



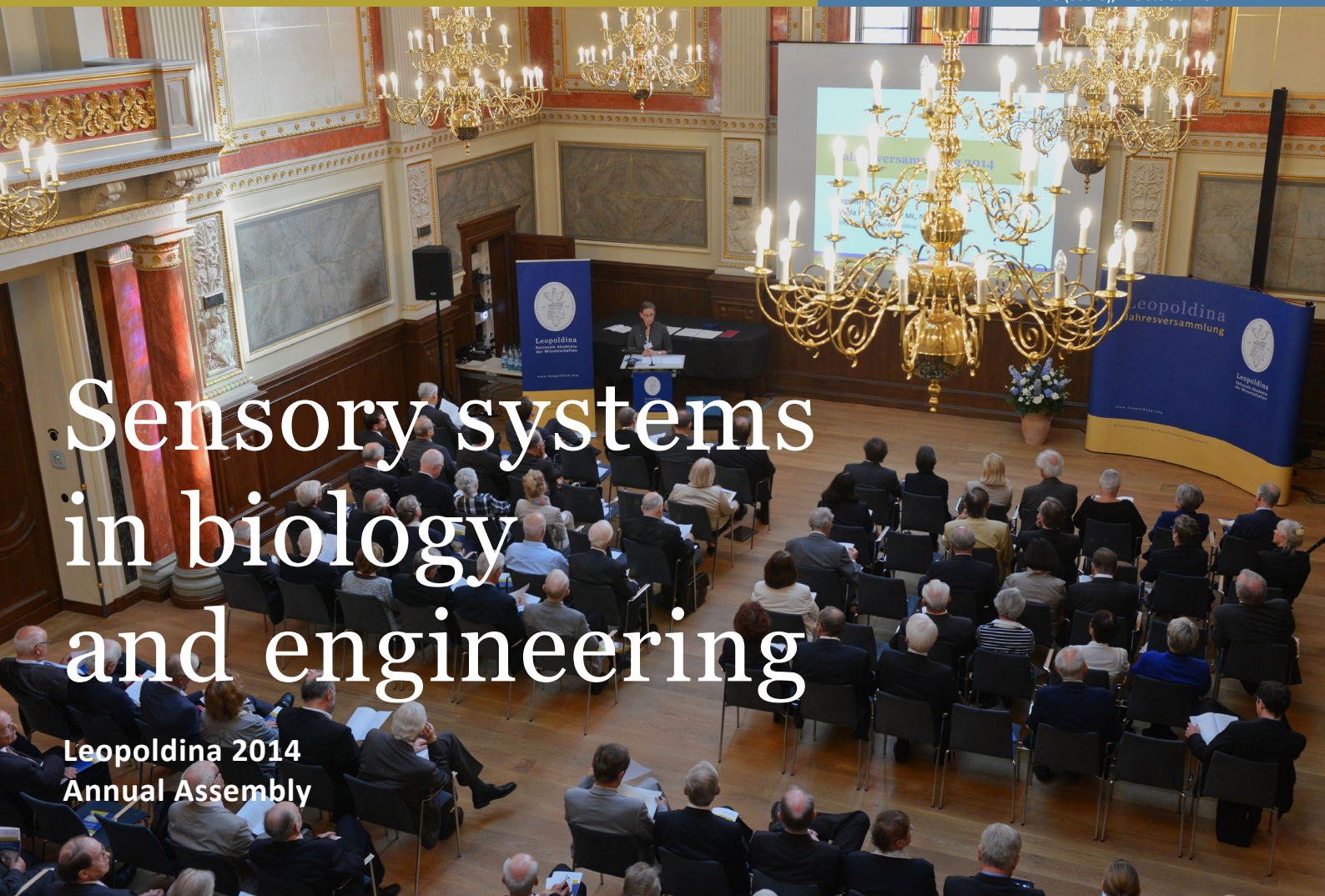
Leopoldina
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Leopoldina news

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Deutsche Akademie der Naturforscher Leopoldina –
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Editorial

Dear members
and friends of the Leopoldina,



Science is the basis for many social developments. It is therefore an open system that depends on, among

other things, exchange with the public. Science as a system includes discussions about research and its findings. Communicating with people is crucial to fostering an understanding of research and faith in those who do it. Scientists working in the field of science-based policy advice are especially reliant on this exchange. This is because independent science-based policy advice must be oriented towards the questions and needs of the society it serves.

Intensifying our communication activities will be one of the goals of my second term in office, starting in March 2015. Another major theme for the coming years will be networking within the academy and collaborating with other academies and research institutions. Working groups will interact even more than they do now. They could, for instance, address specific areas of their work together and formulate shared solutions. The overall goal is to make our policy advice even more consistent.

Clearly, we cannot solve the challenges of our time by working at the national level alone. This is why the Leopoldina – and I, personally – will continue to work on building networks with international partners. I am especially looking forward to continuing my activities on the UN Secretary-General's Scientific Advisory Board, as part of which I intend to help formulate global sustainability goals for the post-2015 world.



The report was presented at a press conference held on 9 September by Michael Hecker ML, Alfred Pühler ML, Dierk Scheel ML, Regine Kahmann ML and Roland Eils (left to right). Photo: David Ausserhofer

The challenges of OMICS

Leopoldina presents report on tomorrow's life sciences

Large quantities of data, also known as big data, are representing new challenges for life sciences today. Using high-throughput screening, life scientists are now collecting more comprehensive data than ever before on genes, proteins and metabolic products. OMICS technologies, such as genomics, transcriptomics, proteomics and metabolomics, have the potential to revolutionise our understanding of life. However, scientists are currently only able to evaluate a fraction of the data generated. Storage and transfer are also a major problem.

What structural conditions does Germany's science system need to fulfil in order for the OMICS revolution to succeed? A Leopoldina standing committee addressed this question, and the outcome of its work is contained in the first Report on Tomorrow's Science, which is entitled "Lebenswissenschaften im Umbruch. Herausforderungen der OMICS-Technologien für Deutschlands Infrastrukturen in Forschung und Lehre" ("Radical changes in the life sciences: The challenges of OMICS technologies for Germany's research and teaching infrastructures").

Better promotion of young researchers in the life sciences

The report draws attention to the lack of sustainability in the present organisa-

tional and financing structures within the life sciences. It notes that existing investments currently put Germany in a good position, but that, unlike non-university research institutes, universities, which are largely financed via Germany's states and third-party funding, cannot afford to run the expensive infrastructures on a permanent basis. There is no other way to access technologies, and young researchers have very few reliable prospects for an academic career. In particular, the bioinformatics requirements of the technologies are vastly underestimated. It is almost impossible to do top-level university research or provide up-to-date training to the necessary extent.

Aiming for a national infrastructure for IT and OMICS

The report proposes establishing a national OMICS and IT infrastructure that would take the form of centres distributed around the country and would be set up as a joint project between the federal government, the state governments and scientific institutes. The goal of this national OMICS and IT infrastructure would be to allow scientists involved in research and teaching to use high-level, cutting-edge technologies and expertise in their region and throughout Germany, irrespective of what institute they belong to. (cbr)

From senses to sensors

Annual Assembly sheds light on the many different aspects of perception and control

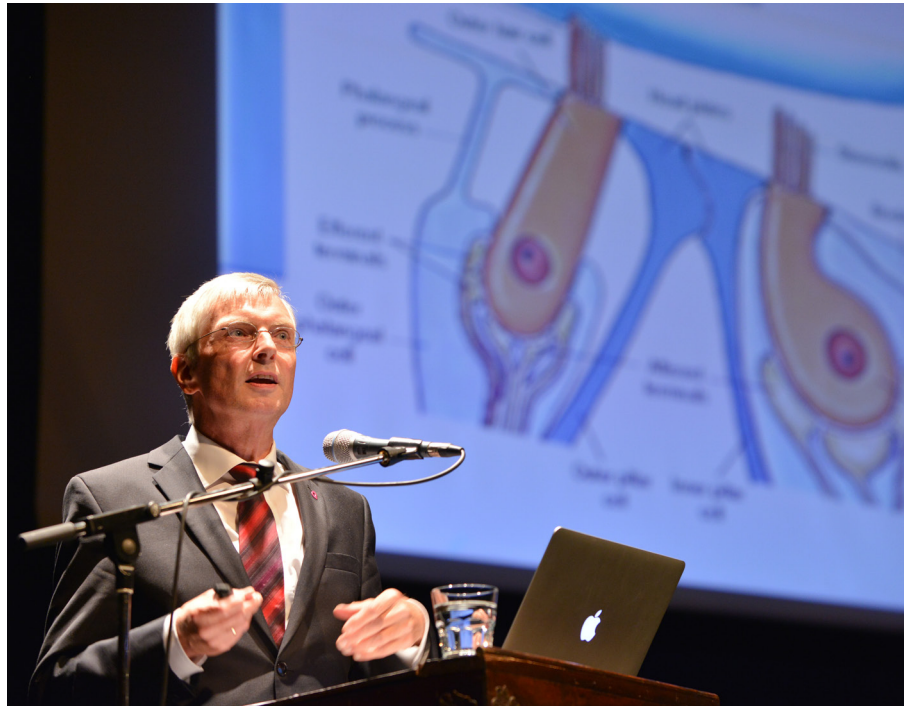
The Leopoldina's 2014 Annual Assembly, held from 19 to 21 September in Rostock, focused on the connection between perception and control as both a fundamental principle of all life and a challenge for new technological developments. Around 300 participants attended the 17 talks during the three-day event, which was entitled "Perception and Control: Sensory Systems in Biology and Engineering". The scientific organising was handled by Prof. Rudolf Guthoff ML, Prof. Gottfried Schmalz ML and Prof. Eberhart Zrenner ML. The guests included Abitur (A-level) students from all over Germany, who were able to attend the talks and engage in discussions with scientists thanks to funding from the Leopoldina Circle of Friends.

The event began with an opening lecture by Prof. Ulrich Benjamin Kaupp ML, who took the audience on a journey to the physical limits of perception. In his talk, entitled "Sensitivity at the Physical Limit – How Cells Detect Single Photons or Molecules", he described the complex biochemical signalling pathways that exist in cells and can perceive stimuli and transform them into cellular signals.

In Session I, Prof. Alexander Waibel presented the possibilities of machine translation in his talk "A World Without Language Barriers: Utopia or Reality?" Waibel used a real-time translation of his talk to give an impressive demonstration of what the programs can do.

Next, Prof. Marlies Knipper ML gave a presentation entitled "About Hearing Disorders, Stress and Emotions: How Hearing Shapes our Brain Functions". She explained how stress levels in humans can affect the central nervous system's ability to compensate for hearing damage, and how this can manifest itself in conditions such as tinnitus.

Prof. Brigitte Röder ML opened Session II with an experiment that demonstrated how sensory organs interact to process impressions from our environment. In her talk, "Multisensory Processing in Humans", she showed a video of a person speaking in which the lip movements did not quite match the soundtrack. With their eyes open, the audience heard "da da", but with them closed, they heard



Musicologist and physician Eckart Altenmüller (top) speaking about the perception of music; Abitur students (bottom left) are guests at the Annual Assembly; Organisers Eberhart Zrenner, Rudolf Guthoff and Gottfried Schmalz (bottom right).

Photos: Markus Scholz

"ba ba". This was because the sight of the lip movements corresponding to "da da" overruled the sound of the syllables that were actually uttered "ba ba". Building on the observation that different sensory systems provide redundant as well as complementary information, Röder's research seeks to establish whether or not one sensory system can replace another.

Prof. Eberhart Zrenner ML gave a talk entitled "Fighting Blindness with Artificial Retina". He showed the audience a chip that can be implanted into the retina of patients who suffer from severe retinal degeneration, and played videos of patients talking about their experiences with the implant.

Speaking on the Friday evening, Prof.

Eckart Altenmüller gave a memorable and entertaining presentation in which he explored why humans love music, what makes us get goosebumps when listening to music, and how people become good musicians. The audience were also treated to the talents of Rostock pianist Janika Simowitsch, who sat at a grand piano playing the pieces used as examples in Altenmüller's talk.

Prof. Gerd Hirzinger ML opened the programme on Saturday with a talk entitled "Humanoid Robots – The Complex Sensor-Actuator Systems of the Future". He stressed the important role that mechatronics play in robotics and demonstrated new possibilities such as intuitive machine control and ultralight, highly

sensitive robot arms. He also showed how these can be used in vehicle assembly, medical technology, and space travel.

During Session III, Prof. Michael Hecker ML answered the question of how bacteria communicate with their ecosystems. He emphasised that, outside the laboratory environment, bacteria typically experience situations of starvation and stress. Hecker then demonstrated how they have adapted to this by, in particular, regulating gene expression: bacteria can recognise a specific lack of something and then form special proteins that help them react to the situation. His conclusion: “A healthy degree of constraint can unleash incredible powers of creativity.”

In his talk entitled “Brain-Computer Interfaces – Medical Perspectives and

Ethical Implications”, Prof. Gabriel Curio took the audience from the clinical problem to the technological solution. He showed how patients who are completely paralysed can use their brainwaves to control machines and thus communicate with their environment. The method also works on healthy people. For instance, brainwaves can show when a driver plans to brake – before he or she actually brakes. This can make it possible to buy time in an emergency.

Summing up, organiser Guthoff said that the Annual Assembly had demonstrated the unity of basic and applied research: “Both require the same curiosity and the same enthusiasm. The talks, which were in the most diverse of disciplines, showed this to impressive effect.” (jk/mik)

Statement on Taxonomy available

In June, the Leopoldina published its statement on taxonomic research in the era of OMICS technologies. In this statement, the Leopoldina presents an overview of taxonomic research in Germany, proposes how it can maintain and improve its position on the international stage and underlines that, more than ever before, a modern taxonomic science is emerging that has an integrative character. The statement „Challenges and Opportunities of Integrative Taxonomy for Research and Society“ is now available in English. (mik)

■ THE STATEMENT CAN BE FOUND HERE.

Measuring forces inside cells

Carsten Grashoff receives Early Career Award for his work on developing tension sensors



Carsten Grashoff receives his award in Rostock.

Photo: Markus Scholz

Our cells have to withstand a great deal. Skin cells are compressed, the cells in our bones have to carry our weight, and cell migration pushes cells around. Minute mechanical forces act on the cells in each of these cases. Carsten Grashoff wanted to understand those forces, so he developed a system that can measure, with microscopic accuracy, how much force is acting on a protein. Now, Grashoff's work has been recognised with the Leopoldina Early Career Award, worth 30.000 €, presented by the Commerzbank Foundation.

When asked what the prize means to him, Grashoff (37) doesn't miss a beat: “The motivation to carry on,” he replies, and speaks about how the award is helping sustain his spirit of inventiveness,

react to forces.

Grashoff studied at TU Bergakademie Freiberg, because it is the only university that offers the interdisciplinary programme Applied Natural Sciences. “That meant I didn't have to decide between biology, chemistry and physics,” he explains. For his PhD, he wanted to find out how cells – such as skin cells at the top of the epidermis – hold themselves together. Even in cells, holding requires strength. Grashoff then took that thought a step further and began wondering what forces exist inside a cell.

We already know that cells react to mechanical forces: if we do a lot of exercise, for example, our muscle cells grow. However, scientists were previously una-

ble to measure exactly where forces were acting and how strong they were. “There was no method, so we developed one,” says Grashoff. He laid the foundation for the work while he was living in the United States, a period that he considers the most important in his career so far. During his stay there, he developed a kind of tension sensor. He recreated an elastic protein that is found in a particular spider's web and stretches like a chest expander when pulled. Grashoff put this expander protein between two fluorescent molecules that cause each other to emit light when they get close enough together. The fluorescence allows him to identify how much the elastic protein connector has been stretched and thus measure the forces acting on it.

The method meant Grashoff could prove that the forces in a protein are not evenly distributed during cell migration. He is now determined to refine the system's technology with his working group so that they can gain an even better understanding of the mechanisms.

“The whole team is crucial,” he says, “and so is a fascination for science!” The Leopoldina Early Career Award has given everyone a motivational boost, and Grashoff is now taking his inventive spirit to the next level. (cwe)

„The level of science is extremely high“

Nobel Laureate Bruce Beutler on Leopoldina's 2014 Annual Assembly

Bruce Beutler ML gave a lecture on „Sensing Microbes and Responding to them: a Forward Genetic Approach in Mammals“ at the Leopoldina Annual Assembly. The immunologist and geneticist, who received the 2011 Nobel Prize in Physiology or Medicine for his research on innate immunity, met with Michael Kraft to discuss vaccine fatigue, possible measures against Ebola and his highlights of the meeting.

What were your highlights of this year's Leopoldina Annual Assembly?

Beutler: I love a meeting where there are diverse topics. If I can hear, let's say, about an artificial retina or about certain aspects of neurobiology that aren't usually in my sensorium, then I enjoy that a lot. So this is my favorite type of meeting. And the level of science is extremely high.

This year's Annual Assembly takes place just after the World-Sepsis-Day. On this occasion it was pointed out that sepsis, on which you did a lot of research, is an underrated problem. Would you agree?

Beutler: Physicians have always been aware that it's a serious problem. But one might have a patient with diabetes who ultimately dies of sepsis and the relatives are inclined to think: „Grandma died of diabetes.“ Sepsis often occurs as a complication of another medical problem, and the public doesn't seem to realize that it's the proximal cause of many deaths. Probably education on the subject would be helpful.

Ebola appears to be another example of a threat which we neglected. Has there been too little research on it?

Beutler: We haven't neglected it from the research side. Quite a lot is known about filoviruses of which Ebola and Marburg are examples. There's been extensive crystallographic work done on proteins of the virion. There has been an effort to make monoclonal antibodies against Ebola, they are even being used already. The question is whether they are really successful or not. You'd have to do a prospective trial to know.

Should we use them as a measure to help



Bruce Beutler gave a lecture on „Sensing Microbes and Responding to them“.

Photo: Markus Scholz

people in Western Africa right now?

Beutler: It's a difficult thing to do from an ethical standpoint. The epidemic is a terrible tragedy and there might be tens of thousands of deaths before it runs its course. But the main problem seems to be a lack of infrastructure for containing the disease, for isolating patients and treating them safely.

When you received the Nobel Prize in 2011, you mentioned the astonishing progress in immunology and genetics within the last 50 years. When we look 50 years into the future: Will diseases like Ebola, Bird Flu or HIV be eradicated by then?

Beutler: There will probably be a gap between understanding and application, as there always seems to be. Yet, if we look at the situation with HIV, it was 100 percent fatal, a horrible, fast disease 20 years ago. Look at the situation now! People with HIV live nearly a normal lifespan, provided they have access to medication. This is due to huge advances in the understanding of the disease which required the tools of molecular biology, and to really extraordinary developments in pharma. It seems almost miraculous, and there is a real prospect for gradually eliminating a disease that once seemed apocalyptic. These things encourage me tremendously about the potential for technology and pharma to cure disease once properly ap-

plied to it. Why should it not be the same with Ebola? It's certainly possible.

Some experts fear a resurgence of infectious diseases, due to vaccine fatigue. Is that a threat to public health?

Beutler: It definitely is. Every therapeutic modality has some risks, but with vaccines there are two issues to consider. First of all, the risk is far less than the risk of not vaccinating. Second, if you don't get vaccinated, unlike with most medicines, you place others in danger, as you may infect and possibly kill them. Many people may die as the result of one person failing to be vaccinated. I would think as a matter of social responsibility, people should use vaccines, should vaccinate their children, and should not yield to superstition.

Another problem is the rising number of bacteria resistant to antibiotics. Is it even more dangerous than not vaccinating?

Beutler: Maybe I would say it's less dangerous in the long run. It's something that is manageable. If physicians would prescribe antibiotics appropriately, that would do a lot toward overcoming the problem. And physicians, of all people, should be educable when it comes to something so important to their mission. It's also possible to develop new antibiotics, more than we're doing now. We may be able to keep ahead of bacteria, at least in part.

Jörg Hacker confirmed as President

Elections in the Leopoldina Senate and Presidium

Prof. Jörg Hacker ML will continue to lead the Leopoldina for another five years. The Senate voted unanimously for the microbiologist to remain President of the academy when they cast their ballots on 18 September. The new term of office begins on 1 March 2015.

Hacker has been at the helm of the Leopoldina since 2010. Prior to being elected President, he was in charge of the Robert Koch Institute in Berlin. Between 2003 and 2009, he was Vice-President of the German Research Foundation.

During their meeting on the eve of the 2014 Annual Assembly in Rostock, the Senate also voted on filling the vacancy for one of the academy's four Vice-President positions, and appointed a new secretary for Class III (Medicine) and a new representative for Swiss academy members. Prof Martin J. Lohse ML, professor of pharmacology and toxicology at the University of Würzburg, was re-elected



Members of the Presidium outside the main building of the University of Rostock. Photo: Markus Scholz

as one of the four Vice-Presidents. Prof. Martin Quack ML, professor of physical chemistry at ETH Zurich in Switzerland, became a new member of the Presidium when he was elected as the representative for Swiss academy members. He succeeds Swiss pathologist Prof. Philipp U. Heitz ML, who had served two terms in office and was not eligible for re-election.

Heitz had also occupied the office of secretary of Class III (Medicine). The Senate elected Prof. Hans-Peter Zenner ML

to take over this position. Zenner is the director of the University Department of Otolaryngology, Head and Neck Surgery in Tübingen and was already a member of the Presidium.

Martin Quack has been a member of the Leopoldina since 1998 and belongs to the Chemistry Section. He was appointed professor of physical chemistry at ETH Zurich in 1983. He served as President of the German Bunsen Society for Physical Chemistry (DBG) from 2011 to 2012. (jk)

A major contributor to the Leopoldina structure

Leopoldina honours Swiss pathologist Philipp U. Heitz with its Medal of Merit

The Leopoldina presented Swiss pathologist Prof. Philipp U. Heitz ML with its Medal of Merit at the opening celebrations for the Annual Assembly. Heitz was elected to the Leopoldina Presidium in 2004, where he was responsible for representing the interests of the academy's Swiss members. After serving two terms in office, he was no longer eligible to stand for election.

In addition to rendering outstanding services to Swiss members, Heitz also helped secure the success of the academy's structural reforms, which were decided in 2009. "Philipp U. Heitz has made an outstanding contribution to the academy. When it came to dividing the individual sections into four classes in 2009, he worked hard to get the new structure established," said President Prof. Jörg Ha-



Philipp U. Heitz

Photo: Markus Scholz

cker ML. Heitz will continue to be actively involved in the Leopoldina in the future, as spokesman for the standing committee

on science and ethics and for the working group on personalised medicine. He was also a member of the working group on preimplantation genetic diagnostics.

Philipp U. Heitz (born in 1939 in St Gallen, Switzerland) studied human medicine at the University of Geneva and the University of Vienna. He began working as a researcher in London and Basel in 1975 and took up a teaching position at the University of Basel in 1982. He moved to the University of Zurich in 1987 and remained there, serving as a full professor of pathology and as chairman of the pathology department, until his retirement in 2004.

Most of Heitz's research was concerned with the biology of endocrine diseases in humans. (jk)

Breaking out of the “silence”

Class III symposium on advances in clinical medicine / Lecture by Niels Birbaumer

Chronic disorders of the motor system or a stroke can result in full or partial paralysis. In the worst case scenario, the patient has a fully functioning brain but is imprisoned in a body that he or she cannot move. Prof. Niels Birbaumer ML of the University of Tübingen has spent years researching interactions between the brain and machines. He wants to make it possible for patients to communicate with their environment.

Amyotrophic lateral sclerosis (ALS) is a chronic disease in which sufferers gradually lose the ability to move. In his Leopoldina Lecture, Birbaumer used videos of ALS patients to show how they were able to move dots on a computer screen using only their brainwaves. It is a skill that everyone, irrespective of age or IQ, can learn. However, even this technology starts to

Patients rate their quality of life surprisingly high

reach its limits once patients enter the final stage of the disease. This is because, as well as losing the last vestiges of their motor skills, patients also lose the ability to focus their thoughts and can no longer use brainwaves to communicate. Nevertheless, the advances in communication are a help to those affected. Surveys show that they give their quality of life a surprisingly high rating.

Brain-machine interfaces also play an important role in cases of partial paralysis, which are mostly caused by stroke. The interfaces can control motor prosthetics and thus boost learning effects for the brain because its intentions are translated directly into motor feedback. This can bypass damaged areas of the brain and means that other parts will be able to take over the functions of the damaged areas sooner. Learning effects are extremely important for training and subsequent physiotherapy of the paralysed areas, as they can help restore at least some of the lost abilities.

Birbaumer then outlined other possibilities that can be opened up by training specific areas of the brain. In addition to motor skills, it is also possible to train emotional states. Birbaumer spent a long



time working on this with psychopaths in prisons. The fear centres in psychopaths' brains are largely inactive, which means they can't understand their victims' emotions. By training the silent brain areas, it was possible to alter their emotional reactions.

Major progress in ion and proton beam therapy

The Class III symposium, entitled “Advances in Clinical Medicine”, was held the following day and included reports on progress achieved in cancer therapy.

Prof. Jürgen Debus ML of Heidelberg University Hospital talked about advances in using ion and proton beams in cancer therapy. The methods can now be used to treat patients for whom normal

radiotherapy is not an option because their tumours are, for instance, too deep or surrounded by sensitive tissue.

Prof. Hans-Ulrich Häring ML reported on advances in research into type 2 diabetes mellitus. The past two decades have seen an enormous increase in the number of people suffering from this disease worldwide, which means it is now a major economic burden on healthcare systems. Approaches for individual gene therapies already exist, but diabetes mellitus is a condition influenced by many factors that scientists have yet to fully understand. It is thought that embryos are affected in utero by the food their mother eats. We still have a long way to go before we arrive at a complete understanding of the development of the disease and its risk factors. (hst)



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Abbreviations:

ML = Member of the Leopoldina