New model of how brain functions are organized may revolutionize stroke rehab

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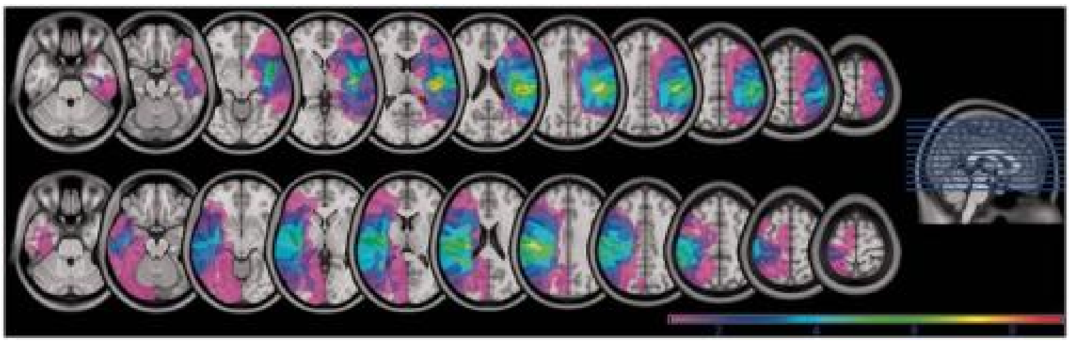

Overlap images showing locations of lesions between groups with right and left hemisphere damage (color scale of magenta to red shows increasing overlap). Lesions are confined to either left or right hemisphere. Credit: Sainburg Lab

(Medical Xpress)—A new model of brain lateralization for movement could dramatically improve the future of rehabilitation for stroke patients, according to Penn State researcher Robert Sainburg, who proposed and confirmed the model through novel virtual reality and brain lesion experiments.

Since the 1860s, neuroscientists have known that the human brain is organized into two hemispheres, each of which is responsible for different functions. Known as neural lateralization, this functional division has significant implications for the control of movement and is familiar in the phenomenon of handedness.

Understanding the connections between neural lateralization and motor control is crucial to many applications, including the rehabilitation of stroke patients. While most people intuitively understand handedness, the neural foundations underlying motor asymmetry have until recently remained elusive, according to Sainburg, professor of kinesiology and neurology and participant in the neuroscience and physiology graduate programs at the University's Huck Institutes of the Life Sciences.

Research by Sainburg and his colleagues in the Center for Motor Control and published in the journal *Brain* has revealed a new model of motor lateralization that accounts for the neural foundations of handedness. The discovery could fundamentally change the way post-stroke rehabilitation is designed.

"Each hemisphere of the brain is specialized for different aspects of motor control, and thus each arm is 'dominant' for different features of movement," said Sainburg. "The dominant arm is used for applying specific force sequences—such as when slicing a loaf of bread with a knife—and the other arm is used for impeding forces to maintain stable posture, such as holding the loaf of bread. Together these specialized control mechanisms are seamlessly integrated into every day activities.

"Our research has shown that this integration breaks down in neural disorders such as stroke, which produces different motor deficits depending on whether the right or left hemisphere has been damaged," Sainburg continued. "Traditionally, physical rehabilitation professionals have used the same protocols to practice movements of the paretic arm, regardless of the hemisphere that has been damaged. Our research shows that each arm should be treated for different control deficits, and it also indicates that therapists should directly retrain patients in how to use the two arms together in order to recover function."

In preparing to test their model, Sainburg and his team selected study participants from the New Mexico Veterans Administration Hospital and Penn State Milton S. Hershey Medical Center based on specific criteria in order to accurately distinguish the motor control mechanisms specific to each brain hemisphere. Participants were then asked to perform a series of tasks on a virtual reality interface, programmed and designed by Sainburg, which allowed the researchers to record detailed 3D position and motion data. The data for all the participants' hand trajectories and final positions were then aggregated to compare the effects of left versus right hemisphere damage on different aspects of control.

"Our results indicated that while both groups of patients showed similar clinical impairment in the contralesional arm, this was produced by different motor control deficits," Sainburg said. "Right hemisphere damaged patients were able to make straight movements that were directed toward the targets, but were unable to stabilize their arms in the targets at the end of motion. In contrast, left hemisphere damaged patients were unable to make straight and efficient movements, but had no difficulty stabilizing their arms at the end of motion. These results confirmed that each hemisphere contributes unique control to its contralesional arm, verifying why our arms seem different when we use them for the same tasks."

Results mirror those of Sainburg's prior studies of motor deficits in unilateral stroke patients, focused on the ipsilesional arm, which formed the basis for his model of lateralization.

"Because both arms in stroke patients show motor deficits that are specific to the hemisphere that was damaged, we have concluded that the left arm is not simply controlled with the right hemisphere and vice versa," Sainburg said. "This is a revolutionarily new perspective on sensorimotor control: each hemisphere contributes different control mechanisms to the coordination of both arms, regardless of which arm is considered dominant."

Sainburg and his colleagues are currently designing follow-up studies that will aid the development of new rehabilitation protocols addressing the specific motor deficits associated with each hemisphere.

Provided by Pennsylvania State University

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