive and negative things. According to the motto: I have a beautiful nose, but my mouth is not that beautiful. That is okay; both are part of me.”

No Fear of Calories

Around ten years ago the psychologist developed a concept for treating patients with eating disorders that includes three components. The first phase consists of a nutritional training designed to help the patients to adopt good eating habits and lose their fear of eating a normal meal. It isn’t a form of nutritional consultation – the patients usually know better than their therapists how many calories are in a portion of spaghetti with meat sauce. But they don’t necessarily know why carbohydrates and fats are also good for them. The second phase is a body image therapy. The patients look at themselves repeatedly in the mirror and express their thoughts and fears, much like in the experiments. However, these sessions generally last between 40 and 60 minutes. The girls and young women can’t just slink past the mirror like they can at a department store. “We ask them to look at their body closely and describe in detail what they don’t like about it and what feelings the sight of it evokes in them. In addition, we ask them to provide a detailed description of body zones they are more or less satisfied with.” The third phase focuses on the topics stress and food, the former representing a host of pressure situations that can vary from person to person, explains the psychologist. “It can have to do with setting the bar too high with regard to one’s performance, having a strong need for control, or wishing to increase one’s sense of self-worth by saying: I’m strong, I don’t need the food, I can stand being hungry.”

Tuschen-Caffier and her team evaluated the effect of the therapy on women suffering from eating disorders with the help of questionnaires. The results speak for the effectiveness of the treatment concept so far, but up to now they have only been based on self-evaluations by the patients and evaluations of the patients by the therapists. How reliable is this data? “We aren’t insinuating that anyone is lying deliberately, but it is possible that some of the patients are sugarcoating their statements – for instance because they don’t want to disappoint the therapists,” explains Tuschen-Caffier. The data collected by the eye tracker, on the other hand, may be considered objective. The research team thus plans to ask the same women to stand in front of the mirror with the eye tracker fixed to their heads after the therapy is over with. The team wants to check whether the patients’ viewing patterns with regard to their body have changed after the treatment. Will the patients spend less time dwelling on the parts of their body they are dissatisfied with? “If this weren’t the case, then we would have to change our therapy,” says the psychologist. “Combining fundamental research with therapy research is a matter of great personal importance for me."

Prof. Dr. Brunna Tuschen-Caffier *studied psychology at the University of Heidelberg, where she also earned her PhD. In 1998 she completed her habilitation project, in which she investigated the psychological and physiological stress reactions of women with bulimia nervosa. From 2000 to 2003 she taught and researched at the University of Siegen as a professor of clinical psychology. From 2003 to 2007 she held the same position at the University of Bielefeld. Since 2007 Tuschen-Caffier has served as professor of clinical psychology and psychotherapy at the University of Freiburg and head of the Department of Clinical Psychology and Psychotherapy. Her research interests include fundamental research as well as prevention and therapy research, especially on patients with anxiety and eating disorders.*

Further Reading

Svaldi, J./Caffier, D./Tuschen-Caffier, B. (2012): Automatic and intentional processing of body pictures in binge eating disorder. In: Psychotherapy and Psychosomatics 81/1, pp. 52 – 53.

Tuschen-Caffier, B. (2008): Körperbildstörungen. In: Herpertz, S./de Zwaan, M./Zipfel, S. (Hrsg.): Handbuch Essstörungen und Adipositas. Berlin/Heidelberg/New York, pp. 82 – 86.

Tuschen-Caffier, B. (2005): Konfrontation mit dem eigenen Körperbild. In: Wittchen, H.-U./ Neudeck, P. (Hrsg.): Konfrontationstherapie bei psychischen Störungen. Theorie und Praxis. Göttingen, pp. 227 – 248.

Bye-Bye Gasoline Prices

Scientists at the University of Freiburg Are Developing Chemicals to Make Batteries More Powerful and Electric Cars More Popular

by Felix Austen

Plug it in, charge it up, drive away: This could be the key to mobility in the future. But electric cars need better energy storage solutions in order to establish themselves on the market. Photo: arsdigital/Fotolia

It's a phenomenon known to many: You drink too much at the party, have too little to eat, or eat too many potato chips and then forget to drink a glass of water when you get home. The consequences are a lack of electrolytes and a headache. Prof. Dr. Ingo Krossing from the University of Freiburg has a similar problem. He too is suffering from headaches due to electrolytes, but for a different reason. Electrolytes are liquids containing dissolved salts that make them electrically conductive. Krossing holds the university's chair in molecular and coordination chemistry and is developing a completely new kind of electrolyte at the Freiburg Materials Research Center to help the electric car finally achieve its breakthrough.

Plans for electric motors to displace the combustion engine in cars have not been very successful so far. Despite considerable research efforts, only a fraction of the one million electric cars the German federal government

“In order to power a car for 500 kilometers without being recharged, a battery built according to current technology would have to weigh 800 or 900 kilograms”

wants to see on the streets by 2020 have hit the pavement. The electric motor itself is not the problem. It is regarded as technically mature. Hardly another machine – and certainly not the combustion engine – can hold a candle to it as far as energy efficiency is concerned. Whereas diesel engines convert a maximum of 50 percent of the energy fed to them into the acceleration of the car, and gasoline engines even less, electric motors can achieve up to 99 percent. Outside of reducing their weight, there is hardly anything left for engineers to improve on electric motors.

Current Batteries Are Too Heavy

The weak point is energy storage. “In order to power a car for 500 kilometers without being recharged, a battery built according to current technology would have to weigh 800 or 900 kilograms,” says Krossing. “Much too heavy.” That would be 0.5 megajoules of energy per kilogram of battery. By way of comparison, a kilogram of gasoline contains around 43 megajoules of energy. It will thus be necessary to develop batteries with much higher storage capacities in order to meet the needs of drivers.

Low energy capacity is not the only problem with the batteries. The materials they are made of also need to be able to hold up under extreme conditions. After all, a car needs to run even in the middle of winter or on a hot summer day. The electrolyte fluid is particularly sensitive. If temperatures drop below minus 20 degrees Celsius, the electrolyte cannot form any crystals and the battery will not deliver any power. If the electrolyte is too hot, on the other hand, the salts dissolve in the solution and trigger further irreversible chemical processes. This ruins the battery and must therefore be avoided at all costs.

The Problem is the Price

This is where Krossing’s research comes in. “This isn’t an academic problem but a technical problem,” he says. “There are electrolytes that withstand the extreme temperatures. For example, we built a battery and left it in an oven for a week at 80 degrees Celsius. When we took it back out, it functioned perfectly.” The problem is not whether it is possible to build such batteries, but how expensive they are. “Our battery salts cost 500 euros per kilogram. That is alright for conducting research.” The electrolyte salts used in production lithium-ion batteries for flashlights, mobile telephones, or laptop computers currently cost around 30 euros per kilogram. “That’s what we’re aiming at.”

The electrolytes will also play an important role in the necessary reduction of weight. Better electrolytes hold a higher charge without causing the battery to self-discharge. This means that

Technically mature: Small-scale lithium-ion batteries are already mass produced for devices like mobile phones. Photo: WoGi/Fotolia

I. *A lithium-ion battery is made up of several cells that are only several millimeters thick. In most cases the cells are stacked up in blocks or rolled up in cylinders.*

II. *The cell of a lithium-ion battery is composed essentially of three components: two metal plates with electrodes attached to them and a plastic film, the separator. One of the electrodes consists of a copper plate covered with a coating of graphite and contains many electrons. It is thus negatively charged and forms the anode, the negative pole. When the battery is full, the graphite coating also contains the lithium atoms. The separator separates the anode from the other metal plate, the cathode – like a thin sandwich with a piece of lettuce between two slices of bread. The separator is soaked in an electrolyte, a liquid that conducts the positively charged lithium ions. The cathode, the positive pole, is composed of an aluminum plate covered with a coating of, for example, lithium cobalt oxide. The cobalt oxide contains many positive cobalt atoms that can absorb electrons. The cathode is thus positively charged.*

Design and Functioning of a Lithium-Ion Battery

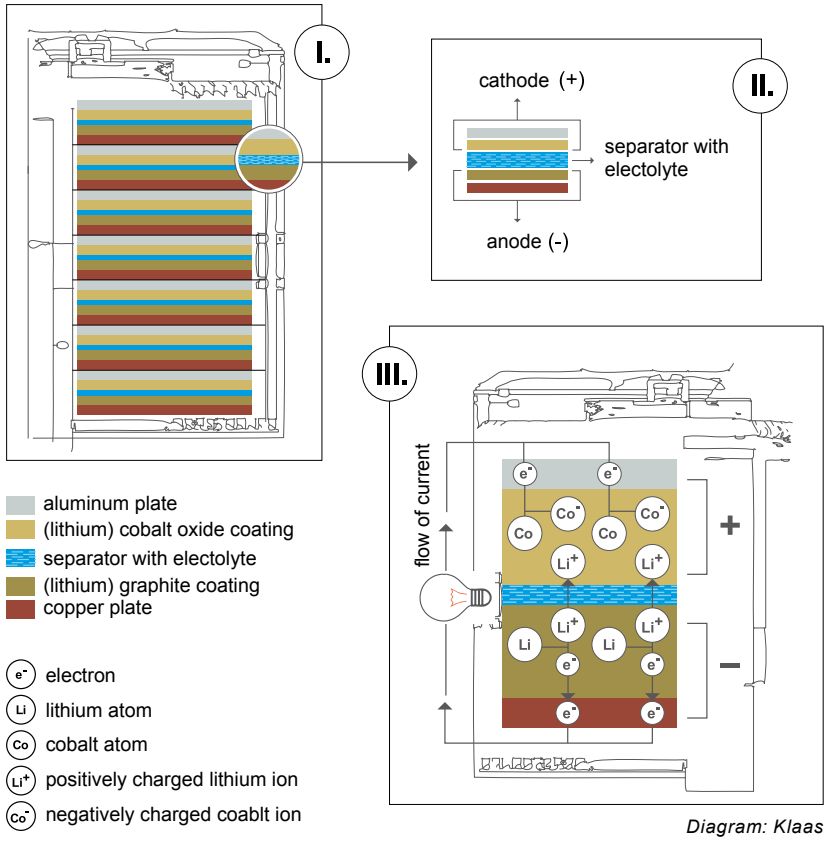


Diagram: Klaas

more energy can be stored in a battery of the same weight with new electrode materials. There are several ways to produce salts that exhibit the desired behavior. One possibility is to mix additional additives into the solutions. They can prevent undesirable reactions by blocking highly reactive constituents of the electrolytes. This method will certainly be technically relevant, believes Krossing, but he doesn't think much of it from a scientific perspective. "It's something I would describe as typical alchemy. We add something to it, don't really know what will happen, and hope that it makes it better. The scientific approach is to develop fundamentally new substances that are better."

New Ions Are Often Useful

Krossing began his search for new substances 15 years ago in his habilitation thesis, in which he also dealt with salts. A salt is composed of cations and anions, or in other words positively and negatively charged ions. It is electrically neutral, meaning that there are exactly the same amount of charges from cations and anions. A well-known example is table salt, whose chemical name is "sodium chloride" and which is composed of equal parts of negatively charged chloride anions and positively charged sodium cations. In his habilitation thesis, Krossing created an entirely new kind of anion whose purpose consists solely in stabilizing cations with unusual properties. It is precisely these anions that enable a battery to be used after being stored in an oven. Krossing has since created new ions again and again – and they often prove to be very useful. "This is fundamental research, terra incognita. I was not born to improve lithium ion batteries." But he's ended up doing it anyway.

"The scientific approach is to develop fundamentally new substances that are better"

III. *The available electrons rush with a tremendous amount of energy from the anode to the cathode. However, the separator prevents them from flowing directly to the cathode. They can only travel from the negative to the positive pole over an external circuit. In doing so, they give off energy with which they, for example, light up a lamp along the way – this is the battery's electrical current. Whenever an electron flows, a lithium atom gives off an electron, mediated by the graphite coating, thus feeding the copper. In this way, the amount of electrons – and thus also the voltage in the copper conductor – remains constant. The lithium atom loses the energy that is available to the electron in order to illuminate the lamp. A positively charged lithium ion remains. In contrast to the electron, it can pass through the separator and travel through the electrolyte directly to the cobalt oxide. When all of the lithium atoms have separated from their electrons and have reached the positive pole, the battery is empty: The cobalt atoms in the cobalt oxide have absorbed the electrons, and the positively charged lithium ions have caused the cathode to be converted into lithium cobalt oxide. When an opposing voltage is applied, the process is reversed: Electrons and lithium ions travel back by separate paths and meet again in the graphite. The battery is recharged.*

At one point he was approached by the company Merck, which specializes in battery electrolytes. "They said: You're already doing this stuff anyway. Don't you have anything we can use?" This is when Krossing and his team started developing electrolytes for batteries. "The transitions between the electrodes and the electrolytes are an important aspect, so close cooperation and exchange with the materials researchers who develop the electrodes is very important." This fact was also taken note of by BASF, which had previously produced cathode materials for lithium-ion batteries, then decided to launch activities in the area of electrolytes, and finally ended up buying out Merck's electrolyte division. However, the chemical giant has decided to continue the cooperation with Krossing's department.

Althogh Ingo Krossing has already found another promising new electrolyte, it will be 10 to 15 years before it flows in the tanks of the future. There are still many hurdles to overcome on the path from the laboratory at the Materials Research Center to serial production: tests, approval procedures, bureaucracy. So what is this new electrolyte? "That, of course, is something I can't reveal."

Prof. Dr. Ingo Krossing *studied chemistry at the Ludwig-Maximilian University of Munich, where he also went on to earn his PhD in inorganic chemistry. He then conducted research for two years at the University of New Brunswick, Canada. Afterwards, he completed his habilitation at the University of Karlsruhe, remained there for two more years as a lecturer, and then accepted a position at the Swiss Federal Institute of Technology in Lausanne, where he served for two years as an assistant professor. Since 2006 he has held the chair in molecular and coordination chemistry in Freiburg. His research focuses primarily on charged systems and the computer-aided synthesis of cations and anions. Krossing is a senior fellow at the Freiburg Institute for Advanced Studies (FRIAS) and a member of the Freiburg Materials Research Center (FMF).*

Further Reading-

Trapp, N./Krossing, I. (2009): Chemie mit schwach koordinierenden Anionen: Exotisches und Nützliches. In: Nachrichten aus der Chemie 57/6, pp. 632.

Krossing, I./Raabe, I. (2004): Noncoordinating anions – fact or fiction? A survey of likely candidates. In: Angewandte Chemie International Edition 43/16, pp. 2066–2090.

http://portal.uni-freiburg.de/molchem/research

More Order in Law

Researchers in Freiburg Are Working on a Concept for Simplifying the Administrative Regulations of the European Union

by Lars Schönewerk

The European Commission proposes legislation and ensures that the member states adhere to European law. A simplification of European administrative law would greatly change working procedures and power structures in the organization. Photo: European Commission

Haste makes waste, warns a common proverb. But when a pressing problem surfaces, the only option is to take immediate action. When the mills of administration grind too slowly, however, a solution can be a long time coming. When the first reports on enterohemorrhagic *Escherichia coli* (EHEC) shocked the media world, doctors didn't yet know enough to correctly gauge the dangers of this bacterial disease or the risks of taking drugs to treat it. The idea was to prevent the disease from spreading over international and intercontinental borders with the help of rapid crisis management, but the gears of the bureaucratic apparatus jammed in communicating the threat posed by the epidemic. Today, the threat is gone, but the communication problem remains. Even the exchange between the state and federal level in Germany was deficient – and the necessity of coordinating the flow of information with European food safety officials made things even more complicated.

"When you liberalize markets, you come up against difficulties. First come the goods over the border, then come the problems," says Prof. Dr. Jens-Peter Schneider, expert in admini-

"We want to simplify administrative law on the European level, not infringe on national law or undermine the influence of the states"

strative and information law at the University of Freiburg. What this means in the case of the European Union (EU) is that in order to enjoy the advantages of integration, the European economic administration needs to deal with its problematic consequences. Although EU law has an abundance of provisions for emergency preparedness or risk management at its disposal, they are only valid in specific sectors or regulatory domains. In addition to a general product safety code regulating things like toys, for instance, there are also special codes intended specifically for the safety of food and drugs. Depending on which sector is involved, the administrative jurisdiction may lie with any of several directorates-general of the European Commission, various committees of the European Parliament, or a Council of Ministers with a rotating presidency.

The Administrative Burden Is Growing

In the outcome, there are often very different regulations for identical or at least similar legal problems – such as the question of how to organize hearings before an administrative decision or the exchange of information between national agencies and European administrative offices – and the authority of these regulations is often undermined by loopholes. In addition, the administrative management of the single market depends on the interaction between European and national legal norms in 27 member states whose administrative practices sometimes differ greatly from one another. The administrative burden is growing, and the legal system is becoming more complicated and less transparent for lawmakers, agencies, and companies as well as for citizens. The situation is similar to what the national legal order in many countries looked like before they codified general rules for administrative procedures. As the legal committee of the European Parliament recently criticized, this state of affairs is no longer acceptable for a democratic EU administration run in accordance with the rule of law.

In order to address these problems, Schneider and his colleague from Luxembourg Prof. Dr. Herwig Hofmann founded the Research Network on EU Administrative Law (ReNEUAL), which is composed of a group of professors from outstanding universities from 15 European nations. The network draws on the fundamental research of Schneider's colleague Jürgen Schwarze, professor of German and foreign public law, European law, and international law at the University of Freiburg, and expands on it by placing the focus on the new information technology-based infrastructures of the European administrative network.

The Same Rules for the Same Procedures

The goal of the project is to bring the current sector-specific regulations into line, thus improving the cooperation in the European administrative network. In particular, the project aims to relieve the burden on the European legislative organs by presenting to them standardized rules – on issues like the right of those concerned to be heard or the exchange of information between agencies – that can be written into legislative texts. ReNEUAL is thus composed of experts in various fields of law, allowing it to treat problems from several different perspectives. The network strives to formulate regulations in such a way that they are applicable to as many fields of law as possible and can function alongside the most important national legal systems. Schneider, for instance, heads a work group within the network that deals primarily with information management. This is an area in which a properly functioning European administration is particularly crucial, says the jurist: "When a problem arises in a certain country, whether with a drug or a food product, it is important for reliable information to be communicated over the border as quickly as possible so that other countries have a solid basis on which to react to it."

Although ReNEUAL views itself primarily as a network for excellent research, it also seeks contact with legal practitioners in order to ensure that regulations it later recommends are not only suitable in theory. In March 2012, the experts thus attended an international conference at the European Parliament in Brussels, Belgium. The conference was organized by European Ombudsman Nikiforos Diamandouros, who helps citizens

The administrative law of the European Union is confusing because there are different rules for each sector. For example, in addition to a general product safety code regulating things like toys, there are also special codes intended specifically for the safety of food and drugs.
Photos: xiangdong Li, babimu, by-studio (all Fotolia)

in their dealings with the EU administration and investigates complaints concerning abuses. Schneider and his colleagues reported on the state of their previous work at the conference. The European Parliament stands behind the project, and the President of the European Court of Justice also supports the researchers' positions. ReNEUAL was even mentioned in one of the parliament's recent resolutions. The Council of the EU, on the other hand, which represents the member states, remains skeptical. It fears that the network could infringe on the sovereignty of the national states. This fear is unfounded, says Schneider: "We want to simplify administrative law on the European level, not infringe on national law or undermine the influence of the states. On the contrary, we want to make their work easier."

The Lawmakers Decide on the Recommendations

Opinions are mixed at the European Commission, the EU body corresponding to the government of a nation state. Among other things, the commission is responsible for proposing legislation and ensuring that the member states adhere to European law. The European Commission is following the work of the network with great interest but is not yet entirely convinced, because the planned changes would interfere greatly with their way of doing things. The commission is divided into various directorates-general that are responsible for individual sectors of the economy and their specific rules. Across-the-board regulations would thus completely change the balance of power in the organization. However, even within their ranks there are supporters. Commissioner for Justice Dr. Viviane Reding, for instance, characterized "the consolidation of European administrative law as one of the most important tasks of European legal science" during a meeting of the European Law Institute.

In the end, whether and how the recommendations are implemented is the decision of the European lawmakers. But even if the harmonization of the sectors fails, the first version of the ReNEUAL recommendations, set to be completed in 2014, can serve as a point of reference for new regulations. The concept is also helpful as a Europe-wide code of practice for teachers or students of law, and even the national states might be able to learn something from it: "Information administration is an area in which the EU is a step ahead of Germany. In the EU one sometimes stumbles upon things that one never would have thought about as a national lawmaker."

Further Reading

Schneider, J.-P./Lipowicz, I. (Hrsg.) (2011): Perspektiven des deutschen, polnischen und europäischen Informationsrechts. Ergebnisse einer deutsch-polnischen Alexander von Humboldt-Institutspartnerschaft. Osnabrück. (= Schriften zum Europäischen und Internationalen Recht 18).

Ziller, J. (2011): Alternatives in drafting an EU administrative procedure law. (A link to the document may be found at www.reneual.eu).

Schneider, J.-P./Caballero, F. V. (Hrsg.) (2009): Strukturen des Europäischen Verwaltungsverbunds. Ergebnisse einer deutsch-spanischen Forschungsgruppe. Berlin. (= Die Verwaltung, Beiheft 8).

Prof. Dr. Jens-Peter Schneider
studied law and economics in Marburg and Freiburg from 1983 to 1988 and earned his doctorate in Freiburg in 1990. He then completed three years of practical legal training in Hamburg, San Francisco, and Bonn. In 1999 he completed his habilitation in Hamburg and received his professorial lecturing qualification in constitutional, administrative, and European law as well as in administrative sciences. In 2000 he was appointed to a chair at the University of Osnabrück. Since 2010 he has served as professor of public law and director of the Department of Public Law and European Information and Infrastructural Law at the Institute of Media and Information Law of the University of Freiburg. He is an honorary fellow of the Jean Monnet Centre of Excellence in European Studies at the University of Osnabrück and an leading member of the research network ReNEUAL.

Masthead

uni'wissen, the research magazine of the University of Freiburg, is published twice yearly.

Publisher
Albert-Ludwigs-Universität Freiburg,
Rector Prof. Dr. Dr. h.c. Hans-Jochen Schiewer

Responsible for Content
Rudolf-Werner Dreier,
Director of the Office of Public Relations

Expert Advisory Board
Prof. Dr. Jürgen Bauhus, Forest and Environmental Sciences
Prof. Dr. Ralf von den Hoff, Archaeology
Prof. Dr. Ralf Reski, Biology
Prof. Dr. Sabine Rospert, Medicine
Prof. Dr. Margit Zacharias, Microsystems Engineering

Editorial Staff
Nicolas Scherger (Head Editor)
Eva Opitz
Rimma Gerenstein

Address of Editorial Staff
Presse- und Öffentlichkeitsarbeit
Albert-Ludwigs-Universität
Fahnenbergplatz, D-79085 Freiburg
Phone +49 (0)761 203-8812
Fax +49 (0)761 203-4278
Email uniwissen@pr.uni-freiburg.de

Print Run
10,000 copies

English Translation
Dr. David Heyde

Photos
Unless otherwise indicated, property of the university.
Cover photo: Bender

Conception, Design, Production
qu-int. | marken | medien | kommunikation
Alter Zollhof, Freiburg
www.qu-int.com

Advertisements
Daniel Adler, **qu-int.** | marken | medien | kommunikation
Phone 0761/28288-16
Fax 0761/28288-69
Email uni-publikationen@qu-int.com

Printing and Production
Hofmann Druck, Emmendingen

Distribution
Office of Public Relations

Yearly Subscription Price
6 euros
uni'wissen is available free of charge for students and employees of the university.

ISSN 2194-8054

uni'wissen is available online at www.wissen.uni-freiburg.de.

Presse und Öffentlichkeitsarbeit
Albert-Ludwigs-Universität
Fahnenbergplatz, 79098 Freiburg
Phone +49 (0)761 203-8812
Fax +49 (0)761 203-4278
Email uniwissen@pr.uni-freiburg.de
www.wissen.uni-freiburg.de