

STATE OF MIND

The Mind
RESEARCH NETWORK
FOR NEURODIAGNOSTIC DISCOVERY

SPRING 2007

Official Newsletter of the MIND Institute

NEW RESEARCHERS ARRIVE AT MIND

Dr. Vince D. Calhoun Begins as Director of Image Analysis and MR Research

Imagine you're a research scientist investigating cognitive function as it relates to, say, schizophrenia. You've recruited subjects, collected histories and other clinical information, and spent hours gathering neuroimaging data, including MRI, fMRI, EEG, MEG and DTI. Now what? Without a way to analyze and compare that data, what you essentially have is a lot of numbers. This is where Dr. Vince Calhoun, MIND's Director of Image Analysis and MR Research, comes in. Dr. Calhoun is a recent arrival from the Institute of Living in Connecticut, where he began to develop techniques for making sense of this complex brain imaging data. Along with his team of Post-Docs, Research Assistants, Software Engineers and assorted collaborators, he has created algorithms which map dynamic networks of brain function, structure and genetics and how these are impacted while being stimulated by various tasks. Asked to explain the purpose of all this image analysis, Dr. Calhoun replies, "Since each imaging modality has its own inherent limitations, the integration of this data is needed to understand the healthy and especially the disordered human brain. Our group does quantitative neuroimaging as a means to learn more about psychiatric conditions, in particular, Alzheimer's Disease, Bipolar Disorder and Schizophrenia." His work also reaches beyond these areas, "We are also involved in a large study investigating the impact of alcohol upon brain patterns during simulated driving. I have a particular interest in MRI since it provides information about several types of brain structure and function."

After receiving master's degrees in Biomedical Engineering and Information Systems from the Johns Hopkins University,

and his Ph.D. in Electrical Engineering from the University of Maryland, Dr. Calhoun became Director of the Medical Image Analysis Lab at the Olin Neuropsychiatry Research Center in 2002. At that time he also received an academic appointment in Psychiatry at Yale University. On his move to New Mexico in late 2006, Dr. Calhoun states, "The work to be done here at MIND is a perfect segue from what I was doing in Hartford. MIND had already collected large data sets through its work on the MIND Clinical Imaging Consortium (MCIC, a multi-site schizophrenia program). And with the arrival

continued back page

Dr. Kent A. Kiehl to Head New Mobile Imaging Core

While no one would dispute the overwhelming costs, both monetarily and psychologically, of criminal behaviors on today's society, there are many differing opinions on what can be done to help alleviate these burdens. Stricter penalties and more efficient incarceration? More efforts put into the rehabilitation of the prison population? What about the underlying causes of these antisocial behaviors? As the new Director of the MIND Mobile Imaging Core and Clinical Cognitive Neuroscience, Dr. Kent A. Kiehl, is dedicated to using state-of-the-art brain imaging techniques to identify the neurocognitive architecture underlying some of society's most enigmatic and costly mental health disorders. These include alcohol and substance abuse as well as criminal psychopathy (i.e., the psychopathic personality), the latter being commonly associated with severe and

continued bottom next page



Letter from the President



The November 2006 Federal elections resulted in a 'shifting sands' funding scenario for The MIND Institute. Whereas an annual Department of Energy (DOE) earmark had been the sole source of research and operational funding for MIND in Albuquerque, as well as a key funding source for our partners at Harvard Medical School, University of Minnesota, and University of New Mexico, by December we knew that our traditional source of funding had disappeared. Working closely with Senator Pete Domenici and his staff, we were encouraged to apply for a peer-reviewed grant from DOE. In January, we marshaled our scientists together and under the direction of our science director, Vince Clark, and with the help and dedication of our excellent administrative staff, we put together—in a two-week period—a 700-page proposal. This proposal, "Research and Development of Better Diagnostic Tools for Mental Illness and Neurological Disorders," went out the end of January, we received comments from reviewers at the end of February, and by the time this newsletter is published we hope to be in receipt of \$7M from the Department of Energy.

This exercise, while exhausting and difficult, helped us to crystallize our research strengths as well as point us towards future directions. One of these directions combines our research strengths of multi-modal imaging and cognitive neuroscience as we successfully competed for a grant from the Defense Advanced Research Projects Agency (DARPA). In addition, this project represents a new avenue for funding, the Department of Defense (DoD). Our collaborations with Sandia and Los Alamos National Laboratories couple neuroscience research, advanced modeling and simulation, and product engineering targeted to research opportunities for which MIND and its collaborators are strongly suited (e.g., traumatic brain injury and post-traumatic brain disorders).

The original charter of The MIND Institute was to advance the state of neuroscience by investing in research in neuroimaging tools and technologies. DOE guidelines continue to support this approach and we've been successful in developing new and better tools (please see *State of Mind*, Summer 2006). Some years ago our charter was amended to include research specific to schizophrenia through the use of neuroimaging. This too has been successful as attested with the launch of our FIRST Program (also *State of Mind*, Summer 2006). Neuroimaging tools and techniques have enhanced schizophrenia research and we believe the same holds true for other mental illnesses and brain disorders.

As we broaden our sources of funding, we broaden our charter to include neurodiagnostic discovery. Our tools and our research can be combined to help further the diagnoses of mental illnesses and brain disorders. Whether it is schizophrenia research, learning disabilities, traumatic brain injury, addiction, epilepsy or other neurological diseases or disorders, we have the right combination of in-house tools and nation-wide collaborations to make significant impact on these devastating illnesses. Our past efforts have paved the way for this new adaptive direction.

Since November we've received over \$17M from fourteen awards to MIND researchers. We have several additional grants to DARPA, NIH, and DOE in the pipeline as we continue to diversify funding. We also look to our Board of Trustees to help us identify and secure other philanthropic sources of funding, and we are staffing up our Research Office to help our researchers identify and apply for funds from other foundation and agency sources (e.g., NSF, Keck Foundation, Stanley Foundation, Kresge Foundation). Our scientists and our suite of advanced imaging tools are our greatest assets and we are creating an environment to help them further their success.

It is a very exciting time here at MIND and we hope you will continue to support us as we continue to grow.

Thank you.

John Rasure

Dr. Kent Kiehl

continued from front page

repetitive criminal behavior that leads to incarceration. Current estimates suggest that criminality costs society more than 1 trillion dollars per year—15 times the societal costs associated with schizophrenia. "To bring those immense numbers to a more practical level", Dr. Kiehl elaborates, "that translates to a cost of \$3500 a year for each and every New Mexican."

Dr. Kiehl's academic career has taken him from the University of California, Davis, to the University of British Columbia where he received both his Masters and his Ph.D., in Psychology/Neuroscience. While an undergraduate, he began

exploring techniques for examining the brain's electrical activity. "I became very interested in studying event-related brain potentials (ERPs). I wanted to apply these methods to understanding human cognition, specifically abnormal human cognition. To this end, I began to study ERP research on psychopathy and schizophrenia."

It was during his graduate studies that Dr. Kiehl became the first to utilize brain imaging to study the psychopathic personality.

In January 2001 Dr. Kiehl accepted a position as Director of the Clinical Cognitive Neuroscience Laboratory at the Institute of Living in Connecticut, as well as joining the faculty at Yale University. He continued to examine affective, cognitive and language processes in criminal psychopaths using ERPs and fMRI, a costly and time consuming undertaking. "From the start, there were many obstacles to overcome. Inmates needed to be transferred from prison to the MRI scanner at the UBC Hospital, which of course needed to be done by trained security personnel." While the costs associated with this were substantial, the biggest shortcomings were caused by security restrictions. "We were limited to transporting five prisoners per month, and were prohibited from working with some of the more 'interesting' inmates—the segment of the prison population we most wanted to study." Dr. Kiehl was also performing clinical psychological services for the Correctional Services of Canada, "The

continued next page



Kent Kiehl with members of the Mobile Imaging Team

Mobile MRI Comes to The MIND Institute

February saw the arrival of MIND's latest imaging acquisition—the Siemens Avanto Mobile MRI. Headed by Dr. Kent Kiehl, MIND Mobile Imaging Core will be dedicated to using state-of-the-art brain imaging techniques to delineate the neurocognitive architecture underlying some of society's most enigmatic and costly mental health disorders, including alcohol and substance abuse and criminal psychopathy. These disorders are commonly associated with severe and repetitive criminal behavior that leads to incarceration. The new MIND Mobile Imaging system is the first of its kind that will be deployed to prison facilities to study these populations in large numbers.

The cost of crime in the US is now estimated to be 1 trillion dollars a year. For New Mexico, our portion of the bill is over 6.5 billion. And growing. Something must be done to better understand the brain functions associated with criminal behavior. The data collected by the Mobile MRI will increase our understanding of how different treatments work to prevent relapses to methamphetamine, heroin and cocaine addiction and which treatments work best for different individuals. With this research we also hope to better understand the environmental, cognitive, and behavioral characteristics that are most likely to predict serious adult criminal behavior in adolescents, which could lead to development of treatment programs to help at-risk adolescents avoid future criminal behavior and its consequences.

The MIND Mobile Imaging system is comprised of a Siemens' Avanto Magnetic Resonance Imaging system (the most advanced 1.5T system in the Siemens product line) and a 72-channel high-resolution EEG/ERP Biosemi system. Once outfitted by our IT Department with the latest computing and networking equipment the Mobile MRI will leave on the first leg of its tour in late April, where it will be driven from site to site and located inside the grounds of men's and women's correctional facilities and juvenile detention centers. Inmates who volunteer for this program may receive therapy at no additional cost to the State.

Understanding the mental processes behind illegal behavior is the first step in providing better therapy for inmates in order to reduce recidivism rates and decrease the cost of criminal behavior to society.

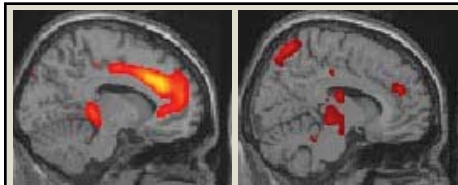


work primarily involved risk assessments on the mentally ill patients at the maximum security prison in the area." It was during this period that he began to develop the idea to build a custom mobile MRI system that could be taken directly into the prison—an idea that remained dormant for several years.

While at the Institute of Living, Dr. Kiehl was able to complete the testing of 50 subjects over a five year period. With MIND's acquisition of the Siemens 1.5Tesla Avanto Mobile MRI, his team will eclipse those subject numbers in less than two weeks. "The shortcoming of most imaging-based research is small sample groups", he says. "Over then next year or so we plan on scanning thousands of inmates. By gathering brain imaging, as well as clinical and genetic information for each of these subjects, we will have a very large set from which MIND researchers can draw on for their own studies". With these kinds of numbers come huge amounts of data, "That was an important part of my decision to come to MIND. More than just their shared vision of deploying a mobile MRI system to study incarcerated populations, they had the infrastructure necessary to process and store the huge amount of information we were planning to gather." When fully operational, the Mobile Imaging team will be collecting up to one and a half terabytes of data per month, which when analyzed expands to over six terabytes—all of which must be backed up and stored in a way that it remains fully accessible to investigators. "With such a wide range of disciplines among its researchers, MIND is in a unique position to take full advantage of the amount of data the Mobile MRI is capable of collecting." Continuing on the topic of his decision to relocate to MIND, Dr. Kiehl elaborates, "It's important to note that the New Mexico Corrections Department has also been instrumental in this process. They have been very open to working with us to develop

a program of research to treat inmates and hopefully reduce the burden of crime on society, starting here in New Mexico."

Another factor in his decision to relocate to Albuquerque was the University of New Mexico. Dr. Kiehl explains, "Being offered a position as an Associate Professor in the Psychology Department was a major key to my recruitment. During my training, I had the



The Anterior Cingulate shows decreased activity (right) when compared to that of a healthy juvenile (left) when a mistake is recognized during a simple cognitive task. Recent research has associated this deficit with a callous and unemotional subtype of Conduct Disorder in youths that closely resembles adult conceptualizations of psychopathy.

good fortune to work under the tutelage of some very talented scientists." He continues, "Building a legacy here at UNM and MIND is something I feel very strongly about. I am not only a researcher, but also a teacher—I want to cultivate a great mentorship program in forensic cognitive neuroscience." In addition to the twelve members of his team from Yale who made the cross country trip, Dr. Kiehl has already added another eight locally to his staff.

While the Mobile MRI is currently scheduled to gather data from prison populations, the potential uses don't end there. "There are people living right here in remote areas of New Mexico for whom traveling to a hospital or clinic with an MRI just isn't possible." Then there are other remote populations where the MIND

Mobile Imaging Core could be put to use. "For example, preliminary discussions are underway with the U.S. Military to study soldiers before active deployment to see if we can use brain imaging to predict which individuals are susceptible to Post Traumatic Stress Disorder. A brain-based test predicting susceptibility to PTSD could dramatically improve the quality of life for many active-duty personnel."

With his background in Psychology, Dr. Kiehl is also interested in putting his expertise in ERP and fMRI to use in studies of schizophrenia. "A rather pressing need in psychiatry is to find ways to differentiate schizophrenia and psychotic bipolar disorder during the early stages of the illnesses." The study he is currently involved with hypothesizes that patterns observed during ERP and fMRI will allow patients to be identified as being either schizophrenic or having bipolar psychosis. "We are currently studying both relapsing and first-episode patients with either disorder during the first week of a psychotic episode, along with healthy control patients." The study is also longitudinal—subjects are brought back for follow-up scanning sessions at regular intervals. Dr. Kiehl explains, "The hope is to identify consistent markers that will aid in the proper diagnosis of those suffering from these disorders. Treatments can then be tailored to be of the greatest benefit to each individual."

John Rasure, MIND's CEO, echoes the sentiment. "We're very fortunate to have Dr. Kiehl as part of our team. We not only get a top-notch, proven researcher with several NIH Grants, The MIND Research Network and the State of New Mexico will also benefit in a multitude of other ways. The data collection capabilities of the Mobile Imaging Core will provide subjects for all our investigators, so it goes far beyond the specific studies Kent will be conducting for his own research. We are just scratching the surface of all the possibilities."

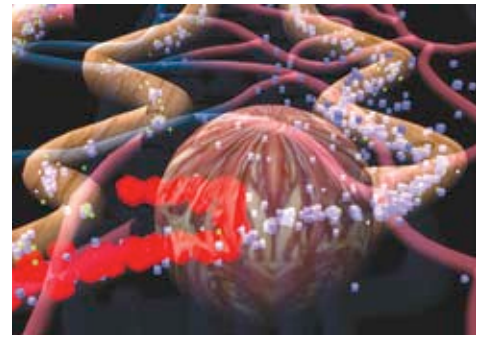
Art & Artifice Panel Discussion Held at MIND

On Saturday February 10th, the MIND Institute was privileged to hold a panel discussion in conjunction with the *Art & Artifice of Science* exhibition currently at the Museum of Fine Arts in Santa Fe, and *Mapping Bodies: The Art & Artifice of Science* at 516 ARTS in Albuquerque. These exhibits are meant to explore the intersection of art and science by examining the work of contemporary artists from New Mexico and beyond, who use the language, look and technologies of science in their work. The exhibitions build on two of New Mexico's long-standing strengths: its wealth of artistic talent and scientific innovation, giving a fresh perspective on the state's long history as nexus of art and science. These exhibitions encourage visitors to reconsider the polarization of the two disciplines by emphasizing the creativity inherent in scientific investigation and the rigor and discipline demanded of artistic exploration.

The discussion was kicked off by our own Rex Jung, Ph.D., a Research Scientist here at the MIND Institute. His research interests focus upon the structural correlates of intelligence, creativity, and positive affect, making him particularly suited to the day's topic. Dr. Jung also collaborated on "Threshold", an interactive touch screen projection with two other panelists, Albuquerque's Mary Tsiongas and Masumi Shibata (the 4th member of this team, Min Kim Park, was unfortunately unable to attend). Also participating in the discussion were Gary Schneider, a New York-based artist presenting pieces from his photographic series "Genetic Self-Portrait", Panaiotis, Assistant Professor at UNM with his computer simulation titled "The Waters of Life: A Reified Voyage into the Kidney", and Gail Wight, Professor of Electronic Media at Stanford talking about selected components of her exhibit "Sliding Scale".



Retinas, Gary Schneider, 1998, Gelatin Silver Prints



The Waters of Life: A Reified Voyage into the Kidney
Panaiotis, 2004-06
Computer Simulation, Modeling, Interactive Virtual Reality

The Albuquerque portion of this exhibition is curated by Arif Khan, who also hosted the day's discussion. Mr. Khan is an independent curator working with the Museum of Fine Arts and the Gallery Director at the Tamarind Institute in Albuquerque. Also in attendance was Laura Addison, Curator of Contemporary Art at the Museum of Fine Arts in Santa Fe. The MIND Institute was pleased to have had the opportunity to participate, and we hope to continue our involvement with the art community here in New Mexico. Thanks to all who attended and participated, helping to make it an enlightening and thought-provoking afternoon.

- The Museum of Fine Arts is located at 107 West Palace Ave on the Plaza in Downtown Santa Fe. The exhibition runs through May 20. www.mfasantafe.org
- 516 ARTS is located at 516 Central Ave SW in downtown Albuquerque. www.516arts.org

Dr. Vince Calhoun *continued from front page*

of the Mobile 1.5T and a new 3T MRI scanner there are plans to acquire exponentially larger sets." Not only would his old friend and past collaborator from Hartford, Dr. Kent Kiehl, also be relocating to New Mexico, there were talented people already in place at MIND he was looking forward to working with. "Seeing Jeremy Bockholt's (MIND's Director of Neuroinformatics) database work with the information collected from the MCIC, and knowing he was also interested in multi-modal analysis made this move a good fit for everyone."

As an undergraduate in Electrical Engineering at the University of Kansas, Dr. Calhoun also studied biology. When he was a senior, he was exposed to MRI technology.

"I thought the physics behind it was really cool. It began my move into bioengineering, where I became aware that many of the body's physiological process such as blood flow and the electrical impulses in the brain could be modeled using engineering principles." With his varied background, he also believes he has a lot to offer as an associate professor in the Department of Electrical and Computer Engineering at the University of New Mexico. "Teaching here at the

University was especially important to me. The Electrical Engineering Department is very interested in increasing its Bioengineering capabilities—I hope to get more Bioengineers interested in neuroimaging."

While collaboration among researchers at MIND is commonplace, Dr. Calhoun is in a unique position to be of great value to most of the investigations that happen here. "Image analysis is inherent to any neuroimaging-based research. I enjoy the merging together of information from various imaging modalities, and even other sources." Dr. Calhoun explains, "I'm approaching any particular task from both a systems and a software development viewpoint. Often analysis is too narrow in scope. Mental illness is complex—we are trying to compare a healthy brain to one with a neurological disorder, when we actually know little about how a healthy brain functions." Dr. Calhoun believes answers will come with analysis of data in a multitude of variations, which will lead to finding which combinations will be the most useful. "I want to create tools that enable investigators, regardless of whether or not they have an engineering or software development background. Tools that respect the complexity of the data."



Dr. Calhoun meets with his team

The Mind Research Network is a non-profit partnership dedicated to helping people now by improving the diagnosis and understanding of neurological disorders, and in the future by finding methods of prevention, better treatments and ultimately cures. Based in Albuquerque, New Mexico, Mind scientists collaborate with colleagues at nationally renowned partnering sites across the country.

For more information, please visit our website at www.themindinstitute.org or call us at **505-272-5028** or toll free at **866-254-6463**

The MIND Institute
Pete & Nancy Domenici Hall
1101 Yale Blvd. NE
Albuquerque, New Mexico 87131
505/272-5028
www.themindinstitute.org