Unlocking the Mysteries of the Mind

Understanding the human brain through neuroimaging is the life work of Wayne Drevets, MD, president and director of the Laureate Institute for Brain Research (LIBR). Together with Jerzy Bodurka, PhD, MRI facility director at LIBR, he hopes to transition use of magnetic resonance imaging (MRI) in psychiatric applications from research to clinical practice, to more quickly and objectively diagnose patients and assess therapy.

Prior to joining LIBR, Drs. Drevets and Bodurka worked at the National Institutes of Health (NIH), where they researched neuropsychiatry using fMRI to understand the brain's response to stimuli and identify anatomic changes and cellular abnormalities.

"Today, the field largely uses MRI to exclude a diagnosis that may masquerade as a psychiatric disorder," says Dr. Drevets. He hopes to change this at LIBR with the installation of the Discovery MR750 3.0T system.

Dr. Bodurka is equally optimistic. "Until now, commercially available 3.0T MRI scanners could not process in real time the large amount of data generated in a high resolution whole brain fMRI scan with multi-element coils array," he says. "However, we believe that the Discovery MR750 might be the first 3.0T scanner to provide the level of power, speed and reliability we need for clinical applications in psychiatry."

Several technological advancements, Dr. Bodurka notes, enable the leap to real-time fMRI. "The Discovery MR750 delivers whole body gradients with the highest power and fidelity available on a commercial scanner, while the advance thermal management effectively reduces issues associated with gradient heating.

"Furthermore, the new generation digital multichannel MRI receiver with an optical data architecture located in the MR room provides a signal-to-noise gain not found [today] on other commercially available 3.0T MR systems," Dr. Bodurka adds. "With the nonlinear system drift over time limited to less than 0.1%, the MR750 offers a unique combination of excellent system power and temporal stability that should help reliably capture and accurately measure subtle changes in hemodynamic activity during human brain mapping with fMRI."

Connecting science with practice

With between 3,000 to 4,000 inpatient admissions and more than 80,000 outpatient visits yearly, LIBR offers Drs. Drevets and Bodurka the opportunity to test, assess, and follow a large population of patients longitudinally who suffer from depression, anxiety, eating, and memory disorders.

"We have some evidence that we can use real-time fMRI to help teach healthy individuals to modulate their response to stimuli," says Dr. Drevets. The Institute seeks to apply this knowledge to patients with depression, which affects 150 million people worldwide and is ranked by the World Health Organization as the leading cause of years of life lived with disability for all ages.

But their vision goes far beyond this. "Our goal at Laureate is to transition the use of MRI in psychiatric applications from research to clinical practice so we can more quickly and objectively diagnose patients and assess therapy," says Dr. Drevets. "We also hope to identify people who are at risk for developing certain neurological diseases or psychiatric disorders so that we can intervene earlier in the illness course to prevent or reduce chronic disability."

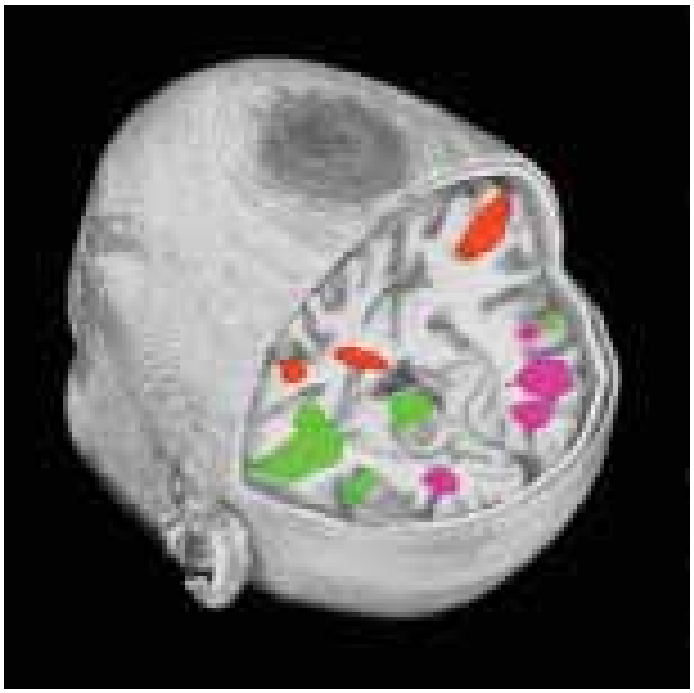

Figure 1. Composite neurofunctional fMRI map showing motor (red), language (green), and visual (purple) activation.

Dr. Jerzy Bodurka

Jerzy Bodurka, PhD, is an MRI physicist and director of the Functional MRI Facility at the Laureate Institute for Brain Research in Tulsa, Oklahoma. He received his doctorate degree in physics from the University of Nicolaus Copernicus in Torun, Poland, and completed part of his postdoctoral training in Nuclear Magnetic Resonance at the Department of Chemistry at Free University of Berlin, Germany. Dr. Bodurka completed his postdoctoral fellowship training in functional MR imaging at the Department of Biophysics at the Medical College of Wisconsin in Milwaukee. In 2000, he joined the NIMH/NIH Functional MRI Facility as a principle MRI physicist; he left NIH to assume his current role at Laureate in July, 2009. Dr. Bodurka is a recipient of NIH Director Award for advancing brain MR imaging by development of array detectors and implementation of parallel imaging.

Dr. Wayne C. Drevets

Wayne C. Drevets, MD, became the Oxley Professor of Psychiatry at Oklahoma University Health Sciences Center (OUHSC) in Tulsa and the director and president of the Laureate Institute for Brain Research (LIBR) in July, 2009. Dr. Drevets previously worked in the NIMH Intramural Research Program, where he served as Senior Scientist and Chief of the Section on Neuroimaging in Mood and Anxiety Disorders since 2001, and Acting Chief, Laboratory on Molecular Pathophysiology since 2008. Prior to 2001, he held appointments in Psychiatry at the University of Pittsburgh School of Medicine for four years and the Washington University School of Medicine for nine years. Dr. Drevets received his MD degree from the University of Kansas, and completed residency training in psychiatry and post doctoral fellowship training in imaging sciences at Washington University. Dr. Drevets' research focuses on applying positron emission tomography (PET) and magnetic resonance imaging (MRI) to characterize the pathophysiology of mood disorders.

About the facility

The Laureate Institute for Brain Research opened May 1, 2009 and currently houses a multidisciplinary team of scientists and clinical research staff who will apply neuroimaging, genetic, pharmacological, and neuropsychological tools to investigate the biology of neuropsychiatric disorders. The Institute's creation was supported by the W.K. Warren Foundation for the purpose of conducting studies aimed at developing more effective treatments or prevention strategies for these disorders. The studies will be led by scientists from diverse backgrounds, including physics, cognitive neuroscience, psychology, psychiatry, developmental neuroscience, computer science, and genetics.

With family history coupled with annual or biannual MRI assessments, LIBR clinicians hope to detect changes in the brain's gray matter, an indication of psychiatric disorder, in patients believed at high risk for disabling psychiatric disorders. "At NIH, we discovered that cases with the smallest amount of gray matter in brain regions known to regulate emotion were those patients who became chronically ill from major depressive disorder," explains Dr. Drevets.

To accomplish this, the LIBR team will combine their specially designed multi-element (16-, 32-channel) head coils with the Discovery MR750's fast reconstruction engine, parallel imaging techniques, and redesigned system architecture to maximize signal and speed.

Researchers and clinicians at Laureate are also considering the potential in using real-time fMRI to teach patients with depressive or anxiety disorders to more effectively modulate their own responses to emotional thoughts or stimuli. This approach to treating depression conceivably may potentially lead to additional understanding for alternative therapy.

Other research being conducted at Laureate investigates in patients who are being treated for depressive disorders whether an fMRI exam that measures patient response to specific emotional paradigms may allow the clinician to objectively assess treatment efficacy within just a few days after treatment was first initiated. Currently, it takes an average of six weeks to assess the response on clinical signs and symptoms.

The facility plans to use GE's advanced MR applications such as Cube or BRAVO for structural imaging. Resting state fMRI will help to map brain functional connectivity while Diffusion Tensor Imaging techniques will be used to visualize white matter trajectories. EPI/BOLD sequences, specifically designed paradigms, and sophisticated postprocessing applications will be deployed to capture and analyze complex, multistate eloquent cortex activations. To increase specificity for some applications, BOLD fMRI responses will be correlated with patients' other physiological parameters.

Drs. Drevets and Bodurka anticipate their research and clinical efforts can change the way certain psychiatric diseases are diagnosed and managed. ■

Figure 2. The BrainWave interface provides the capability to view fMRI results on 3D renderings or orthogonal slices. A simple motor task is presented in orange and yellow colors in the above screen.

Figure 3. BrainWave also provides the flexibility to overlay Fractional Anisotropy maps on the orthogonal slides, create composite maps with multiple fMRI studies and the ability to combine those results with fibers tracked from DTI acquisitions.