Scientists visualize critical part of basal ganglia pathways

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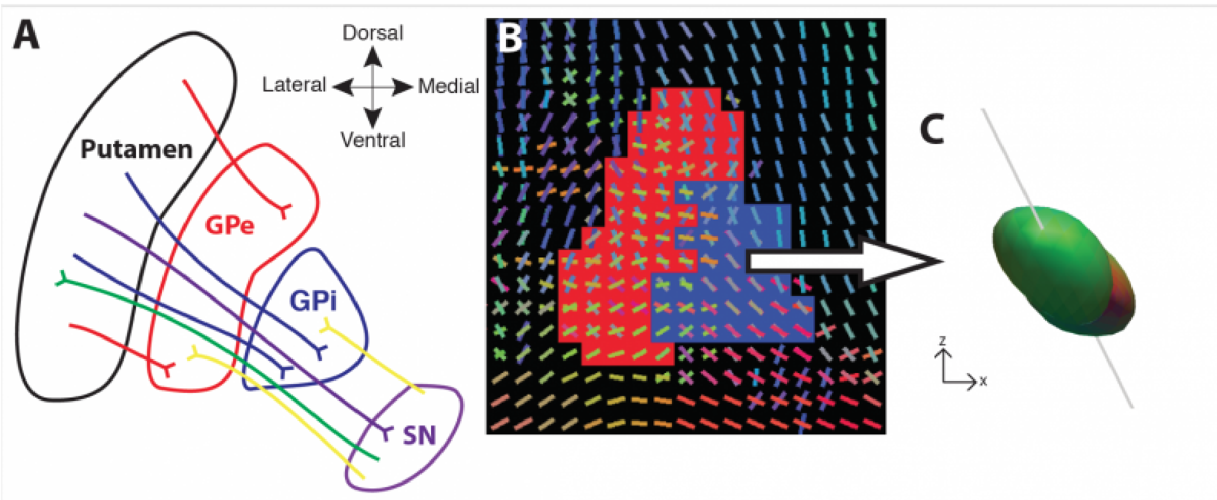

For the first time, Carnegie Mellon University BrainHub scientists have used a non-invasive brain-imaging tool to detect the pathways that connect the parts of the basal ganglia. Schematic of the major fiber pathways through the basal ganglia (A); visualization of the fibers shows their dorsolateral orientation (B,C). Credit: Carnegie Mellon University

Certain diseases, like Parkinson's and Huntingdon's disease, are associated with damage to the pathways between the brain's basal ganglia regions. The basal ganglia sits at the base of the brain and is responsible for, among other things, coordinating movement. It is made up of four interconnected, deep brain structures that imaging techniques have previously been unable to visualize.

For the first time, Carnegie Mellon University BrainHub scientists have used a non-invasive brain-imaging tool to detect the pathways that connect the parts of the basal ganglia. Published in *NeuroImage*, the research provides a better understanding of this area's circuitry, which could potentially lead to technologies to help track disease progression for Parkinson's and Huntington's disease and other neurological disorders.

"Clinically, it is difficult to see the pathways within the basal ganglia with neuroimaging techniques, like the ever popular MRI, because many of the fiber bundles that make up key parts of this circuit are very small and buried within dense cell bodies," said Patrick Beukema, the lead author and a graduate student in the Center for Neuroscience at the University of Pittsburgh (CNUP) and the joint Pitt and CMU Center for the Basis of Neural Cognition (CNBC).

"For reasons that are not fully understood, the pathways that connect the basal ganglia's regions are highly susceptible to damage. Because they are important for motor control, this damage can result in substantial motor deficits, so it is highly desirable to discover more about this area," Beukema said.

Diffusion MRI measures the movement of water molecules to create a visual representation of the brain's axons. In this study, the research team used two types of diffusion imaging to visualize the major pathways that connect the internal circuitry of the basal ganglia. Sixty healthy adults had their brains scanned using diffusion spectrum imaging, which provided a picture of the orientation of moving water molecules. And, multi-shell imaging was used on 78 healthy adults to get similar images using different imaging parameters.

The results from both imaging techniques showed that it is possible to detect the small but important fiber connections in the brain. The researchers also found that by looking at the general patterns of water movement in the basal ganglia, they could automatically distinguish one small brain region from the other.

"The pathways that Patrick has been able to visualize are critical to so many functions, yet we haven't been able to see them in the living human brain before. This opens the door to so many research and clinical opportunities," said Timothy J. Verstynen, assistant professor of psychology in CMU's Dietrich College of Humanities and Social Sciences and CNBC faculty member.

This is not the first brain research breakthrough to happen at Carnegie Mellon. CMU is the birthplace of artificial intelligence and cognitive psychology and has been a leader in the study of brain and behavior for more than 50 years. The university has created some of the first cognitive tutors, helped to develop the Jeopardy-winning Watson, founded a groundbreaking doctoral program in neural computation, and completed cutting-edge work in understanding the genetics of autism. Building on its strengths in biology, computer science, psychology, statistics and engineering, CMU launched BrainHub, an initiative that focuses on how the structure and activity of the brain give rise to complex behaviors.

More information: *NeuroImage*, www.sciencedirect.com/science/ … ii/S1053811915006424

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