Can you offer a synopsis of the major aims and objectives of the Max Planck Institute for Human Cognitive and Brain Sciences (MPI-CBS)?

Uniting all the researchers working at the Institute is a broad aim to understand the neuronal basis of cognitive functions, such as speech, perception and action, as well as the interaction between different people, as is investigated in social neuroscience. An additional goal is the translation of our research for dissemination into society for the benefit of those affected by conditions such as dyslexia or stroke and to enhance public compassion.

What first sparked your interest in neurology?

Originally, what motivated me to understand the mechanisms of the brain in the context of disease and look for solutions was a fascinating teacher I had in high school who suffered from multiple sclerosis, a severe neurological disorder.

How have your past experiences prepared you for the role of Director at MPI-CBS?

As Director of the Department of Neurology, I undertake both clinical and research activities, and share our research breakthroughs. In preparation for this role, I was Head of the Department of Neurology at Charité Hospital in Berlin, where I primarily worked in the clinic, but also dedicated time to research.

Can you elaborate on the broad remit of research areas covered by scientists at the Institute?

MPI-CBS is divided into the Departments of Social Neuroscience, Neuropsychology, Neurology and Neurophysics. Directors and individual researchers work very closely; there are joint method labs, interdepartmental projects and meetings every week. With regard to our current endeavours, the Department of Neurophysics is planning to use magnetic resonance imaging (MRI) to understand tissues in vivo without cutting into the brain. The Department of Neuropsychology has a focus on language, while the Department of Social Neuroscience investigates the foundations of human sociality. The Department of Neurology is aiming to understand plasticity in the context of stroke, for instance, how we learn motor function and movement, comparing healthy individuals to those affected by stroke in order to treat the condition and prevent events from recurring. All the departments are united by similar approaches, especially with regard to brain imaging techniques. We focus on the same mechanisms and signals that underlie different functions.

How has MPI-CBS evolved since you last spoke to International Innovation in July 2012?

We have recently experienced institutional development; a year ago Dr Robert Turner retired and is now Director Emeritus at the Institute. In April, we recruited a successor, Dr Nikolaus Weiskopf. In terms of major discoveries, the Department of Neuropsychology has put forward a new model regarding the information flow between different brain areas within the cortical language circuitry. In the Department of Social Neuroscience, the internationally highly regarded large-scale longitudinal study, ‘Resource project’, has been undertaken to understand whether and how certain forms of meditation training can improve compassion and health in adults. Additionally, in the Department of Neurology, we have been able to identify different phases of learning and establish a multiphase model of the diverse processes, brain areas and networks involved to improve clinical practice.

Why is multidisciplinary collaboration particularly important in neurology and brain research?

We require expertise from different disciplines to address the major challenges outstanding in the field. As such, the Directors of the Institutes all come from diverse backgrounds, including psychology, physics, medicine and neurology. This approach filters to all levels of MPIs; we recruit mathematicians, physicists, psychologists, linguists, neurologists and psychiatrists. We have a very broad recruitment scheme and, though the practical work is usually completed in small teams, they too comprise...
A BRIEF HISTORY

Established in 1948, the Max Planck Society is Germany’s most successful research organisation and home to many of the world’s leading researchers. In fact, in the last six decades, 10 Nobel laureates have been Max Planck Institute scientists. The success of the Society is borne from its understanding of research and priority areas, with the researchers themselves defining the subjects and selecting their staff. At present, there are 82 Max Planck Institutes conducting basic research in the natural sciences, life sciences, social sciences and humanities.

people from different backgrounds. If we want to address a question that involves, for example, MRI of language function we require a physicist who is an expert on MR machines, a linguist for the task design, a computer scientist or mathematician to disentangle the signals, an expert in human physiology to relate these signals to underlying neurophysiology, and perhaps another computer scientist who derives a computational model from the findings.

Our partnerships with other MPIs are also very important; for instance, we frequently collaborate with the MPI for Human Development in Berlin, MPI for Evolutionary Anthropology in Leipzig and MPI for Neurology in Cologne. We also work closely with the MPI for Psycholinguistics in Nijmegen.

Why does the Institute place such importance on investing in imaging technology? Can you describe some of the most recent and high-tech facilities that the Institute has and provide examples of how they are contributing to research?

Around 30-40 years ago, almost all we knew about the brain was based on invasive studies in animals and postmortem studies in humans. Now, imaging provides us with a view into the living brain without harming the organ, which is why we are so fascinated by this technology. It can tell us about brain structure, which is important for the clinical diagnosis of tumours and stroke, as well as brain function, to understand where certain faculties are located. This technology helps us define networks and understand metabolic changes in both control and diseased subjects. In addition, magnetic stimulation can also be used to change brain function without causing damage.

At the Institute, we have several types of equipment in the field of MRI. Whereas typical clinical systems operate at a magnetic field strength of 1.5 tesla, we have an ultra-high imaging system operating at 7 tesla. We have also just ordered another unique system called a connectome MRI, which is exceptional due to its ultra-high field gradients, which allow the identification of fibres bundles at a much higher resolution – only one other machine exists worldwide. Moreover, magnetencephalography and electroencephalography allow us to examine neurons on a millisecond time scale. Therefore, rather than obtaining high spatial resolution, they give us very high temporal resolution in order to capture the dynamics of brain function.

To what extent is the research carried out at the Institute translated for use in the clinic? What steps does MPI-CBS take to facilitate this?

The Institute operates a clinic in partnership with the University Hospital in Leipzig. Therefore, the people who conduct research at MPI are the same as those who work in the clinic and apply the resulting practices for the benefit of patients. We also have an MRI scanner that is located in the clinic; the techniques we have developed to look inside the brain are employed there to identify changes in patients. If a region of the brain is used to learn a certain skill, then damage to that region after a stroke, for example, will impair that ability. We use techniques that enable us to understand why the diseased brains can use other approaches to learn the same skill by examining the brain of patients while they are in the process of learning; we teach them how to improve movement.

A new technology we have recently acquired is an exoskeleton; an individual is placed inside and the robot performs movements that the patient should learn. We are also looking into virtual reality approaches so that people can see themselves performing a movement, enabling them to both feel and visualise the effort needed to complete the task. Techniques such as transcranial stimulation are also used to increase or decrease the activity of a certain brain area. We identify areas in the brain that are showing less activity following a stroke; then, in order to compensate for this, we increase brain activity.

In what areas is funding most needed in the neurology landscape at present, and what are some of the challenges that MPI-CBS and other research institutes face?

There are several areas, such as computational approaches to simulating and understanding the brain, where a great deal of progress is foreseen to be achieved by the Human Brain Project [see page 28]. Therefore, one area where further investment would be beneficial is in the translation of computational approaches into large empirical and intervention studies. Many of these are underpowered in terms of size, which is a significant problem resulting in a great number of false positives. Additionally, investment is needed to support young researchers to embark on long-term studies, providing them with good career prospects.