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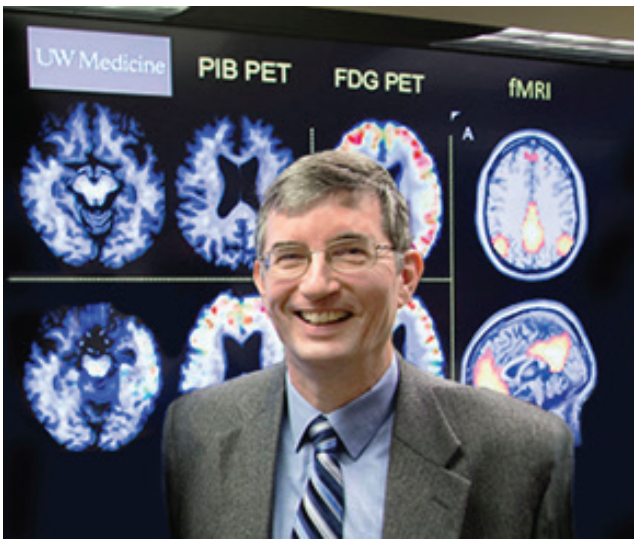
Image Analysis Stretches the Boundaries of Brain Imaging

by Kate Forster



Thomas Grabowski leads a team that assists investigators to navigate the brain imaging space – from the way data are acquired and prepared for analysis to the way data are interpreted.

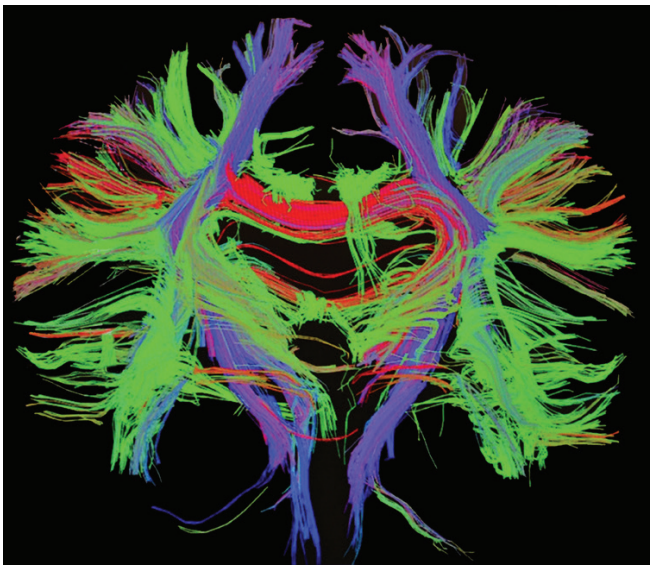
Brain imaging is becoming an increasingly important part of translational neuroscience, and magnetic resonance imaging (MRI) in particular has evolved to the point where scientists can examine the brain's structure and function in great detail. This is especially important in the study of intellectual and developmental disabilities (IDD). Image Analysis is one of four components of the CHDD Brain Imaging Core (BIC), and it helps investigators who want to bring MRI technology to bear on their work by providing the expertise and interdisciplinary understanding needed to effectively employ brain imaging in research addressing scientific questions in the field of IDD. "The Image Analysis Component helps investigators navigate the brain imaging space—from the way data are acquired and prepared for analysis to the way data are interpreted. Probably our most important function is that we provide neuroscientist-level expertise that can help with the experimental design of pilot studies," said Thomas Grabowski, M.D., professor of radiology and neurology, director of the department of radiology's Integrated Brain Imaging Center (IBIC) and CHDD's Image Analysis Component. "We have the expertise to operationalize an investigator's ideas about what's going on in the brain by applying those ideas to the particular tools and techniques that we have available to us. We can advise on which approach is best to take for the question an investigator has. This can save people months and even years of work."

A staff research scientist provides technical guidance to research affiliates as they design their studies. This can include a number of different modes of support, such as integrating images that have been acquired by different methods; providing methods for measuring structural MRI; helping with research methodology; and training on how to use the CHDD mock scanner. The staff research scientist also trains and assists in developing new analysis techniques and in collecting and analyzing neuroimaging data. For research affiliates who collaborate with IBIC, the staff research scientist provides training in the IBIC-supported image processing workflows and technologies, such as morphometric, functional MRI (fMRI), and diffusion tensor imaging (DTI) analysis.

Equipment and technical expertise

The Imaging Analysis Component also provides the necessary infrastructure for neuroimaging and analysis, the cornerstone of which is a high-field 3T MRI scanner. “Depending on how you program the scanner, you can make it sensitive to brain structure or brain function in different ways. The scanner is most frequently used for fMRI imaging. We also look at measures of brain structure and the integrity of the white matter in the brain using a DTI approach. The same diffusion-based MRI can be used to develop more detailed pictures of structural brain connectivity,” noted Grabowski. The Image Analysis Component also uses XNAT, an imaging informatics software platform that can import, archive, process, and distribute imaging and related study data. A wide range of software tools are available to help with functional, diffusion, and structural image processing. Among the available tools are FSL5, SPM8, AFNI, FreeSurfer, BioImage Suite, Brains3, ANTS, MRIcron, and many others, as well as general purpose scientific analysis software, Matlab, and extensive Python libraries. Also available is a MATLAB-based library of software used in advanced analysis of Event Related Potentials. It includes functions such as jitter-analysis, continuous wavelet transformation and wavelet coherence, signal pattern detection, and source analysis based on a Finite Element Method.

Finally, the Image Analysis Component offers task paradigms that can be adapted to a particular application. This is essential when there is a limited amount of time and a single hour spent in the scanner can be costly. “We understand that the amount of time a subject typically spends in the scanner is brief, so we’ve prepared an optimal set of imaging sequences that people need to go through. All those details have been thought about and planned in advance,” said Grabowski.



Diffusion imaging reconstruction of white matter pathways.

“Different MRI techniques provide a privileged view of the brain which can allow for really cutting-edge research in IDD,” said Grabowski. “We can get all sorts of information from these images in a noninvasive way that you can’t get from human subjects in any other way. So it’s a very important technology, and it’s hard to imagine a viable developmental disability program without an imaging component. The area of brain imaging and image analysis has become pretty sophisticated, so you really need expertise on your side, and we want to provide a common resource that is accessible to CHDD affiliates.”

CHDD is an interdisciplinary center dedicated to the prevention and amelioration of developmental disabilities through research, training, clinical service, and community outreach. CHDD includes the University Center of Excellence in Developmental Disabilities and the Eunice Kennedy Shriver Intellectual and Developmental Disabilities Research Center.

CHDD Outlook

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