High-resolution brain mapping taken to next level

Scientists delving into the workings of the human brain show with fMRI the existence of narrow 'columns' in the brain that play a key role in visual perception.

Brain studies took a dramatic advance this week when scientists at RIKEN's Laboratory for Cognitive Brain Mapping reported evidence that what each of your eyes sees can be 'seen' by high-resolution fMRI in specific - but extremely narrow - parts of the brain. Until now medical researchers have been able to determine through post-mortem tests in lab animals that groups of cortical brain cells, such as the visual sectors in the brains of ferrets, physically change with induced activity. Similarly, through specimen staining during autopsy, this could also be identified in humans who had lost function in one eye years before their death. A clear difference between fully and partially sighted individuals is indicated by the cell structure of brain slices viewed under a microscope.

For the first time, researchers from RIKEN Brain Science Institute, Wako, report they could replicate evidence of such changes in brain cells of living human test subjects during high-resolution scanning using functional magnetic resonance imaging (fMRI). Moreover, they were able to determine that each eye effectively leaves its own physical 'imprint' on separate groups of cells. This is a dramatic first in the field of neurological studies at this level, and implies that some brain functions may be mappable to a degree of specificity never before considered possible.

One of the difficulties in such studies has been the nature of the test itself, and the fact that to watch this occur on fMRI the test subjects must be alive, cooperative and virtually immobile. In fact, the researchers made a point of thanking their unnamed test subjects for 'their time and efforts participating in the experiment' in findings published online on October 14 at Nature Neuroscience.

The tests required that the volunteers undergo training on how to keep their heads perfectly still so movement blurring was minimized during multiple high-resolution fMRI scans lasting as long as several minutes. The test subjects were also required to bite down on a stationary 'bite bar' to restrict even slight head movement. Blurring caused by the act of breathing and cranial blood movement was further canceled out by sophisticated post-processing techniques similar to those utilized by astronomers to correct for 'camera shake' and atmospheric distortion when photographing far-off
celestial bodies.
Under such rigorous conditions, the research team, headed by Cheng Kang and Keiji Tanaka, found that in 'ocular columns' of the human brain as narrow as 0.8-1.5 mm (less than the width of a sewing needle), replicable evidence existed of induced changes in predictable groups of brain cells. This has never before been reported to this degree of specificity in human subjects. The researchers also reported the first indication that specific 'temporal frequency' domains, which play an important role in visual movement recognition, exist in primates.

The research is significant because it provides new evidence that highly specific areas may be responsible for certain cortical activities involving visual orientation, spatial perception, left and right eye interaction, and other visual functions. Being able to precisely pinpoint these areas can lead to improved medical and surgical treatments as well as a better understanding of brain function.
The existence of temporal frequency domains in humans also fills a gap in our understanding of physiological processes and human perception of moving images, the researchers noted.

**Original work:**

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