Scientists identify brain circuits used in sensation of touch

October 10 2007

The ability to tactually recognize fine spatial details, such as the raised dots used in braille, is especially important to those who are blind. With that in mind, a team of researchers has identified the neural circuitry that facilitates spatial discrimination through touch. Understanding this circuitry may lead to the creation of sensory-substitution devices, such as tactile maps for the visually impaired.

The findings appear in the Oct. 10 edition of *The Journal of Neuroscience*.

The research team, led by Krish Sathian, MD, PhD, professor of neurology in Emory University School of Medicine, included first author Randall Stilla, research MRI technologist at Emory, and Gopikrishna Deshpande, Stephen Laconte and Xiaoping Hu of the Coulter Department of Biomedical Engineering at Georgia Tech and Emory.

Using functional magnetic resonance imaging (fMRI), the researchers found heightened neural activity in a network of frontoparietal regions of the brain when people engaged in fine tactile spatial discrimination. Within this network, the levels of activity in two subregions of the right posteromedial parietal cortex--the right posterior intraparietal sulcus (pIPS) and the right precuneus--were predictive of individual participants' tactile sensitivities.

To determine which areas of the brain were involved in identifying fine spatial details, the researchers asked 22 volunteers to determine only by touch whether the central dot of three vertically arranged dots was offset to the left or to the right of the other two.

"Using their right index fingers, the subjects got to feel the dots for one second to determine in which direction the central dot was offset," says Dr. Sathian. "We also varied the amount the dot was offset from the other two, which allowed us to quantify people's sensitivity. In other words, we asked what is the minimal offset required to discriminate."

In a separate control task, the subjects were asked to determine how long they were touched by three perfectly aligned dots. Brain activity during that temporal task was contrasted with brain activity during the spatial task. The researchers found that different brain regions showed more activity during either spatial or temporal processing.

"What is interesting is that we found the most relevant areas of the brain for spatial processing are on the right side, the same side of the body that was used to feel the stimuli. This is the opposite side to the one that might be expected," says Randall Stilla.

"We usually think of the left side of the brain as controlling the right side of the body, which is generally true. But more and more we are finding that the right side of the brain is particularly important in many types of sensory processing," adds Dr. Sathian.

Dr. Sathian's and Dr. Hu's laboratories also collaborated to determine the strength and direction of the connections between the areas of the brain that govern tactile spatial acuity (perception). Such collaboration, explains Dr. Hu, allows the application of cutting-edge image analysis methods to fundamental questions in neuroscience.

"We found that there are two pathways into the right posteromedial cortex that not only predict individuals' acuity but also predict the magnitude of neural activation," says Dr. Deshpande, who performed the connectivity analyses. "In better performers, the paths predicting acuity converge from the left somatosensory cortex and right frontal eye field (an attentional control center), onto the right pIPS. What's more, these paths are stronger during spatial discrimination than temporal discrimination."

The researchers are not yet sure why this particular neural pathway exists. Dr. Sathian suggests the signal patterns may be a combination of attentional, tactile, and visual processing reflecting the visualization of the spatial configurations. Future research, he says, will attempt to unravel the mechanisms underlying these different component processes.

Source: Emory University