The human brain employs the same neurons in seeing an object and later imagining it, Caltech/UCLA research reveals

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In a study of nine epilepsy patients awaiting brain surgery, researchers have discovered that humans use the same neurons to conjure up mental images that they use when they see the real object with their eyes.

In the November 16 issue of the journal Nature, UCLA neurosurgeon and neuroscientist Itzhak Fried and Caltech neuroscientists Christof Koch and Gabriel Kreiman report on results obtained by questioning nine patients who had been fitted with brain sensors. The patients, all suffering from severe epilepsy uncontrolled with drugs, were being observed for a period of 1-2 weeks so that the regions of their brains responsible for their seizures could be identified and later surgically removed.

During their extended hospital stay, the patients were asked to look at photos of famous people such as President Clinton, pictures of animals, abstract drawings, and other images. While they were looking at the images, the researchers noted the precise neurons that were active.

Then, the subjects were instructed to close their eyes and vividly imagine the images. Again, the researchers took note of the neurons active at the time of visual imagery.

Analysis of the data showed that a subset of neurons in the hippocampus, amygdala, entorhinal cortex, and parahippocampal gyrus would fire both when the patient looked at the image, as well as when he or she imagined the image.

The results build upon previous work by Fried's group showing that single neurons in the human brain are involved in memory and can respond selectively to a wide variety of visual stimuli and stimulus features such as facial expression and gender.

According to Koch, a professor of computation and neural systems at Caltech, the study helps settle long-standing questions about the nature of human imagery. Particularly, the research sheds light on the process at work when humans see things with the "mind's eye."

"If you try to recall how many sunflowers there are in the Van Gogh painting, there is something that goes on in your head that gives rise to this visual image," Koch says. "There has been an ongoing debate about whether the brain areas involved in perception during 'vision with your eyes' are the same ones used during visual imagery."

The problem has been difficult to address because the techniques that yield very precise results in animals are generally not suitable for humans, and because the brain imaging techniques suitable for humans are not very precise, Koch says. Such techniques can image only large portions of the brain, each containing on the order of one million very diverse nerve cells.

"Recording the activity of single cells allows us to investigate the neuronal correlates of visual awareness at a detailed level of temporal and spatial resolution," says Kreiman.

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