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A New Role for Diffusion MRI in Treating Anxiety and Depression

- Better understandings of the brain mechanisms of anxiety and depression would help clinicians determine how to treat the disorders.
- Researchers are using advanced MRI technologies to gain such understandings.
- A recently published paper details the latest advances in applying these technologies to studies of neural connectivity, which are helping to elucidate the underlying mechanisms of mental disorders.

Anxiety disorders and depression are widespread among adolescents in the United States, affecting as many as one in four 13-to-18-year-olds. Determining the best treatment can be difficult, though, as the medical community still doesn't fully understand the biology underlying such conditions.

Now, using cutting-edge brain imaging technology, a study under way at Massachusetts General Hospital could offer new insights into this biology, and thus help to improve the ways we approach anxiety and depression. Ultimately, the work could also yield a quantitative means of diagnosing the disorders.

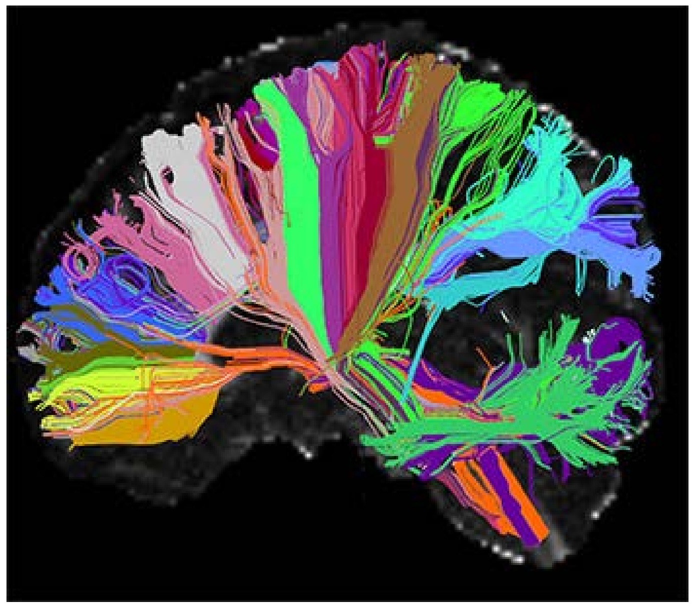

Figure 1. Diffusion MR: This image from a diffusion MRI of the human brain shows long-distance connections within the brain. Wiring associated with particular brain structures is of the same color. The image, by Viviana Siless, PhD, and Anastasia Yendiki, PhD, of Mass General's Athinoula A. Martinos Center for Biomedical Imaging was added to the NIH Image Gallery in June 2016.

Examining Mental Disorders as Part of the Human Connectome

Called the Boston Adolescent Neuroimaging of Depression and Anxiety (BANDA) study, the current research emerged from the Human Connectome Project (HCP), a large-scale, multi-institutional collaboration including the Athinoula A. Martinos Center for Biomedical Imaging at Mass General. Since its launch in 2010, the HCP has demonstrated an extraordinary ability to map the neural pathways in the healthy human brain. Using a range of MRI-based technologies, many of them developed at the Martinos Center, it has already helped to answer many seemingly intractable basic science questions.

Begun in late 2015, the BANDA study is now also applying these technologies to a population of adolescents with anxiety disorders and depression. It is among the first projects funded by the National Institutes of Health to look at a disease population using data-collection protocols developed by the HCP.

The study has been recruiting patients from three sites across Boston, including Mass General's Child Cognitive Behavioral Therapy program, as well as sites at Boston University and McLean Hospital. It also has been recruiting patients from among those presenting to the general child outpatient clinic in the Psychiatry department at Mass General. All of the scanning for the study is done at the Martinos Center using the state-of-the-art MRI instrumentation there.

Diffusion MRI and the Highways and Byways of the Brain

The researchers are exploring the brain mechanisms of anxiety disorders and depression by studying the wiring between different areas of the brain, in particular scrutinizing the white-matter fiber bundles that connect those areas using a technology known as diffusion MRI. Introduced just more than a decade ago, diffusion MRI has already yielded important insights into major pathways in the human brain—the superhighways of neural connectivity. Now, as the technology improves, researchers are able to see smaller pathways, one- or two-lane roads merging with the highways and then pulling away again, twisting and turning toward some other part of the brain.

Imaging these smaller roads is especially important because the changes in connectivity associated with anxiety and depression do not usually disrupt an entire highway. Rather, they are more likely to be subtle disruptions of specific offshoots. For this reason, the investigators have been exploring ways to further refine the reconstruction of white-matter fiber bundles using diffusion MRI.

In a paper recently published online in the journal NeuroImage, the researchers report an algorithm they developed to parse the hundreds of thousands of brain connections obtained from a high-resolution diffusion MRI scan and group them into anatomically meaningful bundles. Typically, such algorithms will bundle connections based on their proximity to one another. This can be problematic, though, as fibers near one another do not necessarily belong to the same pathway. In the paper, Anastasia Yendiki, PhD, and her colleagues—first author Viviana Siless, PhD; Ken Chang; and Bruce Fischl, PhD—present an algorithm that bundles connections based on the surrounding anatomical structures that they pass through or near to. In a validation study using healthy-subject data from the Human Connectome Project, this approach showed a 20% improvement in the overlap with manually defined pathways.

The researchers are already using the algorithm to analyze data from the first year of scanning in the BANDA project. Other applications could also benefit from its use, including studies looking at large data sets with substantial anatomical variability, such as healthy subjects and disease populations like Alzheimer's or epilepsy patients, or healthy subjects across a wide range of ages.

Further Information

For further information about the BANDA study at Mass General, please contact Anastasia Yendiki, PhD, Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital. We would like to thank Dr. Yendiki for her advice and assistance in preparing this article.

Study Enrollment

Patients interested in participating in the study can learn more by contacting Mass General's Child Cognitive Behavioral Therapy program by phone (617-726-6324) or email (banda-mgh@mit.edu). They can enroll in the study using the online sign-up form.

References

Siless V, Chang K, Fischl B, et al. (2017). *AnatomiCuts: Hierarchical clustering of tractography streamlines based on anatomical similarity*. NeuroImage. **166**:32-45.

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