Portal Wissen

The Research Magazine of the University of Potsdam

Two 2016

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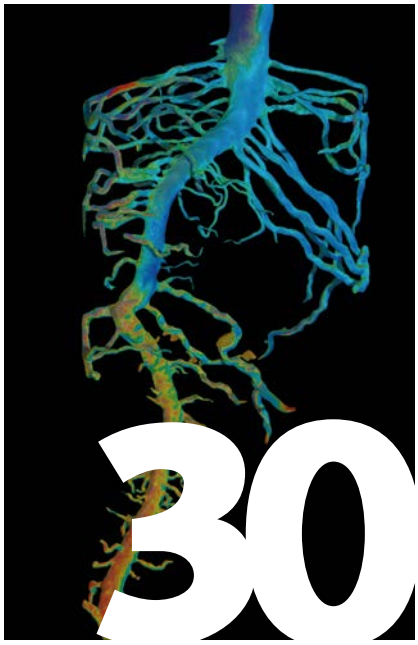

Contents

Imprint

Portal Wissen
The Research Magazine of the University of Potsdam
ISSN 2194-4237

Publisher: Press and Public Relations Department on behalf of the President of the University

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Photos/Figures:
Colangeli, Pierluigi 23 bottom right; Fotolia.com 4 (Kirill Kurashov), 46/47 (Jakub Jirsák), 34 (lassedesignen), 49 (Phoenixpix), 37 right (Photographee.eu), 50 (Photographee.eu), 51 (Photographee.eu), 48 bottom (Rawpixel.com), 14/15 (stokkete), 52/53 (UBER IMAGES), 17 top (zakokor); Fritze, Karla 5 (2), 6/7, 8/9, 10/11, 12 top left, 12 top center, 13 (3), 16, 17 bottom, 22 top left, 22 center left, 24/25, 27 (3), 29 top, 36 (2), 37 top left., 37 2nd from left top, 43, 44, 51 top left, 51 bottom left, 54 (2), 55 (4); Günther, Anne 51 center left; Helmholtz-Zentrum für Umweltforschung (UFZ)/Susan Walter 32 bottom; Leibniz-Institut für Astrophysik Potsdam (AIP) 45 top; LOLA 28 (2); NASA/JPL-Caltech/STScI 42/43; Ouwerkerk, Erik-Jan/Trägerkonsortium BiSS 36/37; privat 22 2nd from top left, 22 2nd from bottom left., 22 bottom left, 29 bottom, 37 2nd from bottom left, 37 bottom left, 48 top; Roese, Thomas 38, 39, 40 (3), 56 top, 57 (3), 58 (2); Tötzke, Dr. Christian 30, 31, 32 top, 33; Ullmann, Wiebke 18/19, 20/21, 21 top (2), 23 top, 23 bottom left; unicom (Collage) 45 bottom; Wikimedia.org 56 bottom (gemeinfrei), 12 bottom (gemeinfrei/Baquoy, Pierre Charles)

Layout/Design:
unicom-berlin.de

Editorial deadline for next issue:
31 January 2017

Advertisements: unicom MediaService,
Tel.: (030) 509 69 89 -15, Fax: -20
Applicable price list for advertisements: No. 1
www.hochschulmedia.de

Print: Brandenburgische Universitätsdruckerei und Verlagsgesellschaft Potsdam mbh
Circulation: 1,500 copies

Portal Wissen online at
www.uni-potsdam.de/portal

small

Let's be honest: even science wants to make it big, at least when it comes to discovering new knowledge. Yet if one thing belongs in the annals of successful research, it is definitely small things. Scientists have long understood that their job is to explore things that they don't see right away. Seneca once wrote, "If something is smaller than the great, this does not mean at all that it is insignificant."

The smallest units of life, such as bacteria or viruses, can often have powerful effects. And again and again, (seemingly) large things must first be disassembled or reduced to small pieces in order to recognize their nature. One of the greatest secrets of our world – the atom, the smallest, if no longer indivisible, unit of chemical elements – revealed itself only by looking at its diminutive size. By no means is 'small' (German: klein) merely a counterpoint to large, at least in linguistic terms; the word comes from West Germanic klaini, which means 'fine' or 'delicate,' and is also related to the English word 'clean.' Fine and clean – certainly something worth striving for in scientific work. And a bit of attention to detail doesn't hurt either.

This doesn't mean that researchers can be small-minded; they should be ready to expect the unexpected and to adjust their work accordingly. And even if they cannot attain their goals in the short term, they need staying power to keep themselves from being talked down, from giving up.

Strictly speaking, research is like putting together a puzzle with tons of tiny pieces; you don't want it to end. Every discovery worthy of a Nobel Prize, every major research project, has to start with a small idea, with a tiny spark, and then the planning of the minutest details can begin. What follows is work focused on minuscule details: hours of interviews searching for the secret of the cerebellum (Latin for 'little brain'), days of field studies searching for Lilliputian forms of life, weeks of experimentation meant to render visible the microscopically tiny, months of archival research that brings odds and ends to light, or years of reading fine print. All while hunting for a big hit...

This is why we've assembled a few 'little' stories about research at the University of Potsdam, under the motto: small, but look out! Nutritional scientists are working on rescuing some of the earth's smaller residents – mice – from the fate of 'lab rats' by developing alternatives to animal testing. Linguists are using innovative methods in several projects to investigate how small children learn languages. Astrophysicists in Potsdam are scanning the skies above Babelsberg for the billions of stars in the Magellan Cloud, which only seem tiny from down here. The Research Center Sanssouci, initiated by the Prussian Palaces and Gardens Foundation and the University of Potsdam, is starting small but will bring about great things for Potsdam's cultural landscape. Biologists are drilling down to the smallest building blocks of life, looking for genes in barley so that new strains with positive characteristics can be cultivated.

Like we said: little things. Have fun reading!

THE EDITORIAL STAFF

Mouse-free is the way to be

Nutritional scientists develop a method to replace animal testing

Photo: Fotolia.com/Kirill Kurashov

In the high-security laboratory.

It is one of the strongest neurotoxins known to man – and yet is also important for medicine. Botulinum toxin is also known as Botox and is used as an anti-wrinkle treatment. However, before the toxin can be used in aesthetic medicine or for the treatment of diseases, its activity has to be determined in extensive testing. Up until now, this has mostly been done in animal models, specifically in mice. Two existing alternative procedures have been approved for only two specific products and are hence not available for general use. A team led by Prof. Dr. Gerhard Püschel, the head of the Department of Nutritional Biochemistry at the Institute of Nutritional Science, has developed a replacement method that uses isolated nerve cells instead of mice. For this project, the researchers were recently awarded the Research Prize of the state of Berlin.

It takes extreme caution and concentration when researchers conduct experiments with botulinum toxin in the laboratory of the Institute of Nutritional Science. A scientist sits at the sterile work bench wearing a protective suit, gloves, and face mask, and the air in the bench's work space is continuously filtered. He transfers the mixture, which contains only a tiny amount of the toxin, with a pipette into cell cultures. These cultures contain nerve cells impacted by the neurotoxin.

The dose makes the poison – this wisdom applies to botulinum toxin like no other. The substance is not just a highly effective neurotoxin, "it is also an important compound in medicine," explains Püschel. Botulinum toxin can offer relief for patients suffering from strabismus, migraines, or torticollis.

The bacterium *Clostridium botulinum* produces the poison, for example in spoiled canned food. When the poison enters nerve cells, it inhibits the release of messenger substances. This means that these nerve cells are no longer able to communicate with adjacent muscle cells, thereby paralyzing the muscle. Botulinum poisoning occurs very rarely in Germany, with only about ten cases of botulism reported each year. In most cases the intoxication is caused by consumption of spoiled food. Even a very low dose of the toxin can lead to respiratory paralysis (apnea) and an excruciating death.

> *„Even a very low dose of the toxin can lead to respiratory paralysis and an excruciating death."*

Botulium toxin is produced in bacterial cultures for classical medical and aesthetic medical applications. Because it is extremely poisonous and there is no antidote, an overdose must be avoided at all costs. During the production process, part of the toxin is inactivated – yet it is not predictable precisely how much. Because the toxin's potency varies, the manufacturer has to test every single batch, usually in animal tests. About 150,000 mice are used for this purpose each year in Germany alone and 40,000 of them die of suffocation. "They try to find the concentration at which half of the animals die," clarifies Püschel.

Püschel is convinced that the use of animal tests is unnecessary in this case. The two pharmaceutical companies Allergan and Merz, which also sell products with botulinum toxin, have already developed substitute procedures. "Yet these procedures have significant disadvantages," Püschel asserts. First, the tests are only approved for a specific preparation that is produced by the company, and cannot be applied to other products. Also, the companies will not disclose details of their procedures and thereby prevent broader application and

THE RESEARCHER

Prof. Dr. Gerhard Püschel studied medicine at the Christian Albrechts University in Kiel and biochemistry at Indiana University in Bloomington (USA). He has been the head of the biochemistry of nutrition department at the University of Potsdam since 1999, and also performs research on mechanisms of insulin resistance in the liver and metabolic disruptions caused by foreign substances.

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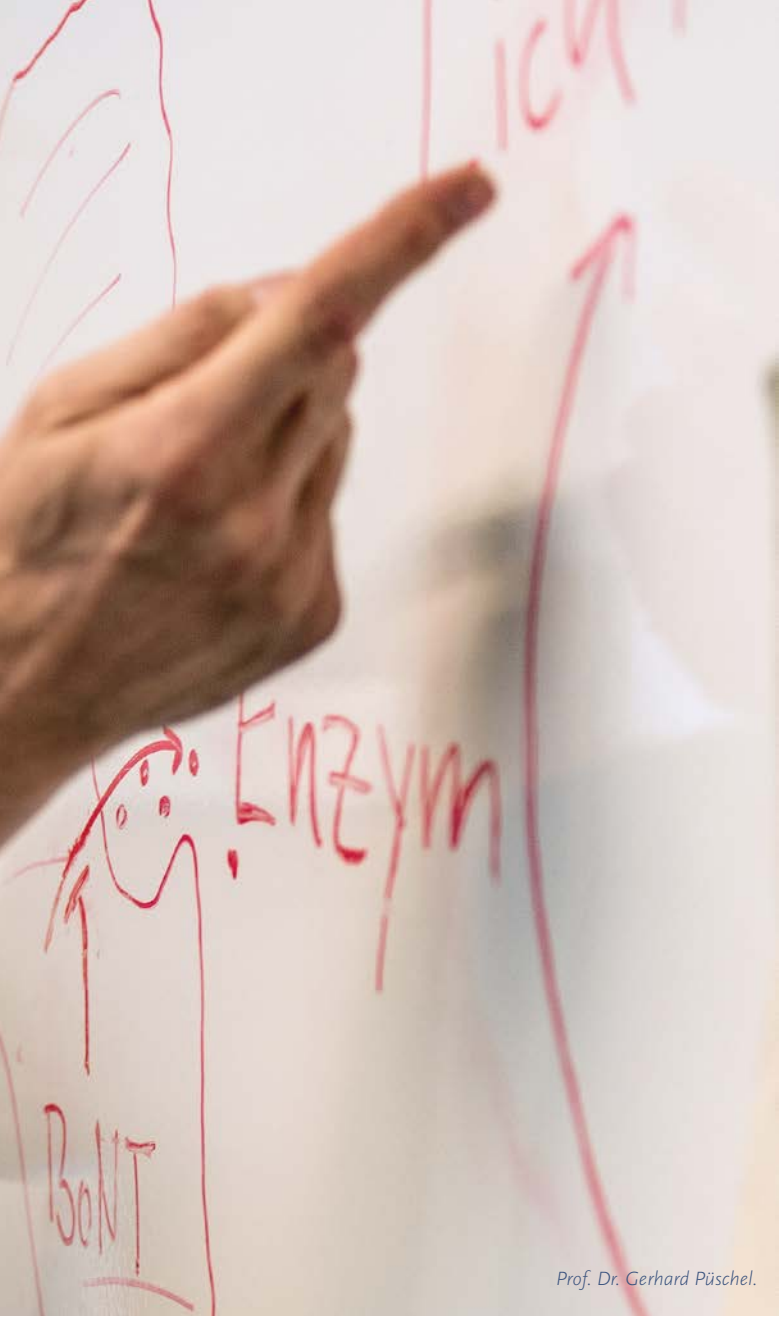
Photos: Fritze, Karla (2)

further development. Moreover, these tests are based on immunological processes that require certain antibodies. For cost reasons, these antibodies are produced by injecting tumor cells into the abdomen of mice, which then develop abdominal dropsy (ascites) from which the antibodies are harvested. "It's actually a cruel irony," reasons Püschel,"because numerous animals suffer and die unnecessarily from this procedure as well".

Püschel's team has developed a process for detecting botulinum toxin and assessing its activity, which can probably be applied to a wide range of products containing the neurotoxin. The assay measures the release of a luminescent firefly enzyme. The scientists in his team have genetically modified the enzyme and integrated the DNA into human nerve cell lines. The trick is that the enzyme behaves in nerve cells just like the messenger substances whose release is suppressed by botulinum toxin. The nerve cells release the enzyme together with the messenger substances. Outside the cell the enzyme produces light and is therefore measurable. The greater the activity of the botulinum toxin to which the nerve cells are exposed, the less enzyme is released. "The advantage of the procedure is that it should be applicable for every serotype of the poison," explains Püschel. The test could therefore deliver reliable results for all possible products that contain the neurotoxin. The scientists found in their first tests that their reporter system can also be used for other substances, such as neurotoxic pesticides. Demand for such a procedure is clear. Gerhard Püschel explains that industry has already expressed interest in the test system.

"The scientists have genetically modified the enzyme and integrated the DNA into human nerve cell lines."

Püschel admits that it was purely by chance that his team's research resulted in a replacement procedure for animal testing. "Originally we wanted to develop a system for our research projects that allowed us to more easily measure nerve cell function." Püschel learned



Prof. Dr. Gerhard Püschel.

about the problems with botulinum toxin testing from a newspaper article. He recognized that the approach his team was already investigating would also be appropriate for detecting botulinum toxin, thereby offering a promising new way to make animal testing in this field unnecessary.

After three years of intense work, the laboratory test is now being further refined and will be brought from the bench to the market. The research team wants to establish a model that resembles the natural target as closely as possible. The neuronal tumor cells that have been used up to now will be replaced by human motor neurons produced in cell culture, the botulinum toxin's natural targets in the human organism. "The cells we've used thus far differ in a few ways from motor neurons that are relevant to the effect of botulinum toxin," says Püschel. While neuronal tumor cells only transmit signals from one nerve cell to another, motor neurons form a direct connection between muscle cells and the nervous system. If the botulinum toxin blocks the release of messenger substances from the motor neurons, this paralyzes the adjacent muscle.

THE PROJECT

Cell-culture-based in vitro process for determining botulinum toxin activity

Participants: University of Potsdam, Institute for Nutritional Science
Duration: 2012–2015 (SET) and 2016–2019 (EFRE-StaF)
Funding: Foundation for the Promotion of Research on Replacement and Complementary Methods to Reduce Animal Testing (SET), European Fund for Regional Development (EFRE-StaF)
http://uni-potsdam.de/u/ewi/BCE/Forschung%20BCE/ForschungsseitenEntwurf_Projekt3_improved.html

The researchers will now try to use induced pluripotent stem cells (IPS cells) to generate a suitable cell culture and to establish the test. These IPS cells, similar to embryonic stem cells, differentiate to every kind of cell, yet were originally taken from adult human tissue cells and then genetically modified. Püschel's lab will now test the conditions under which the IPS cells differentiate to the desired motor neurons to which the existing reporter system for detecting botulinum is going to be adapted. This means the researchers will kill two birds with one stone. First, they will establish the best-suited cell type for the botulinum test, and second, they will make the leap from an animal to a human reporter system – which is a significant point for medical research. "If we manage to do this, then our cell culture will have the exact cells that the toxin targets in humans," says Gerhard Püschel. "And that would be the perfect detection system."

"Black-and-white thinking is not appropriate to judge animal testing."

Püschel knows that black-and-white thinking is not appropriate to judge animal testing. "We also use animal experiments in our research," he says. "Every time we apply for a permit for this kind of experiment, we have to ponder whether it makes sense and can be justified. That's required by law." Before every experiment, researchers have to weigh the significance of the expected results against the pain and suffering caused to the animals in the experiment. And in every single case scientists ask themselves whether there is an alternative. "The knowledge gained and the utility for humans has to be ethically justifiable, considering the animal's suffering," says Püschel. "There are no clear or ready answers to the question of what is ethically justifiable. A society has to talk it out. We're doing that, and that's good."

HEIKE KAMPE

Photo: Fritze, Karla

The Versailles Model

With the Research Center Sanssouci, the Prussian Palaces and Gardens Foundation Berlin-Brandenburg and the University of Potsdam have set their sights on international cooperation

In 2013, Sabine Kunst, who at the time was Minister for Science, Research, and Culture for the State of Brandenburg, returned from Versailles. There she had visited the "Centre de Recherche", which is a research institute that began in 2004 to connect the state's universities with Versailles and the history of King Louis XIV. We can do that too, she thought to herself, and brought on board Dr. Jürgen Luh from the Prussian Palaces and Gardens Foundation and Prof. Dr. Iwan-Michelangelo D'Aprile from the University of Potsdam. And they did it: on January 24, 2016, the Foundation and the University celebrated the joint inauguration of the Research Center Sanssouci (RECS). Both directors talked about what RECS is up to during a tour of the New Palace.

Photo: Fritze, SPSG

The Communs, *the adjoining buildings at the New Palace – and the seat of the University of Potsdam.*

THE PROJECT

The **Research Center Sanssouci** officially opened in January 2016. It is a joint research institution between the Prussian Palaces and Gardens Foundation and the University of Potsdam. The Center examines the historical and natural scientific foundations of today's global knowledge society and generates new approaches to the cultural heritage of Brandenburg-Prussia and the history of the European Enlightenment. RECS will promote the internationalization of these fields of research and strengthen the international orientation of Brandenburg as a place to do research.

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"The aim of the Foundation and the University working together is to project our research results into the world from a broader foundation," says Luh. This kind of institutional cooperation has been in the works since the University's founding. "It's only natural that the region's largest educational institutions come together with the region's largest cultural institution," says D'Aprile. The institute also fills a looming gap; in September 2016, the University of Potsdam will discontinue the last professorship for Prussian history in Germany. "It's worthwhile to pick up the thread and continue doing research on the history of Brandenburg and Prussia," says Luh.

„It's only natural that the region's largest educational institutions come together with the region's largest cultural institution."

A tour with a historian through Frederick's living quarters in the New Palace quickly becomes a personal tour. Luh seems to know everything there is to know about Frederick the Great and his palace: the precious Meissner snowball vases in the "flesh-colored room" constitute one of the largest snowball vase collections ever. There isn't even anything comparable in Saxony. "They show the military successes of the king – without having to mention them explicitly," Luh explains. This is because the porcelain is actually looted art that the monarch had taken from Meissen at the end of the Second Silesian War.

One of the most important tasks of the RECS is to bring this kind of knowledge to the public. The project's subtitle is, "For Knowledge and Society." "We believe that we are charged with communicating our findings and knowledge to the city's society," says D'Aprile. "These are after all two large institutions that shape the city of Potsdam." The newly founded institute, with its presentations and events, is oriented directly at the citizenry, and was represented for example at the Potsdam Music Festival in 2016. The new offices are located in the Zivilkabinetthaus, in the middle of the city. "Potsdam has enormous advantages as a location," says D'Aprile. International visiting scholars value the compact density of archives and libraries; cultural offerings are diverse; and Park Sanssouci is an attraction for visitors from all over the world. This is also due to the cooperative ventures between the University and the Foundation that date back to before the RECS's founding. "Previously, the Uni and the Foundation only worked together on specific projects. Now, for the first time, we have an institutional

basis as a platform to bring these research projects together," says D'Aprile.

Both directors of the new research institute have known each for a long time. After all, Luh was a staffer for the Professor for State History with a focus on Brandenburg-Prussia. He curated the exhibit, "Friederisiko," in the New Palace four years ago. D'Aprile was working at the time on "developmental policy." The RECS directors are supported by the five members of the board of trustees as well as a scholarly advisory board. To begin with, the institute, which is funded by Foundation and University funds, is on trial for three years.

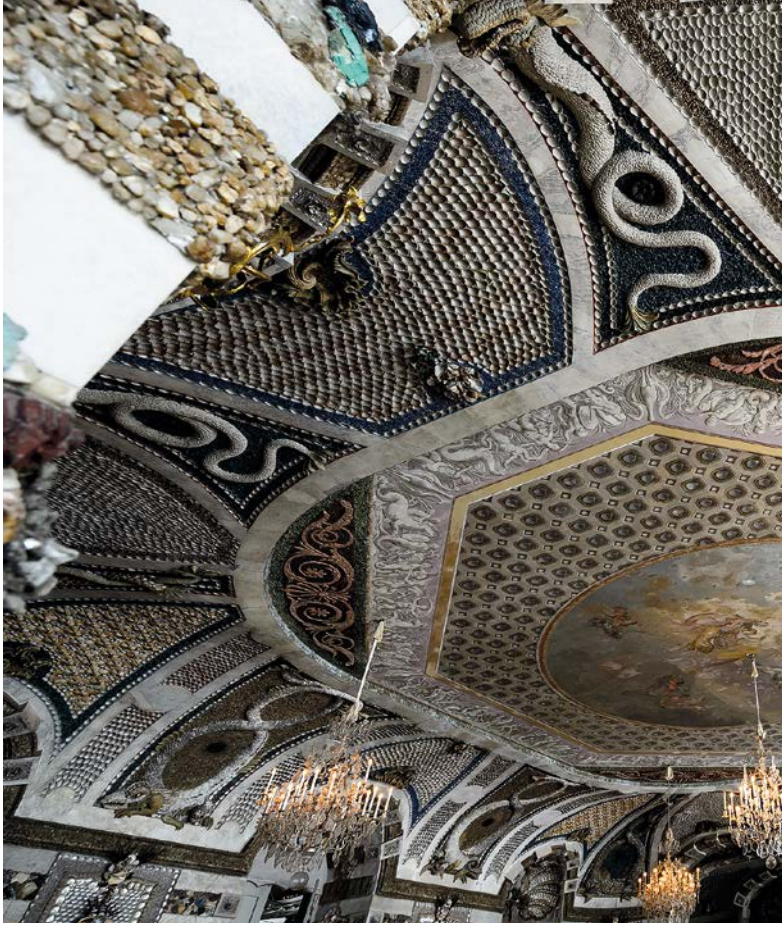
"Frederick wanted fruit, and he also wanted to eat cherries in the winter," explains Luh in the dining room of Frederick's living quarters, looking at one of the king's grand bureaus, covered in images of fruits. He paid dearly for his passion. Frederick's private account invoices show that he paid the exorbitant price of one Taler per cherry, and sometimes more. The fruits chiseled into the bureau mirror this passion and illustrate how important material culture is for history. "Working with objects also gives us insight into the character of their owners," says Luh. Yet it is not only the cultural dimension of materiality research that stands on the RECS agenda. The institute's name, "Research Center Sanssouci," is intentionally held open to be able to bring in the natural sciences. For example, the countless objects in the collections of the Prussian Palaces and Gardens Foundation have to be researched through the lens of materiality. The institute is already working together with a chemist, Prof. Dr. Hans-Gerd Löhmannsröben from the Faculty of Science, who is rendering the history of these materials visible with his chemistry equipment. The age or origin of paintings, furniture, and signatures can be determined in this way. In the New Palace's Grotto Hall, Prof. Dr. Roland Oberhänsli has worked for a while on ascertaining the origins of the 24,000 shells, glass, corals, and snail shells.

"The institute's name, "Research Center Sanssouci," is intentionally held open to be able to bring in the natural sciences."

Another important field of work at the research institute is to develop the links between the cultural heritage of Brandenburg-Prussia and the history of the European Enlightenment. "Potsdam is closely affiliated with the Enlightenment era," explains D'Aprile. "The tolerance

Dr. Jürgen Luh (left) and Prof. Dr. Iwan-Michelangelo D'Aprile in the New Palace.

Photo: Fritze, Karla



of the Edict of Potsdam made the city into a center of the European Enlightenment." Frederick the Great supported this development with intense effort: he hosted French philosophes and also participated in Enlightenment debates with his own philosophical texts. He also invited great French Enlightenment thinkers such as Voltaire or Julien Offray de La Mettrie, the latter of whom was no longer allowed to publish in his own country, for longer stays at his court.

While today historians such as Luh and D'Aprile can move freely about the library, in Frederick's time, this was a privilege reserved only for the king. The bookshelves hold ancient classics, French philosophers, and works on military history. The library also gives information about where Frederick's knowledge as a philosopher came from, and what kind of reading behavior he cultivated. A few books have signs of having been read, such as tiny burns from when a candle tipped over at night; there are inserted pieces of paper with notes. "Frederick was very, very shortsighted, and often had people read aloud to him. He also wore glasses, although we no longer have them," says Luh. Frederick also had a particular love for the octavo format, which is easy to see when looking at the volumes in his library.

" The king also participated in Enlightenment debates with his own philosophical texts. "

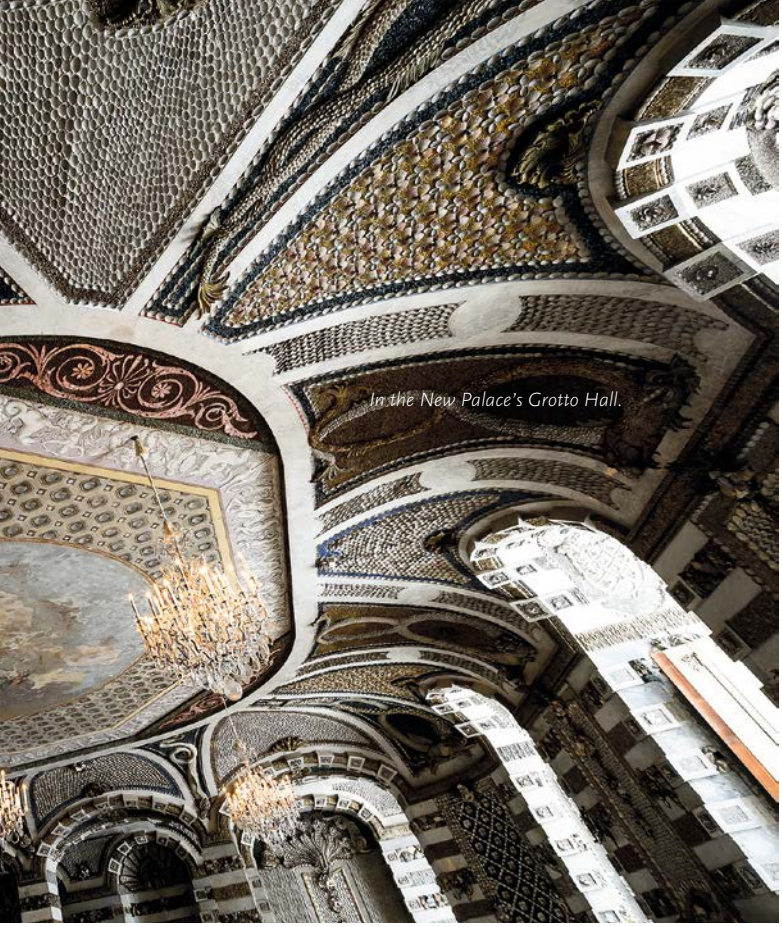
Researching which volumes Frederick received can also be important for one of the research institute's first edition projects. Historian Dr. Avi Lifschitz from the University College of London is currently working with RECS on the first English-language critical edition of

Friedrich II (right) and Voltaire.

Frederick's philosophical works. The critical edition will be published by Princeton University Press. Both directors are pleased about these international partners. After all, one major goal is increase the visibility of the region and and its cultural heritage in the world.

Although Frederick is one of the most important German protagonists of the Enlightenment, RECS research is going far beyond the research on the best-known Prussian king. A publishing project is dedicated to the letters

Photos: Fritze, Karla (2., top); Wikimedia/gemeinfrei (Baquoy, Pierre Charles) (bottom)



In the New Palace's Grotto Hall.

Truc Vu Minh (center), a graduate of the Uni Potsdam, manages the RECS business office.

of Wilhelmine von Bayreuth, Frederick's sister. Rashid Pegah and Yvonne Rehhahn are preparing the online edition of over 100 letters, many of them never seen before, from the margravine, who composed them on her journey to France and Italy. The pamphlets by and about Frederick II are also being edited and will be published on the online portal "perspektivia.net." In 2017, RECS's annual summer school, "Global 18th Century," can also get started. And the RECS Voltaire Fellowships will bring international visiting scholars to Potsdam for three months.

Furthermore, there is a student project in the winter semester 2016/17 on the colonial history of Brandenburg. Truc Vu Minh, director of the RECS office and a graduate of the "Cultural Spaces of Encounter in the Early Modern Period" program at Potsdam, is involved in the seminar project. "The Foundation's collections include several traces of Brandenburg's colonial history, including paintings and sculptures," says Vu Minh. Students in the seminar will comb through the Foundation's holdings, looking for materials related to colonial history. For example, in some portraits of the royal family, there are courtiers labeled as "Moors." "They had a privileged position at court, were often splendidly dressed, and depicted on horseback." They were well-paid for their services; in no way were they slaves. The seminar also includes a critical assessment of contemporary descriptions and the position that African courtiers held in Prussia. The course may result in the production of a digital historical park tour for smartphones, for Potsdamers and for visitors from all over the world.

„RECS research is going far beyond the research on the best-known Prussian king."

By the way, Frederick the Great slept with socks that his servants warmed up at the oven at night – Frederick was constantly worried about freezing – and also slept with a pillow bound to his head. Even today, the New Palace is rather cool; people prefer to keep their jackets on. It's therefore no surprise that Frederick only used it as a summer residence, living there in July and August. It was probably easier to do some enlightening after a good night's sleep, warmly tucked into bed.

JANA SCHOLZ

THE RESEARCHERS

The historian **Dr. Jürgen Luh** has a research focus on the history of the Holy Roman Empire, military history, and the history of Brandenburg-Prussia. He has been responsible for scholarship and research at the Prussian Palaces and Gardens Foundation since 2008. In 2012 he was the curator of the "Friederisiko" exhibition, which marked the 300th anniversary of Frederick II's birth.

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Prof. Dr. Iwan-Michelangelo D'Aprile was Junior Professor for the European Enlightenment from 2009 to 2015 at the University of Potsdam. He holds the professorship in "Cultures of Enlightenment" since 2015. His research focuses on the cultural and intellectual history of the Enlightenment. He has coordinated international research projects in this field, including "ENGLOBE" and "WORLDBRIDGES."

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Photos: Fritze, Karla (3)

Photo: Fotolia.com/stokkete

Good Morning, Twitter!

Language researchers discover social networks as a rich source of data

The ringing of the alarm clock is merciless. People who have difficulty getting out of bed, but love to stay up late, are called "owls" in chronobiology, a field of science that deals with biological rhythms and the physiological processes that accompany them. "Larks," in contrast, find it easy to get up in the morning. But this means that they're tired in the evening. Daylight and your biological clock determine in a natural way when the day begins and when it ends. Whoever has to go to work or school only enjoys this luxury on the weekend, though. The "owl" chronotype suffers unfortunately from the daily rhythm set by the alarm clock. Researchers call this "social jet lag." Because "owls" can't go to sleep early enough, but have to wake up on time anyway, they rack up a lack of sleep that they often have to compensate for on the weekend with more sleep.

Tatjana Scheffler is not a chronobiologist. But she is a computer linguist who is interested in the problem of "social jet lag." She got into this field because of research by her colleague Christopher Kyba, who works on the subject of light pollution at the German Research Center for Geosciences (GFZ). This is because artificial light also affects people's sleep-wake cycles. "Normally, researchers collect data about this in sleep studies that are conducted in laboratories, or with surveys," says Scheffler. However, surveys and subsequent evaluations mean a lot of work. And Scheffler has a solution at hand for precisely this problem.

Part one is the short message service Twitter, and part two is a computer program that can analyze text automatically. The idea is that the phrase "Good morning!" is the key moment that corresponds to when Twitter users wake up. This enables researchers to see when thousands of Twitter users wake up, and to do so on a daily basis.

Researchers worked on a comprehensive study, which began with collecting Tweets, to see if the idea held up. To do this, Scheffler used a programming interface that allows her to call up Tweets automatically. She inputs certain search criteria, such as keywords, hash tags, or user names. This filters all of the Tweets from masses of messages down to specific messages. Then the filtering process is refined. "If for example I only want German Tweets, then I use a language filter. If I'm only interested in certain language or sentence structures, then I can search for just that," says Scheffler. To examine when Twitter users wake up, she

> *„Daylight and your biological clock determine when the day begins and when it ends."*

Dr. Tatjana Scheffler.

Photo: Fritze, Karla

The early bird tweets: "Good morning!"

filters out all Tweets with the phrase, "Good morning!" and associates these with the times at which they were tweeted.

The computer programs have to be trained how to identify and analyze gigantic volumes of linguistic information; then researchers manually add descriptive attributes to a certain volume of text. "That is the most time-consuming step of them all," says Scheffler, and it is called "annotating." The program learns on this basis how to detect and categorize certain text features on its own. This machine learning process enables large volumes of text to be analyzed within the shortest time.

The results of the "Good morning!" study show that this process works. "There are really lots of people who have their cell phone next to their bed, and the first thing that they do in the morning is to Tweet it," says Scheffler. She collected all Tweets with the phrase "Good morning!" for one year. Overall, she evaluated about 1.5 million Tweets from about 200,000 users. She was particularly interested in the differences between wake-up times on workdays, when the alarm clock gives the signal to awaken, and on Sundays, when the wake-up time is determined more by natural factors. "In winter and spring, wake-up times on Sundays are very close to when the sun comes up," she explains. "This has also been shown in sleep studies." This is because in these seasons the internal clock that gives the signal to awaken agrees most with natural light signals. In contrast, wake-up times in summer and winter deviate from sunrise times – which the Twitter data also showed. "We see this as a confirmation of our method," says Scheffler. There are already plans for a joint research project with a chronobiologist in which the researchers will apply the new method.

> *„Overall, she evaluated about 1.5 million Tweets from about 200,000 users."*

Analyzing language from social networks can also benefit other research, says Scheffler, because there is actual communication going on there, not just posts. The structure of these conversations is very interesting for many researchers. What are people talking about? Are they communicating with people who have different opinions? What does the formation of political opinion look like in social media? These questions are interesting above all to social scientists. Computer linguists are supplying the necessary tools to tap into these potential data sources, which can also be useful for political, communication, and media scholars.

HEIKE KAMPE

THE RESEARCHER

Dr. Tatjana Scheffler studied computer linguistics in Saarbrücken and completed her doctorate at the University of Pennsylvania (USA). She has been performing research since 2013 at the University of Potsdam.

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Movement in the Fields

Biologists research interactions between biodiversity and movement patterns

Photo: Ullmann, Wiebke

THE PROJECT

The **BioMove** Research Training Group researches the effect of movement ecology in dynamic agricultural landscapes on biodiversity.

Participating: University of Potsdam, Freie Universität Berlin, Leibniz Institute for Zoo and Wildlife Research, and Leibniz Center for Agricultural Landscape Research
Funding: German Research Association (DFG)
Duration: 2015 – 2020
www.biomove.org

A good 50% of Germany's land – about 18 million hectares – is used for agriculture. This land is subject to rhythms of plowing, sowing, harvesting, and grazing. The fields and pastures are home to both wild animals and plants. How certain organisms adapt to dynamic landscapes, what consequences this has for biodiversity and how changing patterns of movement impinge on mechanisms of coexistence and competition are all being examined by biologists in the DFG Research Training Group BioMove, which started last October.

"It is the wedding of two research disciplines," says biologist Niels Blaum with a wink. BioMove links two fields of research. It is a joint project of the University of Potsdam, Freie Universität Berlin, the Leibniz Institute for Zoo and Wildlife Research (IZW) and the Leibniz Centre for Agricultural Landscape Research (ZALF). While biodiversity research dedicates itself to all aspects of biological diversity, movement ecology asks why, how, and to where organisms move. Between these two disciplines there are overlaps.

"It is the wedding of two research disciplines."

"In order to stop the advancing loss of our biodiversity, we first and foremost need to better understand how diverse species can coexist at all," explains Florian Jeltsch, Professor of Plant Ecology and Conservation Biology and BioMoves' speaker. "The ability of organisms to adapt to environmental change by modifying their movement patterns plays an important but overlooked role." Agricultural landscapes – with their constantly changing conditions – offer an ideal framework to more precisely analyze the connections between individual movement and changes to biodiversity, Jeltsch explains. "This approach is ultimately a step towards an 'individual-based' ecology, comparable to the transition from classical physics to particle physics."

"An agrarian landscape is one of the most dynamic landscapes; it experiences extreme changes on a large scale within one year," says Niels Blaum. Plowing, sowing, fertilizing, harvesting – in the span of a year, the soil and vegetation of cultivated fields change massively. For ecologists and biodiversity researchers, this landscape is an optimal model system to observe how organisms' movement patterns and biodiversity influence each other. The spatial and temporal dimensions of movement determine where certain species compete for food and living space as well as where they can coexist. To examine these complex interactions, researchers from the ZALF and the University of Potsdam developed the idea of AgroScapeLabs. These agrarian landscape laboratories enable experimental research at the level of the landscape – a godsend for every ecologist and biodiversity researcher.

In northeast Brandenburg – in the gathering ground of the creek Quillow – sits the group's 291-km² research area. A mosaic of larger and smaller fields, woods, and small ponds offers optimal conditions for the ongoing research projects. A total of 12 young researchers will complete their doctoral studies as part of the research training group. In their projects, they examine how individual movement patterns and complex biodiversity

Photo: Ullmann, Wiehle

GPS collars can help monitor the movements of rabbits.

A collar with an integrated GPS transmitter.

patterns interconnect and how the landscape determines diversity at the genetic level of certain species. The spectrum of methods is, therefore, diverse. In addition to on-site observation, mapping, and open-air experiments, the young scientists will also do their research with the help of computer models. "The spread of wild disease, for example, depends on how animals move," Jeltsch explains. "This can be simulated with mathematical models."

Biologist Wiebke Ullmann's doctoral project focuses on the hare. In order to research its movements, the young scientist outfitted previously captured hares with GPS-integrated collars. "What do the animals do before the harvest; what do they do after it; how do they move within a year?" She is pursuing these questions with the help of recorded movement patterns. She has already outfitted 36 animals with these transmitters. Niels Blaum pulls up an image on his laptop – a satellite image of the research field. Blue lines running across the field indicate many days of GPS data from a wired hare. Its movements follow a certain pattern: It sticks to fixed paths and uses only a small part of the field. Four days later, however, the movement pattern has changed completely. The hare suddenly moved to areas that it had previously avoided. What happened? "There used to be an alfalfa field here that was mowed down," reports Blaum. "When the plants are tall, the hares can no longer survey the landscape," explains Ullmann. They avoid areas where their sight is limited, so that foxes are not able to sneak

"The animals avoid areas where their sight is limited, so that foxes are not able to sneak up on them."

Photos: Ullmann, Wiebke (2)

THE RESEARCHERS

Prof. Florian Jeltsch studied physics and theoretical ecology in Marburg. Since 2000, he has been Professor for Plant Ecology and Nature Conversation at the University of Potsdam. He is spokesperson of the BioMove Research Training Group.

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PD Dr. Niels Blaum studied biology in Frankfurt/Main and animal physiology in Nice (France). Since 2001, he has researched at the University of Potsdam investigating the influence of land use on biodiversity.

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Dr. Guntram Weithoff studied biology in Berlin. He has been a research assistant at the Institute of Biology and Biochemistry since 2000. His research interests are biological invasions and biodiversity of plankton organisms.

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Wiebke Ullmann studied biology at Humboldt Universität zu Berlin and ecology at the University of Bremen. Since 2013, she has been researching the movement behavior of hares in dynamic agricultural landscapes at the University of Potsdam and the Leibniz Center for Agricultural Landscape Research.

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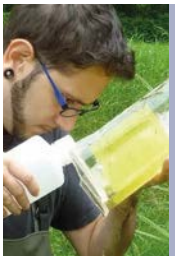

Pierluigi Colangeli studied biology in Bologna and Brussels. Since 2016, he has been a PhD student in the working group Ecology and Ecosystem Modelling.

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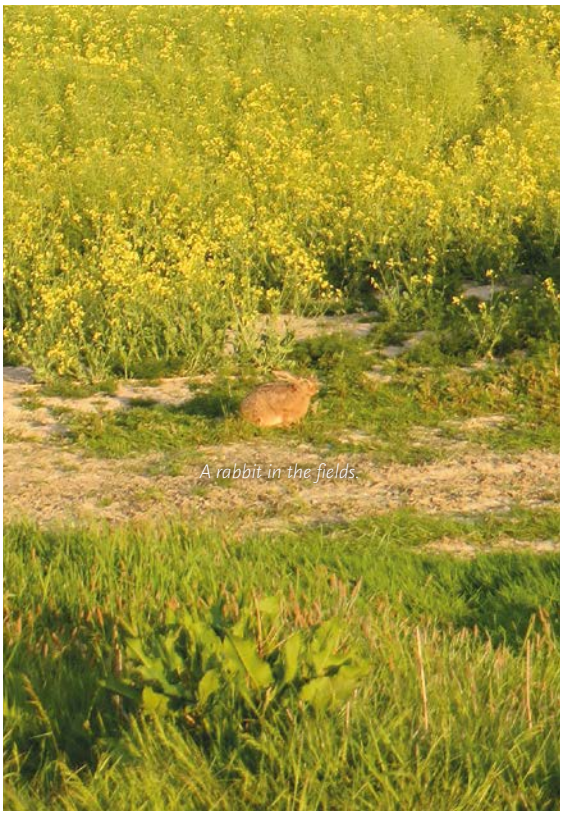
up on them. As soon as an area has been harvested and their sight is free again, they retake the areas they had previously avoided.

To be able to evaluate the information, Ullmann needs not only the movement data of the wired hares. She also has to know what is happening in the surroundings, which fruits are being planted in the fields, and how tall the plants are in a particular season. Once a month, she drives to the research area to measure plant height and evaluate the transmitter data using special geo-information software. This allows her to investigate how plant height, for example, affects the hares' movement patterns. "Telemetry technology has rapidly developed over the past five years," explains Blaum. The research profits from this not only through lighter and smaller transmitters or longer battery life. Especially valuable is the information that the transmitters send in addition to the spatial data. The so-called acceleration data – measured in four-minute intervals – shows the animal's behavior. This allows the researchers to see if the animal slept, ate, or was on the run. This offers an enormous increase in knowledge, stresses Wiebke Ullmann. "With the data, we can even calculate how much energy the hare expended." New technological means enable the researchers to move well beyond simple localization studies. Effects from – human-caused – disruptions become as recognizable as the small-scale behavior of hare. In order to calibrate the system, the researchers initially observed the wired hares under controlled conditions in enclosures and outdoors. Which signals indicate an eating hare? Which ones indicate a fleeing hare? The researchers based the patterns on the corresponding behavior and can now say what is happening based on certain signals. "Using statistical analysis, we can even use this information to assign patterns for which we have no observations," explains Blaum. "This gives us an unbelievable added value of information." Where the hare stops is also important for other organisms – and here is where movement ecology and biodiversity research merges. The brown hare carries plant seeds on its fur and in its feces, resulting in dispersal. The researchers have found up to 20 plant varieties in hare feces, which they allowed to germinate in the greenhouse. "During the course of the agricultural year, the hare is limited and can only do this at certain points in time," explains Ullmann. The researchers will be analyzing which vegetation is growing in the district of the wired hares and what role they play in the dispersal of certain species. The hare is only one of many organisms that the young researchers in BioMove are examining. Bats, storks, mushrooms, and even yeast of flowering plants are objects of their further comprehensive research projects. Biologist Guntram Weithoff and his doctoral student Pierluigi Colangeli are interested in, for example, microscopic water organisms that live in the numerous kettle holes of the landscape laboratory. Rotifers, water fleas, and ciliates – life is surprisingly diverse (with about 100 varieties of zooplankton) in the small, water-filled depres-

Photos: Fritze, Karla (top, center); privat (3)

sions, some of which repeatedly dry out over the course the year. The researchers want to find out how many varieties are dispersed by the wind and how effectively they can settle in new living spaces.

For this purpose, the researchers have installed "windsocks" in the field – pointy nets made of fine-meshed gauze. The biologists use these nets to hunt for specific life phases of the zooplankton – the "dormant stages". These organisms are able to withstand adverse conditions like longer dry spells in well-protected capsules or "dauer larvae" that are about 50 µm large. "We assume that the organisms in dried-out kettle holes are very effective at dispersing themselves through the wind," explains Weithoff.



A rabbit in the fields.

Once a month, the researchers will measure what they captured in their nets. Under the microscope and with the help of genetic analysis, they can determine which species are especially good at traveling with the wind. Whether they also successfully colonize new living spaces is another question that the researchers want to examine using artificial kettle holes. Around 30 water containers will be set up and the colonizing of water organisms in them will be regularly checked. "We will then be able to determine the rates of success and which species are especially successful at colonizing new habitats," says Weithoff. The researchers are planning further lab investigations, in which they will cultivate plankton organisms from the kettle holes under controlled conditions in a culture medium to determine under which conditions certain species prevail.

> *"In the future, we will have to think about how to optimally manage unprotected land in order to maintain biodiversity."*

Wired hares, nets in the wind, artificial water basins, wild plants in flower pots, or pollen-collecting researchers – research at AgroScapeLab Quillow will become especially visible in the coming months and years. Thanks to "the landscape laboratory", the researchers are not only able to realize their research on a grand scale but are also addressing an important question for the future: how can cultivated land contribute to protecting biodiversity? "The fact is, we don't have much land left that we can protect through conservation," explains Niels Blaum. "In the future, we will have to think about how to optimally manage unprotected land in order to maintain biodiversity."

HEIKE KAMPE

Photos: Ullmann, Wiebke (top, bottom left), Colangeli, Pierluigi (bottom right)

Windsocks.

LOLA

is Researching

How ultrasound and video analysis advance language research

Dr. Aude Noiray at LOLA.

Photo: Hinze, Katja

THE PROJECT

Methodology for investigating the development of coarticulation in German children (DFG Grant No: 1098)

Participating: Dr. Aude Noiray (Principal Investigator), Jan Ries (Lab Manager), Helene Killmer (Speech Language therapist). Students involved: Dzhuma Abakarova, Elina Rubertus, Michelle Golchert (all at University of Potsdam). Partners: Dr. Mark Tiede (Haskins Laboratories); Dr. Khalil Iskarous (USC, USA)
Duration: Late 2014–late 2017
Funding: German Research Association (Deutsche Forschungsgemeinschaft, DFG)
http://www.uni-potsdam.de/lola/index.html

The astronaut buckles up and slides deeper into his pilot's chair; he's ready. Then the rocket takes off. Earth slowly disappears while Mars gets bigger and Jupiter appears in the distance. The journey begins ... What sounds like a space adventure – and looks like one – actually takes place on the university campus in Golm in a small, carefully constructed prototype lab. At the Laboratory for Oral Language Acquisition (LOLA), linguists want to use innovative methods to delve deeper into the secrets of language acquisition. They are especially interested in how children learn to master their language – a challenge not only from a scientific perspective.

Dr. Aude Noiray and doctoral candidate Elina Rubertus (right).

"Doing scientific research on speech development in children is quite challenging," says Dr. Aude Noiray, principal investigator at LOLA. "When you want to conduct experiments with children, it is important to stimulate their interest, to take them on a journey." This is exactly what researchers at LOLA do. Without hesitation, they redesigned the technical equipment at the lab to make it look like the cockpit of a spaceship and they embedded the experimental procedure into an interstellar journey. The young participants who come here hardly notice that they are traveling in the name of science. At the beginning of the journey, they select a little puppet character to bring with them on their interplanetary adventures...

It is not only the child-friendly setting at LOLA that is innovative but also the techniques employed and the expertise of the team. The laboratory has combined audio and video analysis with ultrasound imaging techniques rarely used in developmental psycholinguistic research to create a sophisticated platform for speech production analysis. Ultrasound imaging represents the highlight of the platform; it allows for recording the articulatory activity in an area that cannot be examined with standard video equipment: the inner part of the mouth (the 'oral cavity'). This setup is used to investigate the complex interactions of the tongue and the lips during speech production in adults and children. These are mostly unexplored in children. "Most of what we know about articulation in children comes from the acoustic analysis of sound recordings," explains Noiray. "In the past, linguists would record a few children (sometimes their own child) and spend many hours transcribing these recordings and analyzing acoustic data to identify speech patterns. "Nowadays there are new technical possibilities, and we want to use them. It is becoming increasingly obvious that it is not enough to examine only the acoustic aspects of speech production. This is the tip of the iceberg. We also need to look below the surface or into the mouth – and explore the movement of the articulators, especially those of the tongue."

"The laboratory has combined audio and video analysis with ultrasound imaging techniques."

Speech sounds are mainly produced in the mouth via the interaction of mobile articulators (e.g., the lips, the tongue, the jaw) in relation to rather immobile parts (e.g., the palate) that provide places of articulation. The tongue plays a major role in spoken language (development). The tongue apex, blade, dorsum, and root characterize important anatomical and functional parts involved in the formation of most consonants and all vowels in the world's languages. Up to now, their movements have been difficult to investigate, because there was not any method for observing the oral cavity non-invasively, i.e. from the outside. The "imaging method" used with the ultrasound device offers new possibilities. "We are finally able to make the invisible processes of speech production visible," says Noiray with excitement. "I think ultrasound imaging has enormous potential in linguistics for fundamental and applied research, particularly in the clinical field but also for studying first and second language acquisition."

The young linguist gained experience with ultrasound technology as a postdoc fellow at Haskins Laboratories (affiliated with Yale University) in the USA. She first studied speech production in adults from various languages. Over the past year, she has worked intensively on optimizing this technology for research on language acquisition in children. Capitalizing on her experience with preschoolers and school-aged children, she now aims to target an even more challenging population: infants and investigate the emergence of speech sounds (phonemes) and syllables in the first year of life.

Ultrasound imaging is a standard method used in the medical field to visualize various parts of the body (e.g., muscles, nerves, the fetus in pregnant women). At LOLA, Dr. Noiray and her team optimized the technique to be used for the study of speech production in children. Since no instrument or platform existed for imaging the speech apparatus with ultrasound, Noiray designed one and constructed the prototype. "I like designing, building, and testing things. I think it is an exciting part of our work as scientists. Science is a domain in which we can be very creative and use our imagination to develop innovative objects, much like art," she says. "I also think the methodological aspects of our research are crucial for the success of a project – they need to be considered

The ultrasound probe is the centerpiece of the experimental design.

The ultrasound measurements make the movements of the tongue visible.

from the formulation of the initial research question to the interpretation of the results. I wanted to develop an experimental platform that would be fun for kids and at the same time allow us to collect solid data. At the beginning of the project, we brought the team together to brainstorm. We tried to find innovative solutions to the experimental challenges we had to face and that is how we designed our SOLLAR platform (Sonographic and Optical Linguo-Labial Articulation Recording system)." The most sophisticated piece of the SOLLAR platform is an ultrasound transducer that emits ultrasound waves and receives their echo. One of the main challenges is that the transducer must be placed near the tongue without restraining the participant's lower jaw to allow for natural speech production. Since Noiray did not want to fix the probe to the jaw to avoid perturbing speech, she developed a probe holder onto which the ultrasound transducer is mounted. "That was a bit tricky," says Dr. Noiray. "The probe holder has to be flexible enough to move with the natural jaw movement while speaking. Together with a mechanical designer from Yale School of Medicine, we played around with ideas for quite some time. We took measurements, designed plans and came out with a prototype that we tested and improved until we got convincing results. I learned a lot during this collaborative work, not only about design and technical specifics, but also about the fundamental links between empirical and theoretical research. How important it is to have all of the details of the research questions, goals and constraints crystal clear in order to come up with an appropriate tool. In the end, we designed a customized probe holder mounted in a customized pedestal that fit the specifics of our ultrasound device and provided a good trade-off between image quality and the constraints associated with working with children." The ultrasound transducer is placed in the probe holder below the chin of participants (adults or children) in such a way that of the transducer moves up and down together with the jaw when speaking. It is thus always directly below the tongue and records the best possible image of the movement, which is then displayed on a computer screen, as is familiar to us from medical studies. "The whole apparatus is integrated in a spaceship with a video camera and microphone so it is entertaining for children and for us too!"

> *"I wanted to develop an experimental platform that would be fun for kids and at the same time allow us to collect solid data."*

While ultrasound devices used in hospitals and clinics, are usually quite large, the LOLA device is comparatively small and portable. For a good reason: "One day we want to use the device in fieldwork," says Noiray, "because there are many potential applications: going to various countries to draw cross-linguistic comparisons, or investigating endangered languages in communities that live in remote areas. During my postdoc, I once went to British Columbia to record speakers of Tahltan for a documentation project in collaboration with Professor Whalen (CUNY, USA) and Professor Shaw (UBC, Canada). This type of work is very crucial to understand the variety of languages and dialects spoken in the world. But it can often only be done at the places where they are spoken. In these situations, a portable ultrasound imaging system is required."

Photos: Fritze, Karla (3)

Without its little volunteers, nothing would happen at LOLA.

The blue points help to automatically evaluate facial movements via video analysis software.

In addition to optimize ultrasound technique to image the tongue of children, Dr. Noiray and her team developed a platform that integrates standard audio and video analyses of the main articulators used for speech. "In our experiments, we record the acoustic speech signal with a microphone, the movements of the lips and the jaw with a video camera and those of the tongue with ultrasound all simultaneously," explains the researcher. The data are then analyzed with custom-made software developed at LOLA. The program filters out unusable datasets semi-automatically. If, for example, the ultrasound images are blurred because young participants turned their heads, this can be verified based on video recordings. The system also tracks movement of the head and the jaw. For this, blue dots are placed on the participants' faces before the experiment. Software developed at the lab detects the colored dots and track their movement when a participant speaks or moves his head.

It takes at least a decade for children to speak their native language fluently the way adults do. Noiray describes it as a dance. "Dancing is the dynamic coordination of the body. When we dance, we coordinate various limbs in space but also over time to create specific movements and movements are organized in a continuous flow. The same applies to speech. To produce a sound (e.g., "i"), we coordinate the lips and the tongue to produce specific movements. To produce a syllable or a word, articulatory movements overlap with one another; we say they are coarticulated. An interesting aspect is that the temporal and spatial organization of those movements varies across languages. Changing such dynamics changes the sounds produced. When learning to speak their native language, children learn to control their speech articulators to produce specific movement coordinations that take into account the regularities of their native language." In their experiments, whether as space travel or not, the researchers ask children to articulate target words. The combinatorial approach used at the lab allows them to investigate the dynamics of speech. In other words, they examine the coordination of the jaw, the lips and the tongue involved in the production of sounds, syllables and words in adults and track how those develop in children. Some analyses address questions about how speech motor control develops with age and how this interacts with the development of the lexicon and the phonological system of the native language; how variability in word production decreases with practice; how syllables and words are planned in the brain before being produced aloud or how children develop anticipatory coarticulation. "In a syllable such as "gi", the lips can anticipate the configuration for the vowel "i" during the production of the consonant "g", while the tongue is positioned in the back of the oral cavity for the consonants," Noiray says. "It gets even more exciting when words and sentences are created from the combination of these individual sounds, because the specific sequence intended by the child influences the way articulators are coordinated over time. This is an important mechanism we want to investigate." In a current project, the LOLA team is investigating the interplay of consonants (C_1, C_2) and vowels (V_1, V_2) in word pairs of the form "a $C_1V_1C_2V_2$", for example the pseudo-word "eine bode".

> *"It takes at least a decade for children to speak their native language fluently the way adults do."*

Elina Rubertus is even going a step further in her PhD project, which is part of the study. She investigates whether coarticulation mechanisms also extend beyond word boundaries. She examines the final sound (phoneme) of the first word, (e.g., the last "e" in the German indefinite article "eine"). This sound, a so-called schwa, is formed by a neutral tongue position, so to speak, that often corresponds to the tongue's resting position. "Using ultrasound imaging, I want to find out whether this neutral tongue position changes due to the following vowel," she explains, i.e. if the schwa before the word 'bide' has a different tongue position from its position before, for example, the word 'bade'. For the production of an "i" the tongue has a relatively high position in the oral cavity while it is low for the production of "a." If the schwa already demonstrates such differences in tongue

Photos: LOLA (2)

position, we can assume that the vowel is already prepared during the previous syllable to allow fluent speech production." The researchers will test for similar anticipatory processes with the lips to examine both lingual – tongue-related – coarticulation patterns as well as labial – lip-related – ones. "The comparison of various age groups will be very interesting," says Rubertus. "Will children exhibit different patterns from adults? Can we observe a gradual development in the various age groups of our young participants?"

„Children initially have very different speech production strategies and must learn to narrow them down."

The experiments carried out at LOLA focus on spoken language development in children and how this goes hand in hand with lexical and phonological development. Their main interests regard how children become proficient speakers in their native language, and what stands in their way. "A main goal in speaking is to produce specific sounds," summarizes Noiray. "You can achieve this in various ways. This is one reason why children initially have very different speech production strategies and must learn to reduce them to use the ones that are mostly used by adults in their native language." Understanding how language develops in typically developing children could ultimately help diagnose and treat children with speech and/or language disorders.

In a large-scale study funded by the German Research Association, the LOLA team is investigating children aged 3-7 years compared to a control group of adults. Fifteen children per age group are invited to participate in the space travel. In a second part of the study, cognitive and language-related abilities are assessed using standard developmental assessment batteries. Comparing various age groups provide crucial insights into how language develops over time, exposure and practice with the native language. The youngest cohort presents particular challenges. "We were not sure we would succeed in examining three year olds," says Noiray. "At 3 years of age, they are quite shy and cannot stay focused for long. Also, it is not easy to keep them interested in the tasks. Students involved in the project have to be good storytellers! Again, we brainstormed to find interesting scenarios and we optimized the experimental protocol – we practiced and it worked!"

The coarticulation study is designed to provide normative data in a field that lacks direct articulatory insight on language development. In German as well as in most languages, there is not any comparable database yet. Noiray initially planed on working with children with speech or/and language difficulties or with delayed language development. "But we cannot do that without first understanding how language develops when there are no problems." Nonetheless, Noiray already has new plans. While the cross-sectional study on coarticulation is still in progress, a new project on children with a reading disability (often termed 'developmental dyslexia') has already started. LOLA cooperates with the research group of the Marie Curie Innovative Training Network "PredictAble," led by Barbara Höhle, a professor of psycholinguistics in the Department of Linguistics. Together with colleagues from European labs and universities, they are researching whether it is possible to identify language disorders in the early language development of children in bilingual Europe. Within this collaborative grant, LOLA team investigates the relations between spoken language and reading acquisition in typically developing children compared to children at risk or diagnosed with developmental dyslexia. Noiray leads this project jointly with Dr. Ken Pugh (Haskins Laboratories, Yale University, USA).

For Noiray, this is only the beginning of the adventure. She already has ideas for other projects in mind. "And I have a team of clever, rigorous, and very enthusiastic students by my side," she adds with a smile. LOLA is gaining momentum; the journey can begin.

MATTHIAS ZIMMERMANN

THE RESEARCHER

Dr. Aude Noiray studied English, Language, Letters and Foreign Civilization and obtained a master's degree in Language Sciences at the Université Stendhal, Grenoble (France). During her PhD at GIPSA lab – a CNRS laboratory in Grenoble – she visited the Laboratoire de Phonétique in Montréal and McGill University (Canada) to conduct cross-linguistic experiments with Pr. Lucie Ménard. After earning her doctoral degree, she worked as a postdoc at Haskins Laboratories (affiliated with Yale University, USA). Since 2012, she has been teaching and conducting research at the University of Potsdam. She is principal investigator of a DFG grant project and co-investigator of a Marie Curie ITN grant project. She created LOLA lab (Laboratory for Oral language Acquisition) in February 2015.

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Elina Rubertus completed her bachelor's degree in General Theoretical Linguistics and obtained a master's degree in Experimental and Clinical Linguistics (IECL) at the University of Potsdam. Since October 2015, she teaches in the Department of Linguistics while conducting her PhD project at LOLA.

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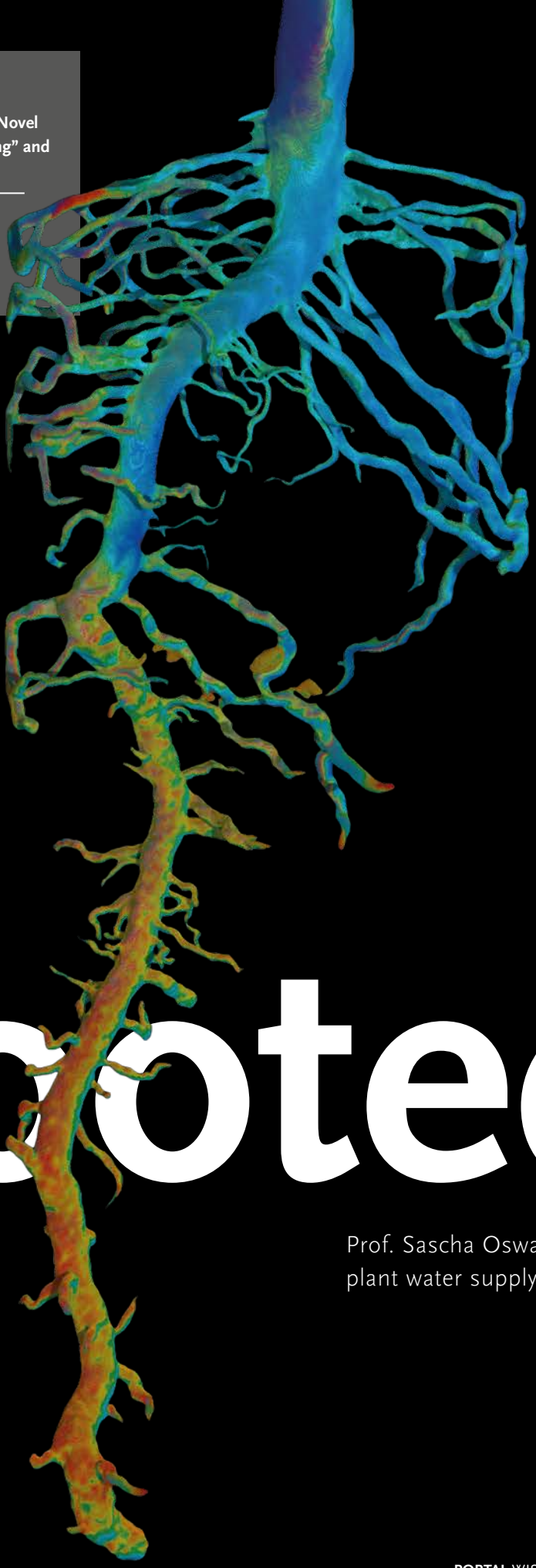
Photos: Fritze, Karla (top), privat (bottom)

THE PROJECT

Visualization of Root-Induced Water Flows by Novel Combinations of "Magnetic Resonance Imaging" and Neutron Tomography

Participants: Prof. Sascha Oswald (University of Potsdam), RWTH Aachen University, Forschungszentrum Jülich GmbH
Duration: 2014–2017



Rooted

Prof. Sascha Oswald visualizes plant water supply

Lupine root after a tracer injection.

Photo: Totzke, Dr. Christian

Our vegetation is not just an essential part of the environment; we also expect its yields to feed the present and future world population, fuel renewable energy sources, and power vehicles. Especially in agriculture, plants need an adequate water supply to thrive. It is no secret that they absorb water through their roots, but many questions remain unanswered due to methodological difficulties: Where exactly do plants take up water? Can they actively control the absorption process? Can certain root secretions even change the soil's properties to enable better access to stored water? It is clear that water must pass through the rhizosphere – the soil in the immediate vicinity of the roots – to get to the roots. It is now known that roots alter the rhizosphere soil not only mechanically but also chemically and biologically. Does this also apply to its hydraulic properties responsible for water movement in the ground? Novel imaging methods help here, because they are able to produce spatially and temporally high-resolution data, enabling a non-invasive, on-site examination of the root system and soil water distribution. Prof. Sascha Oswald is involved with the visualization of these processes.

Sascha Oswald and his team are breaking new ground to gain insight into the visualization of "root-induced water uptake processes." They even combine two imaging techniques: magnetic resonance imaging (MRI) – known primarily for medical applications – and neutron tomography (NT). As an environmental physicist, Oswald is interested in soil hydrology, soil conservation, and groundwater. For some time now, he has been collaborating with the Paul Scherrer Institute – Switzerland's largest research institute for natural and engineering sciences – and the Helmholtz Zentrum Berlin, pursuing cutting-edge research in the fields of matter and material, people and health, and energy and the environment. Both institutes operate large-scale facilities with a variety of measurement techniques that can also be used by external researchers. In addition, these techniques include a method – similar to X-ray – that allows for the production of images with the help of neutrons. Neutrons are extremely sensitive to hydrogen, thus making water "visible," a process that interests environmental scientist, geohydrologists, and soil physicists alike.

Oswald and his team began their investigations with lupine, which belongs to the same plant family as peas and chickpeas. In agriculture, lupine is cultivated primarily as a fodder plant. For studying plant water supply, the scientists used special containers that allowed plant roots to grow in natural soil. The material of the container is critical to the experimental setup. For experiments that explore only the root system and water distribution, experimenters use containers made of aluminum, because it is virtually "transparent" for neutrons. Using acrylic glass, which is nontransparent for neutrons, would produce a black image. Containers are now also made of a special glass that works for both neutron tomography and other methods such as MRI. Combining both methods allows the MRI to provide additional information on the pore structure and the manner in which the water is bound.

"The roots become clearly visible with our method, because they consist of at least 80 percent water," says Oswald. If you let the plants grow and then dry up the soil, primary and secondary roots become visible on the images with good spatial resolution. The increase and decrease of water in the soil and its exact spatial distribution are studied over several days. The dry areas around the roots are where the roots took up water. The roots continue to grow, and the water absorption shifts. "The images show how and where the roots grow, as well as how the water moves without disturbing the system," says Oswald. The images also show each plant's "individuality." They show how differently the root structures of individual plants develop and how this affects water distribution. Young and old, thick and thin roots do not take up the same amount of water. They transport it to varying degrees of effectiveness to the aboveground plant parts. "We have examined this in different variants, especially with agriculturally interesting plants such as corn, lupine, chickpeas, fava beans, and tomatoes." These plants were also chosen because their thick roots and clear structures are conducive to this type of experiment. If the root system is too fine, the structures merge and impair the analysis of image data.

"The roots become clearly visible with our method, because they consist of at least 80 percent water."

Young plants await their duty in the growing chamber.

Photo: Tötzke, Dr. Christian

Something unique emerges from every kernel of corn.

There are now increasingly more effective means of three-dimensionally visualizing root-induced water uptake. In neutron tomography, the object is placed on a revolving table and rotated incrementally within a range of at least 180°. A picture is taken at each angular step, and the resulting image series allows the researcher via computer algorithms to reconstruct the three-dimensional root system and the exact water distribution in the soil.

Such 3-D images suggest that the roots can also alter their immediate environment. They are thus better able to cope with a dilemma: Water absorption increasingly dries the surrounding soil, but the drier the soil, the more it inhibits further water movement, making it harder for the water to reach the roots. In other words, the plant aggravates its own water scarcity until it rains or until it is watered. The researchers found while taking their measurements, however, that this can be reversed in the rhizosphere.

„The resulting image series allows the researcher to reconstruct the three-dimensional root system."

THE RESEARCHER

Prof. Sascha Oswald studied physics at the University of Freiburg and the University of Heidelberg, and earned his doctorate in environmental sciences at ETH Zurich. Since 2009, he has been Professor for Subsurface Hydrology at the University of Potsdam.

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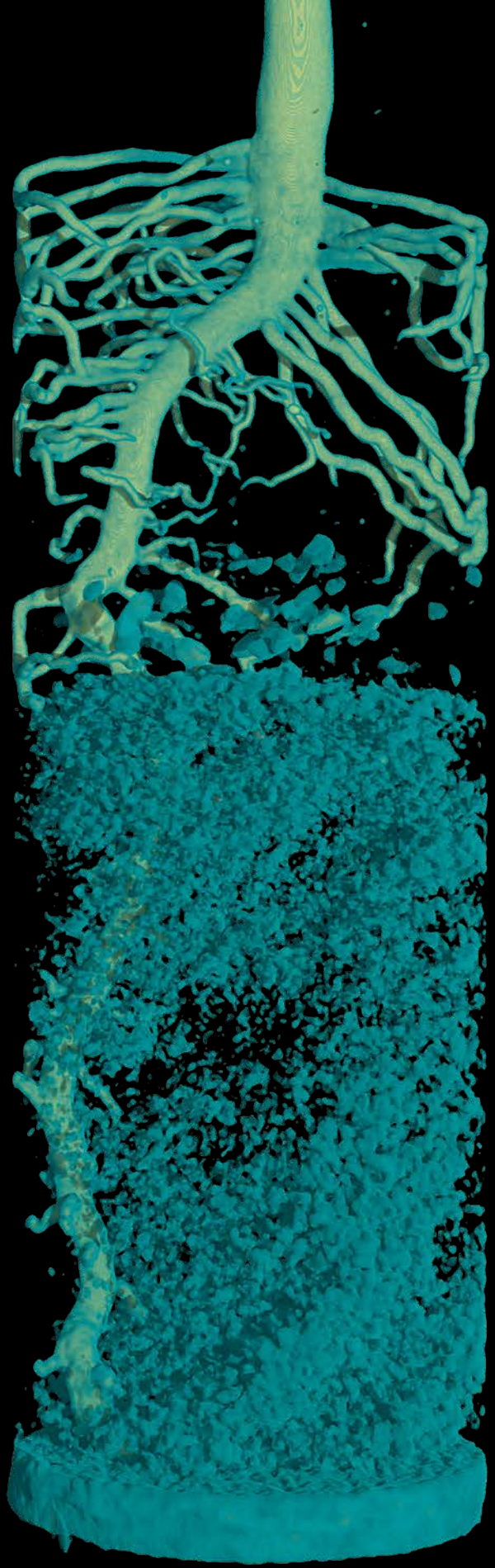
This zone then acts as a buffer that retains the water for longer and absorbs it more slowly after irrigation. This helps the plant to better withstand a critical drought. "We think that the plants produce a kind of mucilage gel or have microbes to produce it for them, thus creating this favorable characteristic of the rhizosphere," Oswald explains. Scientists imagine it as a kind of diaper material, in which gel is able to bind a great deal of water. "It could have a substantial effect and adapt the plant to dry conditions." Objectively, there is no larger quantity of water available, of course, but access to water is maintained in a wider surrounding area. Oswald estimates that these plants gain an advantage of half a day. Sometimes this is just enough to keep the plant from wilting before the next rainfall.

„The plant aggravates its own water scarcity until it rains or until it is watered."

Too much water is problematic as well, because it cuts off the roots from the oxygen supply needed for the root cells to breathe. This can also be observed with a fluorescence-based method, which was developed by one of Oswald's assistants. The method allows a two-dimensional visualization of both the oxygen concentration and the pH distribution. The latter is modified by the plant via root secretions in a way that allows the plant to better absorb nutrients. In addition, a change in pH also may change the functioning of the mucilage.

It is increasingly evident that plants actively influence the biochemical and hydraulic parameters at the interface of root and soil, creating temporally dynamic reactions to environmental conditions. Mapping these processes in the rhizosphere, which forms around the growing root system and is just a few millimeters thick, will continue to challenge researchers.

DR. BARBARA ECKARDT



Three-dimensional water distribution (blue) in the pore space around the root of a lupine.

Photo: Tötzke, Dr. Christian

Photo: Fotolia.com/lassedesignen

Where to Go with Depression?

Influence of Various Treatment Settings on Therapeutic Success

Depression is no longer on the fringes; it is a widespread disease. According to the Federal Ministry of Health, about 4 million people in Germany and 350 million worldwide suffer from a depressive disorder. A team of psychologists and medical experts at the University of Potsdam wants to find out how "various treatment settings influence therapeutic success". The study hopes to offer insight into how and especially where people suffering from depression should be treated.

Nearly one in five Germans suffers from a depressive episode in their lifetime. Depression has long been a challenge for society in general and the health system in particular. Sick days due to depressive diseases are increasing; the number of early retirements doubled between 2000 and 2009. While many people – 25-40% – suffer from a depressive disease only once, others experience several phases of the disease, and 10-15% experience chronic depression. For these chronic sufferers, depression is often the reason for early retirement. For Prof. Michael Rapp of the University of Potsdam, an expert in social and preventive medicine, this finding is as unsatisfying as it is inexplicable. "It is difficult to understand. Depression is actually the disease that psychiatrists and psychotherapists are best able to treat. The 'success rate' is 80%." In fact, many who apply for early retirement have often not had treatment for years and think that their diseases are untreatable. "This, however, is not true – and it will start getting very expensive in the case of early retirement."

> *„Depression is actually the disease that psychiatrists and psychotherapists are best able to treat."*

There are no simple explanations why the number of depressive diseases is increasing. The problem is too complex. On the one hand, destigmatization of depressive disorders is likely to have led to more and more affected people seeking treatment. Many lack sufficient medical coverage to get adequate treatment. It often happens that insufficient capacity leads to patients "only" receiving medication rather than psychological therapy, or they are seen by their general practitioner instead of a specialist physician. On the other hand, it may be that we are exposed to more stress-inducing stimuli – so-called stressors – that promote depressive diseases. What makes them difficult to adequately treat is the – apparently – increasing number of interrelated factors. Each patient needs an individual and adequate form of treatment. "For many diseases, you would intuitively assume that if you have been suffering from it for a long time, it is best to go to a rehabilitation hospital and not to use outpatient treatment," says Rapp. "The same cannot be said for depressive diseases."

THE PROJECT

DepReha – Influence of Various Treatment Settings on Therapeutic Success

Principal Investigators: Prof. Michael Rapp, Prof. Pia-Maria Wippert (both University of Potsdam)
Participating at the University of Potsdam i.a: Andrea Block and Andreas Häusler; Heinrich-Heine-Klinik in Neu Fahrland, Hochschulambulanz der Freien Universität Berlin, Psychiatrische Praxis Dr. Bohlken Berlin-Spandau
Funding: DRV Berlin-Brandenburg
Duration: 2015–2017

This is the starting point of the Potsdam researchers' study. "We want to find out which forms of therapy are most suitable for which patients – and, thus, take a first step towards a treatment approach that is individually tailored from the very beginning," explains health sociologist Prof. Pia-Maria Wippert, who heads the project with Rapp. The researchers are specifically interested in the influence of various treatment settings on the course of therapy. "Whether inpatient in a rehab clinic or outpatient in a specialized outpatient department or a physician's office, for example, the place of treatment essentially influences therapeutic measures and their application." The Potsdam study "DepReha" will show whether these differences also ultimately affect the course and success of therapy. The researchers are collaborating with the Rehabilitation Clinic Neu Fahrland, the outpatient department of Freie Universität Berlin and with a neurologist's office. For the researchers, this proximity to practice is something special and appealing about this study, emphasizes Andreas Häusler, who looks after patients in the outpatient departments. "The project is not being conducted isolated in a laboratory but very close to reality. We meet the participants in the facilities and accompany them for a while. So we have the chance to approach the care of depressed patients from two perspectives – scientifically and practically."

Prof. Dr. Michael Rapp.

About 200 subjects will be examined in a longitudinal study over two years – both physiologically and psychologically. "A testing battery with a wide measurement scale is being used. Its statistical evaluation will help to understand the complex relations and to draw conclusions," explains Rapp.

The three facilities invite newly admitted or treated patients eligible to participate in the study. "We present the project and answer questions in an information meeting," Andrea Block, a member of Wippert's team, explains the approach in the rehabilitation clinic Neu Fahrland. During the clinical routine, blood samples to examine the stress markers are then taken from patients willing to participate who also meet the inclusion criteria. On the next day, a hair sample is taken as well. "The blood and hair samples provide insight into the subjects' stress level," says Wippert. "Not only at the time of measurement. The hair sample indicates the stress development over the past three months, because the stress hormone cortisol is deposited in the hair."

> *"The hair sample indicates the stress development over the past three months."*

The psychological survey is done using questionnaires that capture data, for example, on depressiveness, symptoms of mental disorders, and positive and negative affective conditions but also the so-called 'work ability index' and stress. There is also a health questionnaire. Relevant sociodemographic data are recorded as well.

Prof. Dr. Pia-Maria Wippert.

Photos: Fritze, Karla (2)

This examination is repeated immediately after the treatment and after five and eight months in order to obtain comparative values. "We longitudinally examine whether the treatment setting influences therapeutic success. Could stress be reduced? How are the depression symptoms developing? Were they able to return to work?" says Block. Evaluating the information on the first measure has already provided valuable insight, namely on medical service coverage, Block explains. "Performing a cross-sectional analysis allows us to investigate which patients have which medical conditions, to what degree of severity, and in what treatment setting. In other words: Where do people with particular depressive illnesses go for treatment?"

Such findings are important for the overall goal of the study. Ideally, DepReha will enable physicians and therapists to recommend the appropriate treatment setting for patients. "We hope to identify specific risk profiles," says Häusler. "This could help optimize the success of treatment for specific patient groups. It is quite possible that, for example, patients with a high stress load are best treated in one of the three settings."

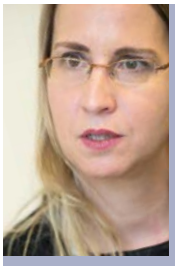
The data are still being collected – and this is as complex as the problem itself. It demands, not least of all, constant coordination of the teams conducting the examinations in the participating medical institutions. "Every two weeks we get together to discuss issues and problems, seek solutions, and distribute tasks," says Block.

The first reliable results will be available in mid-2017, when the other measuring points will be passed, and they can start evaluating them. "You learn to be patient," says Rapp. "It does not help to prematurely evaluate incomplete data and draw conclusions that cannot be confirmed later." The researchers need exactly this patience, particularly for a long-term study like this. Patients will be asked to accurately assess possible long-term effects of various treatment methods up to five years after the two-year main study. The researchers never lose sight of their long-term goal. "Our studies should ultimately help improve the existing medical service networks and individual therapy offerings for reintegrating those with depression," says Wippert. "Even the setting turns out to not affect the course of treatment, it would be an important result that helps patient and health professionals," Rapp adds.

„Our studies should help improve medical service networks and individual therapy offerings for those with depression."

MATTHIAS ZIMMERMANN

THE RESEARCHERS



Prof. Pia-Maria Wippert has been Professor of Sport and Health Sociology at the University of Potsdam since 2010. She specializes in risk stratification of stress-associated diseases and intervention development.

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Prof. Dr. med. Dr. phil. Michael A. Rapp is a psychiatrist and psychotherapist and Professor of Social and Preventive Medicine at the University of Potsdam. For many years, he has been dealing with the predictors and conditions for life-long mental health.

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Andreas Häusler studied psychology at the Technische Universität Berlin. He is a research assistant at the Chair of Social and Preventive Medicine.

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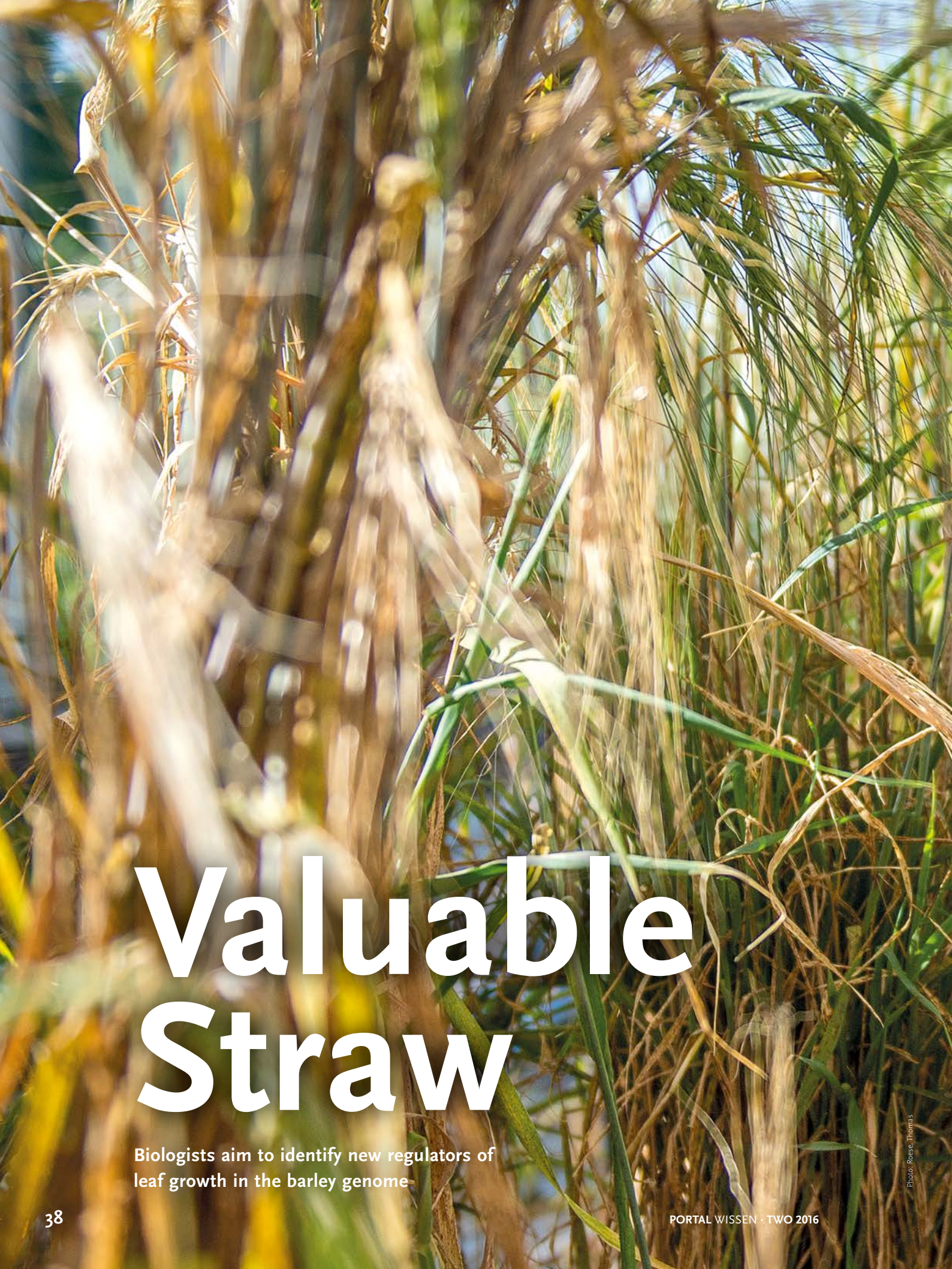

Valuable Straw

Biologists aim to identify new regulators of leaf growth in the barley genome

Photo: Roese, Thomas

Photo: Roese, Thomas

It is among the most widely cultivated crops in Europe. German farmers alone produce about 10 million tons of barley each year. Its straw used to be considered a low-value byproduct. More grain, less straw – for decades, this was the basic aim of barley breeding. The value of biomass, however, is increasing. What was once mainly used as animal bedding or insulation material is now being converted into energy. Farmers, too, could benefit from new barley varieties that produce more biomass. An international consortium, including Potsdam geneticists, is working on this idea.

The barley plants are already looking a bit worn. For three months, they have been standing in tall, narrow pots in a greenhouse in Golm and are starting to form rich tussocks. Brown leaves droop down among green ones. The typical barley heads with their long awns are already fully developed in most of the plants. Some of the plants are covered with small white bags – the sign of an ongoing crossbreeding experiment. The resulting seed is required for further experiments. Biologist Michael Lenhard, Professor of Genetics, examines a leaf between his fingers. Each of the 30 pots contains another type of barley with genetic material different from all the others, which leads to it having unique properties. Some stems are particularly long or short; others have many or only a few ears. The leaf size varies – and this is of particular interest to the geneticist.

> *„Farmers, too, could benefit from new barley varieties that produce more biomass.“*

Michael Lenhard and his team are part of a major research project that examines the potential of barley as an energy crop. “The point is to increase the biomass of plants,” explains the researcher. While the Potsdam researchers are studying leaf size, research groups from Italy, Spain, and Poland who are part of the joint project “BarPLUS” are researching ways of increasing photosynthesis, nitrogen use, and the number of side shoots to increase the biomass of barley plants.

THE RESEARCHER

Prof. Michael Lenhard studied biology in Munich and Oxford. Since 2010, he has been Professor of Genetics at the University of Potsdam and studies the genetic and molecular basis of organ-size control in plants and its evolutionary modification.

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Prof. Dr. Michael Lenhard in the greenhouse.

Photos: Roese, Thomas (3)

The plants on Lenhard's greenhouse table were bred decades ago, developed from mutations of the initial varieties' genetic material. The researcher, therefore, refers to them as "mutants". Now their genotype is to be the starting point for new varieties. The goal is a new barley ideotype with many grains but also more leaf mass, because biomass has for some time now been a valuable asset in the fields – as a source of biofuels or biogas. The high demand for this raw material has boosted rapeseed and corn cultivation. The disadvantage is that instead of potatoes, wheat, and beets, energy plants are increasingly being cultivated. Energy production and food production are in competition.

This might change with barley. The barely has hardly had the reputation of being a suitable energy plant. With good reason? "The composition of the straw in barley is particularly advantageous, because it contains a lot of carbohydrates," explains Lenhard. In fact, the carbohydrate content is higher than in almost all other types of cereal, which is good for the energy yield. In order to breed a new variety that produces a lot of biomass at constant grain yield, the researcher is looking for those sections on the DNA that contain the information for leaf growth, specifically in terms of width: Wider leaves mean more biomass.

„Searching for that section of the genome responsible for the broad leaves is like the famous search for a needle in a haystack."

"The genomes of individual barley mutants differ in millions of positions," says Lenhard. The barley genome is extensive and complex and, with just over 5 billion base pairs, is about one and a half times larger than the human genome. Searching for that section of the genome responsible for the broad leaves is like the famous search for a needle in a haystack. The researchers cross the broad-leaf mutants with a narrow-leafed variety, and their descendants are crossed again with each other. This results in narrow-leafed and broad-leafed plants. In an elaborate process, biologists first determine on which parental chromosome the desired genetic information could be by looking for genetic differences between the initial barley variety and the new crossings that form broader leaves. "We then try to identify the responsible position in the genome," he explains. The researcher expects two years of work and about 2,000 to 3,000 plants per barley mutant before this will happen. "And that's if all goes well."

If the researchers succeed and are able to define which gene segment is responsible for the broad leaves, selective breeding will be able to transfer precisely this property to other varieties. "One would try to crossbreed this mutation into currently high-yielding varieties," explains Lenhard. The number of crossing attempts will depend on where exactly the desired segment is in the genome. High grain yield but more biomass – that is the long-term goal. Knowing which DNA segment is responsible for the broad leaves will enormously facilitate the breeding process and save time and money.

„High grain yield but more biomass – that is the long-term goal."

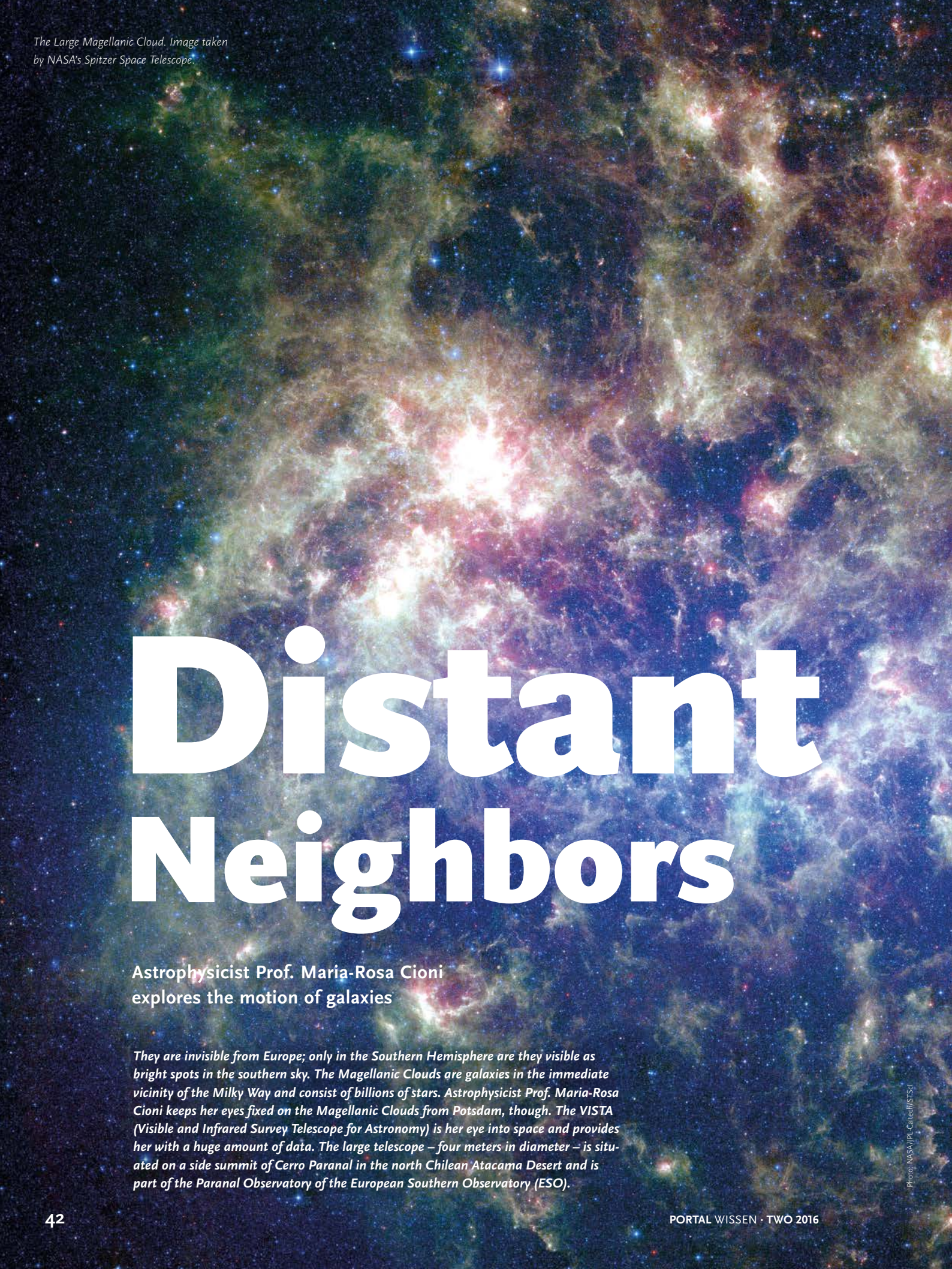
In addition to the molecular and genetic analysis of barley, the project partners will examine other plant properties. What will happen when the different mutants and hybrids are grown in the fields? Will they survive this test and be able to deliver good yields under field conditions? One of the mutants has, for example, particularly broad leaves but the sheaths enclose the heads too closely. This limits fertilization and results in low yields. Many plant properties have to be tested to be able to achieve new varieties that are valuable to farmers. The researchers of the consortium estimate a 5-10% increase in biomass with the new barley varieties. Lenhard thinks that it will take about 10 years until a new variety of barley is in the fields. Until then, patience and perseverance are required. "And a bit of luck."

HEIKE KAMPE

THE PROJECT

"BarPlus" (Modifying canopy architecture and photosynthesis to maximize barley biomass and yield for different end-uses) explores methods for increasing biomass production in barley. The subproject at the University of Potsdam studies the genetic regulators of leaf size.

Participants: University of Potsdam, Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (Italy), University of Lleida (Spain), University of Silesia (Poland)
Funding: European Union, Horizon 2020, FACCE-SURPLUS
Duration: 2016-2019
http://faccesurplus.org/research-projects/barplus/
https://barplus.wordpress.com/



The Large Magellanic Cloud. Image taken by NASA's Spitzer Space Telescope.

Distant Neighbors

Astrophysicist Prof. Maria-Rosa Cioni explores the motion of galaxies

They are invisible from Europe; only in the Southern Hemisphere are they visible as bright spots in the southern sky. The Magellanic Clouds are galaxies in the immediate vicinity of the Milky Way and consist of billions of stars. Astrophysicist Prof. Maria-Rosa Cioni keeps her eyes fixed on the Magellanic Clouds from Potsdam, though. The VISTA (Visible and Infrared Survey Telescope for Astronomy) is her eye into space and provides her with a huge amount of data. The large telescope – four meters in diameter – is situated on a side summit of Cerro Paranal in the north Chilean Atacama Desert and is part of the Paranal Observatory of the European Southern Observatory (ESO).

Photo: NASA/JPL-Caltech/STScI

THE RESEARCHER

Prof. Maria-Rosa Cioni studied astronomy at the University of Bologna (Italy) and obtained her PhD degree at the University of Leiden (Netherlands). At present, she is a guest researcher at the Leibniz Institute for Astrophysics Potsdam (AIP) and DAAD Visiting Professor at the University of Potsdam.

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Photo: Fritze, Karla

Prof. Dr. Maria-Rosa Cioni.

VISTA systematically surveys the night sky in the near-infrared wavelength range of 1 to 2.5 µm. This allows the world's largest survey telescope deep and detailed glimpses into space through haze and dust clouds. The telescope is capable of taking meter-by-meter high-resolution images of the universe, provides insight into the processes of astronomical phenomena, and enables a mapping of the sky. It also focuses on the Magellanic Clouds. While the Large Magellanic Cloud comprises about 15 billion stars, the Small Magellanic Cloud contains about 5 billion.

Italian-born astrophysicist Maria-Rosa Cioni is particularly interested in dwarf galaxies because they are influenced by their proximity to the Milky Way. The two galaxies also interact with one another, which Cioni investigates as head of the large-scale research project VISTA Magellanic Cloud Survey. It is one of six surveys of the southern sky. "We especially want to understand the geometry of these galaxies, the motions of their stars as well as their entire orbital motion," explains Cioni, who recently received one of the world's major acknowledgements for young scientists: the Consolidator Grant of the European Research Council (ERC). Since 2012, she has been doing research at the Leibniz Institute for Astrophysics Potsdam (AIP) and has been a visiting professor at the Institute of Physics and Astronomy of University of Potsdam. The Magellanic Clouds are ideal for her studies, because they are still easily viewed from Earth. "There are many galaxies in the universe that interact with each other, but they are so far away that we are rarely able to observe individual stars," Cioni explains.

Cioni and her 20-member international team have been awarded 2000 hours of observation time at VISTA for the Magellanic Cloud Survey. Researchers want to use the data provided by the telescope to model the galaxies and their movements on a computer. Their calculations should allow glimpses both into the past and the future of the galaxies. "We can measure star positions and star movements very accurately with our devices," Cioni explains. VISTA can capture star movements inside the Magellanic Clouds in the range of milliarcseconds per year – a milliarcsec is about the size of a dime atop the Eiffel Tower as seen from New York City. Billions of stars are measured, and their orbit is extrapolated from the data. Using VISTA, astrophysicists also determine other important metrics such as spectra, brightness, and the chemical composition of stars. Based on these measurements, they develop galaxy models that map the forces acting within them. The positions of individual stars and star groups and their calculated orbital speed and movements reveal gas and mass distribution within galaxies and in the interactions between them.

The data from the Chilean Cerro Paranal go through a complicated procedure before appearing on Cioni's screen, where she can edit them in tables, mathematical equations, and graphs. "In fact, the data initially go to the UK," she explains. "The moment the data are recorded by the telescope, they are directly transmitted to Cambridge." There they are prepared for further examination and are then forwarded to Edinburgh, where they are edited again. Only once the vast amount of data has already been roughly filtered, categorized, and combined are they available to astrophysicists. "You need this infrastructure and an experienced team because the raw data are simply too comprehensive," she emphasizes.

If the desired numbers are there, Cioni begins to "juggle" them, integrates them into her models, and visualizes them in pictures and diagrams. It is this number game on the computer – this sorting, thinking, and calculating – that she loves so much, for which she often has to carve out some time from reading and writing articles and research proposals or preparing conferences and lectures. "I would have probably been happy in another field as well," she says. After all, she studied

Photo: Fritze, Karla

Leibniz Institute for Astrophysics Potsdam (AIP)
The key topics of the Leibniz Institute for Astrophysics Potsdam (AIP) are cosmic magnetic fields and extragalactic astrophysics. A considerable part of the institute's efforts aim at the development of research technology in the fields of spectroscopy, robotic telescopes, and e-science. The AIP is the successor of the Berlin Observatory, founded in 1700, and of the Astrophysical Observatory of Potsdam, founded in 1874. The latter was the world's first observatory to emphasize explicitly the research area of astrophysics. The AIP has been a member of the Leibniz Association since 1992.

mathematics, which laid the groundwork to conduct research in a variety of scientific fields. "But astronomy fascinates me. It is exciting to discover what is out there, and we are part of it. However, it is science itself that excites me and makes me happy." The Magellanic Clouds have been Cioni's research focus since 2009. The vicinity to the Milky Way may one day prove fatal to the dwarf galaxies. Astrophysicists assume that the Milky Way could absorb smaller galaxies since it is much more massive. Stars and dust of the Magellanic Clouds are likely to change their movements so drastically that they will no longer form separate galaxies but instead merge with the Milky Way. "The small galaxies could be completely torn apart. We assume that this has already happened with many galaxies that we can no longer see," explains Cioni. The Magellanic Clouds are perhaps only two "survivors" of a once larger galactic group.

Magellanic Cloud Survey will end in 2018 after nine years of research. Starting in September 2016, Cioni will have access to more data coming from the Gaia spacecraft launched in 2013. Researchers hope to get more precise measurements of the positions and movements of the stars in the Milky Way and, above all, more accurate spectral measurements that reveal more about the composition of matter. The Gaia spacecraft records about 40 million stars daily, including parts of the Magellanic Clouds, during its planned five-year flight. For Cioni, this will result in enormous volumes of data that will have to be evaluated and analyzed. After the project ends, she will continue exploring the Magellanic Clouds. "Then we will proceed with the next step, focusing on the chemical composition of galaxies. There is still much to discover."

HEIKE KAMPE

Photo: Leibniz-Institut für Astrophysik Potsdam (AIP); unicorn (Collage)

Good Leadership in the Public Sector?

Dominik Vogel examines the behavior of public administration leaders

Ministries, district offices, and town halls – nowhere else would you less expect to find charismatic leaders who skillfully lead their employees, motivate them, encourage excellence and inspire identification with their employer. Instead, we expect regulation to dictate the work of everyone from the executive down to the clerk. But is this really true? Administrative scientist Dr. Dominik Vogel wanted to know more about it, so he started examining leadership behavior in public administration. The results surprised not only him.

"It had always been assumed that leadership plays almost no role in the public sector, because things function quite differently there," says Vogel, who wrote his doctoral thesis as a research assistant at the Chair of Public and Non-profit Management. "Hierarchical structures, numerous laws and regulations that determine workflows and tasks, tenured employment, various forms of participation, such as staff councils – these aspects promote conditions that facilitate the smooth running of processes and deemphasize the individual. This, of course, makes leadership more difficult." These assumptions have not been scientifically proven. There was a lack of similar studies. "Until now, we have known next to nothing about these issues."

"It had always been assumed that leadership plays almost no role in the public sector."

Vogel wanted to change this. In his master's thesis, he had researched public employees' motivation, so looking at the "other side" – at leadership behavior – was not farfetched. His "case history" also helped him identify institutions willing to participate in the investigation. This was no matter of course, Vogel explains. "Leadership is a sensitive issue, and many doors remain closed. People are generally interested in this topic but are also afraid of uncovering a potentially sobering reality." Fortunately, the researcher was able to use existing contacts – and confidence. He also offered to provide his project partners with the individual results of the study and to explore areas for improvement together with them. "A true win-win situation," says Vogel. Two federal state authorities and a district authority ultimately agreed to take part in the project.

But how do you actually "measure" leadership behavior? "In general, by using questionnaires," the scientist explains. Although observational studies can offer much data, they are difficult to analyze. The same is true for experimental investigations using roleplay. Field studies that could evaluate measures to improve leadership are possible as well. "In essence, it is about identifying the means and behavior that executives can use to successfully motivate their employees to achieve a common goal – the organization's goal." This is done mainly by interviewing leaders and subordinates. A total of 64 executives at the street-level and 464 of their subordinates completed the questionnaires. The survey was conducted anonymously to comply with strict data protection requirements, but also to prevent possible fear – of bosses getting bad "marks" and of employees facing retaliation for publicly criticizing their superiors. Vogel also worked with a code system to match the statements and combine their evaluation.

THE PROJECT

Leadership in the Public Sector: An empirical analysis of antecedents of leadership behavior

Participants: Dr. Dominik Vogel
Duration: 2011–2015
The dissertation was published by Universitätsverlag Potsdam and is available as an open access document at:
http://nbn-resolving.de/urn/resolver.pl?urn:nbn:de:kobv:517-opus4-89214.

Photo: Fotolia.com/Jakub Jirsák

THE RESEARCHER

Dr. Dominik Vogel studied public policy and management at the University of Konstanz, the University of Potsdam and the Universiteit Twente (NL). Since March 2011, he has been a research assistant at the Chair for Public and Non-profit Management of the University of Potsdam. Since August 2016, Vogel is a Assistant Professor of Business Administration, especially Public Management at the University of Hamburg.

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The investigation's methodological starting point was leadership behavior in private companies, which has long been the focus of research. "I was inspired by a concept called 'taxonomy of effective leadership behavior', long since established in the private sector," he explains. It divides leadership behavior into four categories: task-orientation, relations-orientation, change-orientation, and external-orientation. Task-orientation describes how leaders facilitate performance and control the work process. The second category comprises the relationship of leaders to employees: Do bosses give feedback to their employees on their work? Do they feel responsible for their employees? Do they provide for their development? The third category determines how leaders initiate or moderate changes in workflows transformation, for example as part of digitalization or as a result of new statutory or internal administrative requirements. External-orientation, in turn, describes the leaders' ability and willingness to think beyond their own organizational unit and to consider, for example, the network of the whole institution and even beyond it. Are bosses only interested in their own department, or do they keep an eye on the bigger picture? How do they externally represent their team? Considering the specific features of public administration, Vogel developed two additional categories for his investigations: ethical- and expert-orientation. The first focuses on how leaders are committed to and ensure compliance with ethical standards. Given their normative social role, this category is particularly important for public administration, says the researcher. The second, specially designed category is geared toward examining the dual role that executives in the public service often have to adopt: On the one hand, they are entrusted with executive functions; on the other, they are experts in the field for which they are responsible. As a result, they are not only the boss of their employees but also guide them professionally – in a dual function, one that is predominantly rejected in the private sector.

"I was inspired by a concept long established in the private sector."

Leadership is a management issue, even in public institutions and administrations.

Fotos: privat (top); Fotolia.com/Rawpixel.com (bottom)

With good leadership, all of the gears in a team fit together better.

Vogel also investigated which factors influence the behavior of leaders in administration. What effect do, for example, personal characteristics of bosses have – age, gender, etc. – and how does their motivation to lead, i.e. their interest in it, affect how they lead their subordinates? How do expectations of others affect managers' leadership behavior, both by the employees and the higher management levels? Can leadership behavior be improved, for example through the use of management tools?

The aim of his project was neither to evaluate the leadership qualities of individuals nor of "public authorities", emphasizes Vogel. "I deliberately excluded any assessment of what is good and what is bad. The point was to get an overview of the dimensions that were or were not particularly pronounced in administrative leadership behavior."

How are public administrations actually led? "That depends on whether you ask the managers or the employees," Vogel says with a grin. There is a wide gap between self-perception and the perception of others. "This difference is surprisingly large, 7-25%, larger than in the private sector, where it is normally only 3-5%. "The most significant discrepancy in self-perception and that of others became evident in the category of relations-orientation, i.e. the relationship between boss and employees. It does not mean that the employees accuse their superiors of inactivity or even gave them poor marks in this field. It is, nevertheless, a signal. The employees' assessment was basically average in all categories. "According to the employees, the intensity of leadership behavior is medium, with almost no differences between the individual areas," says Vogel. "It was lower only in change-orientation."

„There is a wide gap between self-perception and the perception of others."

The managers, in turn, stated that they mainly focus their attention on the above-mentioned relations- and ethics-orientation. They also confirmed a below-average interest in change-orientation. "One could say that administrations have difficulty with change," the scientist says. "One could also say that such aspects are considered as being mainly a task of upper management." Rather disappointing though were the influencing factors. The assumption that leadership might be intensified by strategic management tools could not be confirmed. It did become clear, however, that managers who use modern management tools such as quality management or management by objectives also demonstrate more intensive leadership behavior. Personal characteristics – except for motivation to lead – played almost no detectable role. After all, executives pay more attention to their leadership role if they are expected to do so– and also, for example, if it was communicated when they were hired.

He was positively surprised by the results, Vogel emphasizes. "I honestly expected worse – the institutions as well, by the way," he says, laughing. The results he introduced to the executive management boards of the three institutions were met with great interest. Vogel is, however, not very optimistic that they will be taken as an opportunity to devote more attention to leadership behavior in public administration, although he would like to see a practical application of his research. "I think public management research should be application-oriented. Of course, we do not say, 'You do it all wrong, and we know it better', but the findings could be used to improve processes. Feedback instruments about leadership, for example, could be used to close the gap between self-perception and the perception of others."

„Public management research should be application-oriented."

For him as a researcher, the study – his dissertation project – is only the beginning. "I realized that such a broad approach to describing leadership behavior is the best way to cover everyday work and processes in public administration, and we are just beginning to explore this field."

The results can be transferred to universities to a limited extent, Vogel says. "There are parallels in the administrative areas, but institutes and chairs are structured differently and act more autonomously." That does not mean it would not be worth also taking a look at leadership in academic structures at universities. "Leadership is an issue for professors, for example when supervising young researchers. And we could certainly assist them in this field."

MATTHIAS ZIMMERMANN

Eating Right for a Long Life

Joint project "NutriAct" explores nutrition and healthy aging

Too much fat, too much sugar, too much – the ingredients for obesity and diet-related disease are well known. What the head knows does not necessarily go into the belly. What we have learned and experienced has left its pattern on our diet, which is difficult to change. Researchers at the competence cluster NutriAct are nevertheless trying to change it, because they know that people who eat properly in their middle years have a better chance of aging healthily.

"If we want to break the wrong diet pattern, we first need to understand how it developed. What is genetic, and what is influenced by upbringing? What influence does social change have?" asks Tilman Grune. The Potsdam nutritionist is thinking not only of current trends due to changes in the work environment or everyday family life but also of earlier events like the upheaval after 1989. NutriAct considers longer periods in order to describe long-term effects of wrong or right nutritional behavior. "Many diseases in old age, such as type II diabetes or hypertension are caused in the past," says Grune and explains, "If we want to reach the last stage of life healthily, the years between 50 and 70 are crucial." But those who are still healthy at this age do not feel psychological pressure to eat differently and exercise more. We could really use a diet prophylaxis, so to speak, like the dentist gives us for our teeth.

„If we want to break the wrong diet pattern, we first need to understand how it developed."

Tilman Grune is Scientific Director of the German Institute of Human Nutrition Potsdam-Rehbrücke (DIfE) and Professor of Molecular Toxicology at the University of Potsdam. All threads of the joint project NutriAct converge in his office. He directs the federally funded "Competence Cluster Nutrition", a project that unites over 50 partners from 32 research institutions and companies in Berlin and Brandenburg working on these nutritional strategies that support healthy aging.

No scientific database exists yet that would allow us to assess the positive effects of a particular diet or the potential hazards of only a somewhat suitable one. This is the central project that the Institute of Nutrition (IEW) at the Uni-

THE PROJECT

The joint project „NutriAct" (Nutritional Intervention for Healthy Aging: Food Patterns, Behavior, and Products) is one of four "Competence Centers of Nutrition Research" with 5.6 million € of funding from the Federal Ministry of Education and Research. In this network, the University of Potsdam performs central tasks and coordinates five subprojects, works on five of the 20 work packages, and takes part in the network management and training of young researchers.

versity of Potsdam contributes to the competence cluster. "It deals with the identification of biomarkers that detect the intake of certain foods and ingredients and allow conclusions to be drawn as to whether these substances have a preventative or harmful effect on health," explains coordinator Tanja Schwerdtle, Professor of Food Chemistry at the IEW. "These biomarkers enable us to detect, among other things, if people actually ate what they claim to have eaten." It is an incorruptible instrument used in a large-scale intervention study with 500 men and women over 50. Over three years, some of the subjects receive an age-appropriate diet as recommended by the German Society for Nutrition. The results of this group will be compared with the values of another group who gets a diet emphasizing certain fatty acids, fibers, and plant proteins with a positive metabolic effect. "This is a mammoth project that we could only shoulder with the participation of PhD students and students," says Schwerdtle, underlining that the University of Potsdam has taken on the training of young scientists for the competence cluster, together with the Potsdam Graduate School.

For the identification of biomarkers, Schwerdtle is collaborating with scientists of the IEW, DIfE, the Charité hospital, the Fraunhofer Institute for Cell Therapy and Immunology, and with industrial partners, because the results of their joint research are expected to not only form the basis for age-based dietary recommendations but also to help develop age-appropriate foods. They want to develop products that contain all essential nutrients, vegetable plant proteins, and vegetable fat and, on top of that, are tasty and visually appealing. "Perhaps people would enjoy eating something healthy if it is packaged like a sausage or looks like a meatball," Grune says with a smile, adding that it was necessary to build on people's habits to be able to change anything. He sees major development opportunities for the regional food industry in this field. It could make a name for itself throughout Germany beyond asparagus cultivation.

"Perhaps people would enjoy eating something healthy if it is packaged like a sausage or looks like a meatball."

The targeted customers are people over 50. "An age at which many reorient themselves," as Grune is familiar with from personal experience. "The children leave home; there is more time for cooking, for enjoying things. People become aware of the finite nature of their life and want to consciously use their time and stay active and healthy."

Nevertheless, people's diet nowadays is often problematic with unhealthy food choices as well as unhealthy eating and drinking habits. It seems that there are some obstacles preventing them from following a balanced diet and other health behaviors that are essential for an active and healthy aging. A person does usually not eat alone – eating habits are always a social phenomenon. For this reason, Petra Warschburger, Professor of Counseling Psychology at the University of Potsdam, is examining family-related and individual factors that influence adult dietary habits. For this, participants of the EPIC study – a longitudinal DIfE study – and their family members are interviewed. The researcher is also interested in their willingness to change their dietary behavior. Additionally, further psychological tests with a small sample size should measure – among other things – self-control abilities. These findings could be incorporated into internet-based platforms to support a healthy dietary behavior. The aim is to tailor individual diet recommendations by taking into account the personal situation, physical activity, chronic illness or food intolerances in order to provide an optimal dietary mix.

ANTJE HORN-CONRAD

THE RESEARCHERS

Tilman Grune studied Medical Biochemistry in Moscow. Since 2014, he has been Scientific Director of the German Institute of Human Nutrition Potsdam-Rehbrücke (DIfE) and Professor of Molecular Toxicology at the University of Potsdam.

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Photos: Fritze, Karla (top, bottom); Günther, Anne (center)

THE PROJECT

"PredictAble (Understanding and predicting developmental language abilities and disorders in multilingual Europe)" researches the cognitive mechanisms underlying language development and develops cross-linguistic diagnostic instruments for early childhood.

Funding: Marie Skłodowska Curie Action (MSCA) of the European Union, Innovative Training Network (ITN)
Duration: 2015–2019
http://www.uni-potsdam.de/predictable/index.html

Photo: Fotolia.com / UBER IMAGES

The Sooner, the Better

Linguists Research Early Indicators of Developmental Language Disorders

Their vocabulary is small and expanding slowly, words are mispronounced, grammatical rules are not applied correctly – these and other symptoms in children may indicate a developmental language disorder. Such a disorder is especially noticeable in primary and preschool children. There is evidence, however, that measurable indicators of disordered speech development exist much earlier – in the first months of life. Researchers in the EU project network "PredictAble," which started in October 2015, are researching methods for the early detection of language disorders and investigating which common hurdles exist on the path to language acquisition in various languages.

A typical ultrasound image appears on the screen in the Laboratory for Oral Language Acquisition (LOLA), but this black-and-white image is special. It shows tongue movement during speech. The measuring instrument, which looks like a joystick, is positioned below the chin. Children who come to the language lab to be examined by Stefanos Tserkezis are between 4 and 8 years old. The researcher wants to examine the position and shape of the tongue while children form specific sounds, the speed of their movements and the temporal sequence. This also includes examining the coordination of tongue, lip, and jaw movements important for articulation. The aim is to understand the temporal and spatial organization of articulatory gestures in the acquisition of speech fluency and how this connects to the acquisition of reading skills.

"Longitudinal studies show that indicators for being at risk for a language disorder can already be detected at birth," explains Barbara Höhle, Professor of Psycholinguistics and "PredictAble" project coordinator. Such indicators become apparent in the way in which babies process linguistic stimuli. Language acquisition in children has been studied for 15 years in the Potsdam BabyLab. The linguists now know that four-month-olds respond to the specific intonation patterns of their respective language. Their ability to process this early language information is crucial for linguistic skills at a much older age.

> *"Indicators for being at risk for a language disorder can already be detected at birth."*

PredictAble is an EU-funded Marie Skłodowska-Curie Actions Innovative Training Network. European researchers from the universities of Potsdam, Paris Descartes (France), Jyväskylä (Finland), and Pompeu Fabra (Spain) are working together with clinical partners and industry partner NIRx Medizintechnik GmbH. A total of 15 PhD projects are to be implemented within the network, four of them in Potsdam. The aim of "PredictAble" is to develop new diagnostic instruments for language skills that can be used in very young children. In addition to spoken language, the research project also focuses on reading acquisition.

Tserkezis is particularly interested in the last point. In his PhD project, he wants to use ultrasound measurements of tongue movements to examine to what extent speech production is linked to the ability to process written text. There is already evidence suggesting such a connection.

Stefanos Tserkezis in the language lab.

Lilla Zakariás.

Tserkezis divided his participants into two groups. One group consists of children from families in which no one was known to have dyslexia, and the other group of children have at least one family member who does.

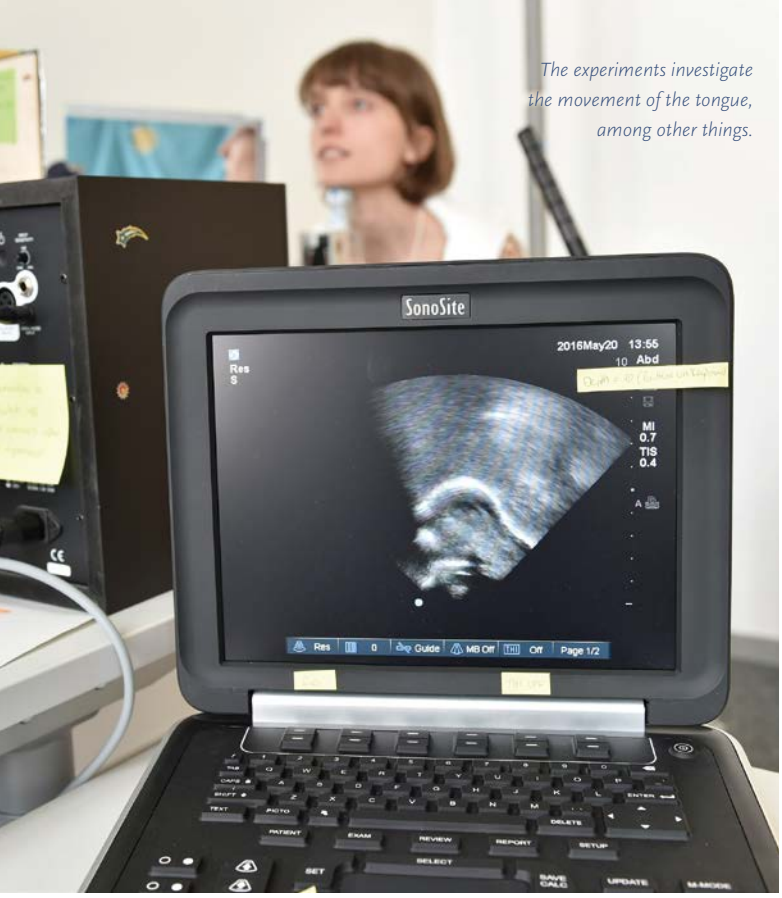
"There is a genetic predisposition to dyslexia," says Tserkezis. Children with an affected parent or sibling have a higher risk of developing dyslexia. The measurements will show whether there are noticeable differences between the two groups concerning the tongue's shape, its position when forming certain sounds, and the speed of movement. If these are measurable, this will be the first step towards a new early diagnostic method for dyslexia – before children are able read or write.

> *„There is a genetic predisposition to dyslexia."*

This research concentrates on very early language acquisition but also uses a cross-linguistic approach. What are the similarities between language acquisition in Finnish, Spanish, French, and German babies? What are the differences? While intonation information is important for German babies, it is not for French babies. For Finnish babies, however, the duration of sounds appears to be an important speech feature. PredictAble researchers are looking for indicators and markers of language development disorders that are valid across languages.

"Our hypothesis is that the underlying problem is the same in all children, no matter what language they are learning," explains Höhle. "Little research has been done in this field." In order to determine general risk factors, the young researchers are examining Hungarian, Finnish, French, Spanish, Catalan, and English in addition to German. Tserkezis will also be conducting his measurements

Photo: Fritze, Karla (top)



The experiments investigate the movement of the tongue, among other things.

outside of Germany; he will spend five months in the U.S. at Haskins Laboratories at Yale University to study the language development of English-speaking children.

Studies are necessary to develop cross-linguistic diagnostic instruments that would identify those points in speech processing that are identical in all languages. Here is where the studies of Lilla Zakariás come into play. The PhD student is searching trade and scientific publications, diagnostic protocols and guidelines, and the Internet for standardized language tests for children, covering various developmental language disorders for all six languages in the network program. "We are here in Germany and know our tests, but we hardly know what is happening in other countries," says Zakariás. While there are approximately 30 different tests in Germany and France, there are fewer in Hungary and Finland, for example.

Zakariás examines exactly which parameters are measured by the various tests – speaking, reading, and writing skills or other cognitive abilities – and determines whether there is an overlap in terms of available tests between the languages. Her research not only provides an overview of all possible tests for the other researchers, but it can also help compare the results of individual studies conducted in the different languages. One can investigate, for example, whether vocabulary size is connected to IQ or other cognitive or social conditions, as well as whether relationships made apparent in one language are valid also in other languages. "Since languages differ, we cannot automatically transfer relations we found in one language to another," she explains.

> *„Our hypothesis is that the underlying problem is the same in all children, no matter what language they are learning."*

This upcoming research is highly relevant for speech therapy practice, because the earlier the problems are detected, the sooner an intervention can start. "This can significantly shorten the duration of speech therapy, because the parents are also given advice and can react accordingly," explains Astrid Fröhling, head of the Center for Applied Psycholinguistics and Patholinguistics Potsdam (ZAPP).

Fröhling, a speech therapist, considers linguistic issues from the practical side in particular. She works with patients suffering from speech disorders every day. She also knows, however, the importance of basic scientific research. "Before we can develop and establish therapies, we need the respective studies," says Fröhling. "We need to know at what points we need to make adjustments." ZAPP is already a long-standing partner for patholinguistic training of students at the University of Potsdam and is one of the clinical project partners that will ultimately ensure the transfer of scientific results into practice. The path will go from research to diagnostics and therapy.

HEIKE KAMPE

THE RESEARCHERS

Prof. Dr. Barbara Höhle studied linguistics, psychology, and social sciences at the Technische Universität Berlin. Since 2004, she has been Professor for Psycholinguistics/ Language Acquisition at the University of Potsdam.

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Photos: Fritze, Karla (3)

The Art of Proper Stimuli

How the "MILON" team makes companies fit

"No sports!" British Prime Minister Winston Churchill – a known cigar smoker and whiskey lover – is alleged to have said this when asked how he achieved his old age. Today we know this is only a legend! The right "dose" of sports and exercise is effective in restoring health, a fact that has also been picked up by health insurance companies and enterprises. A young startup team from the University of Potsdam wants to take advantage of this boom. The startup "MILON" develops customized occupational health management geared especially to small and medium-sized enterprises and also ensures its implementation.

"Our basic idea is actually quite simple," explains Arndt Torick. "We help companies create the best possible health promotion services for their employees. What makes us special is that we offer a one-stop solution:

MILO OF CROTON

When he was 15 years old, **Milo of Croton** took part in the boys' wrestling competition at the 60th Olympic Games in 540 BC. Starting in the 62nd Olympic Games, he dominated "his" sport, winning the men's wrestling title five times. He was a six-time *Periodonikes*: a winner of all pan-Hellenistic games – the Pythian, Isthmian, and Nemian Games – in the same four-year cycle, more times than anyone before and after him. He also made a name for himself as a commander and as a follower of the philosopher Pythagoras of Samos.

Photos: Roese, Thomas (top); Wikimedia.org (bottom right)

from the scientific analysis of the company's current situation to the development and implementation of appropriate courses and formats." Torick is a qualified sports scientist and, like his two colleagues – sports teacher Yolanda Ageitos and sports scientist Anett Stolle – is well-versed when it comes to health promotion. All three have been working in this field for several years as trainers in companies, as sports therapists, and also in research. Formerly, Torick worked as a research assistant at the Department of Sport and Health Sciences at the University of Potsdam for several years. Today he is not only working as a trainer and sport therapist, he also trains instructors of prevention courses. Ageitos specializes in nutrition, while Stolle, who also worked at the Department, has expertise in preventive and rehabilitative exercise programs and relaxation techniques.

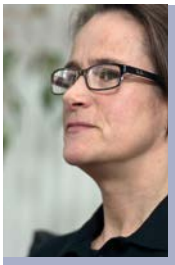
The team needs this range of expertise if they want to be up to the task they set for themselves. From proper and adequate exercise, specific and skillful relaxation to a healthy diet and various means of prevention of addiction: health management has become rather complex. In June 2015, the German Parliament passed the Prevention Act, which requires all companies to offer occupational health management to their employees. "The new law obliges companies to offer occupational health management but also rewards them with tax benefits. Many companies want to introduce it but do not know how," says Ageitos. Health insurance companies are often the first point of contact. They are legally obliged to support companies in developing prevention services but are not allowed to conduct them themselves. "So we thought that we should start at this point and not only ensure the continuation of these courses, but also accompany the process from the very beginning," adds Torick. "We have had this idea for quite some time. The law then inspired us to risk the leap into self-employment. "

The demand for the health experts' knowledge is high. They have developed a great network over the years and have no shortage of interested companies. Their first inquiries began rolling in even before their company was officially founded. It is certainly beneficial that MILON is a "university spin-off" and that the three gained their initial experience in sports science research. "In our field there is a high demand for this," says Torick. "After all, it is important for our partners not to put their occupational health management into the hands of self-proclaimed experts, who have hastily completed a few weekend courses."

„Everything related to establishing a business was absolutely new for us."

For the young entrepreneurs, startup know-how was a hurdle on the road to forming their own company. "Everything related to establishing a business was absolutely new for us," says Torick. "We were constantly talking about our idea, and a former fellow student recommended the startup services of Potsdam Transfer. There we would get the right advice. And that is what we did." The team was accepted into Potsdam Transfer's accelerator program in 2015. After their first interview, they gradually developed a viable business model together with the founding consultants. A subsequent three-day intensive workshop made clear, however, that they needed further coaching regarding legal matters and business management know-how. Torick and his teammates were coached individually to answer their questions: How do you actually start a business? How do you run it? What needs to be considered regarding for example trademark law, patent law, and tax law?

The three founders of MILON are now well prepared and can concentrate on their core business, the four areas that are part of the Prevention Act: exercise, relaxation, nutrition, and prevention of addiction. Not everything is equally relevant for every company – and here the scientists' expertise comes into play. "We first visit the company and discuss the possibilities and limits of their occupational health management with the director or the person in charge," explains Ageitos. They then



THE RESEARCHERS

Yolanda Ageitos completed her training as a medical-technical assistant and dental technician. She then studied to become a sports teacher at the University of Vigo in Spain.

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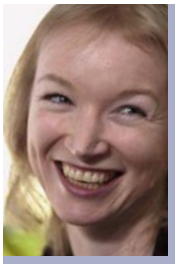

Anett Stolle studied sports sciences with a special focus on rehabilitation and prevention at the University of Potsdam. Since 2001, she has been working as a sports scientist in the therapeutic sector and in occupational health promotion. For some time she researched at the Department of Sport and Health Sciences.

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Arndt Torick studied sports sciences at the University of Potsdam with a special focus on rehabilitation and prevention. Until 2014, he worked as a sports scientist at the Department of Sport and Health Sciences of the University of Potsdam. He then worked in occupational health promotion and management, and as a sports therapist and lecturer in various fields of prevention and rehabilitation.

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Photos: Roese, Thomas (3)

The MILON founders show how healthy motion functions.

Arndt Torick.

analyze the company's individual situation. A company for building technologies, for example, has two large groups of employees with completely different working conditions and sequences of movements: administrative employees who spend the day at the computer and field staff servicing properties on-site. MILON develops the respective information and courses: "We then teach one group how to properly sit at work and the other how to correctly lift loads," says Stolle. "Informational events are not enough, of course. Knowing how to do it correctly does not mean that they will do so in the future. It requires training. We then arrange the adequate back therapy training courses."

But that is not all. "It is hardly helpful if I move properly but have the wrong diet," Ageitos adds. "The Prevention Act is well structured." It provides guidance not only for healthy exercise at various workplaces and relaxation courses, but also nutrition seminars and events on prevention of addiction. For the MILON team, these health management elements go together hand-in-hand and result in a positive interaction when properly dosed and used.

This is where Milo of Croton, the startup's namesake, comes into play. He was the superstar athlete of the ancient world, so to speak. It is not Milo's success, though, that led the founding trio to adopt his name. The "founding myth" and the starting point of MILON's work is the legend of how he became an excellent athlete. Milo was said to be a sickly child. Stronger boys would tease him and even beat him up because he was unable to fight back. The boy decided to change this by getting stronger. Legend has it that Milo began carrying a calf, and the bigger and heavier the calf got, the stronger the boy became.

> *"It is hardly helpful if I move properly but have the wrong diet."*

"For us, the legend is an ideal symbol for the setting of stimuli and the body's adaptation to them," explains Torick. "This is the basis for the work of every teacher, coach, and therapist. The challenge is to set the right stimuli at the right time."

For the sports scientists at MILON, the secret of successful occupational health management lies in the correct proportion of these aspects, which has to be carefully identified. By the way, Winston Churchill, who was anything but a couch potato when he was young, said, "Offer the body something pleasurable so that the soul feels like living in it." It turns out he was right.

MATTHIAS ZIMMERMANN

Photos: Roese, Thomas (2)

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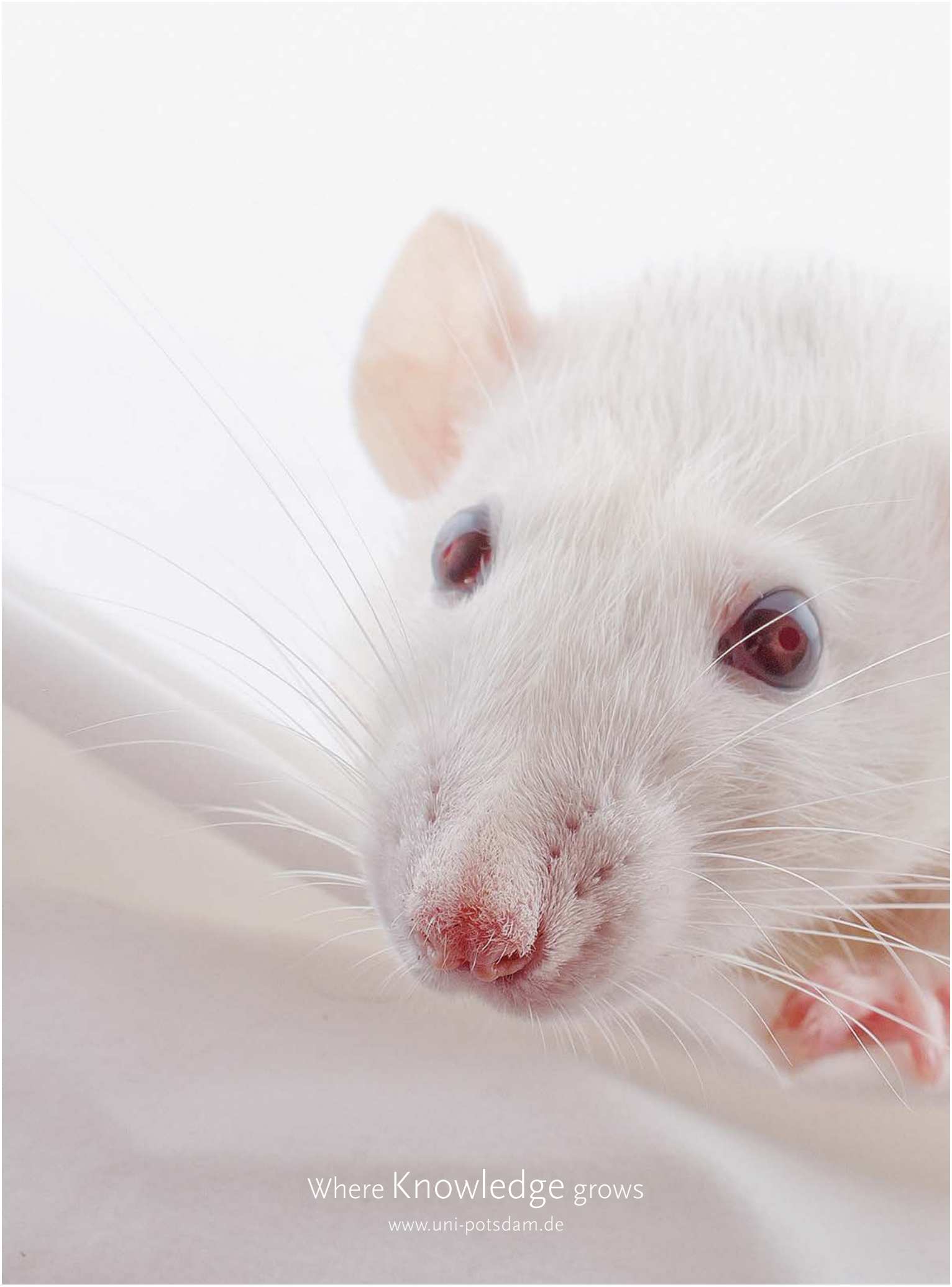
* iPad Air 2 16 GB mit Wi-Fi in Spacegrau, Weiß/Gold oder Weiß/Silber ohne Zuzahlung. Die Mindestvertragslaufzeit beträgt 24 Monate. Nach Ablauf der Mindestlaufzeit gilt der dann gültige Preis für das E-Paper (zzt. 17,75 € monatlich). Preise inkl. MwSt. Der Kauf des iPad steht unter Eigentumsvorbehalt innerhalb der ersten 2 Jahre. Die Garantie für das iPad beläuft sich auf ein Jahr. Mit vollständiger Zahlung des Bezugspreises für die Mindestvertragslaufzeit geht das Eigentum am iPad an den Käufer über. Es gelten die unter pnn.de/ipad veröffentlichten AGB. Weitere iPad-Modelle mit einmaliger Zuzahlung finden Sie online unter pnn.de/ipad. Die einmalige Zuzahlung wird bei Lieferung des Gerätes fällig, zusätzlich werden 2,– € Nachentgelt erhoben. Nur so lange der Vorrat reicht.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