Scientists explain inception of perception in the brain

March 5 2007

The taste of champagne, the sound of a train, the flash of a pop fly into left field – indeed all of human perception – begins in the brain's center. That's where sensory information passes from the thalamus to the neocortex for processing.

That critical transfer is a bit of a brain science mystery: Instead of reacting to information from the thalamus with a burst of excitatory chatter, most cortical cells are quickly and strongly inhibited or silenced. Why does that happen?

In new work published in *Nature Neuroscience*, Brown University and University of California–Davis researchers provide the surprising answer.

The research team found that cortical inhibitory cells, which suppress communication, are relatively insensitive to inputs from the thalamus compared with excitatory cells, which encourage communication. Instead, inhibitory cells react strongly because they get much more stimulation from the thalamus. In fact, the researchers found, inhibitory cells get about eight times the amount of neurotransmitter, the signal-spurring chemicals that initiate nerve impulses. The result is that their silencing effect on brain cell communication overrides the noisy effect from their excitatory neighbors.

Scott Cruikshank, an assistant research professor in the Department of Neuroscience at Brown and lead author of the article, said the team's secondary finding was also unexpected. Inhibitory cells in the cortex not only receive more input from the thalamus – they get that input faster than excitatory cells do.

"What we found is that the amount of information these cells receive as well as the speed of their response is what causes this fast inhibition," Cruikshank said. "What's exciting about these findings is that they help to explain how the cortex handles information at the very earliest stages of processing. And understanding the cortex is critical to understanding not only perception, but memory, language, cognition."

Barry Connors, chair of the Department of Neuroscience and the senior scientist on the project, said the findings may also shed light on the causes of some forms of epilepsy, where the brain's ability to inhibit cell activity is hampered.

"If nothing keeps the excitatory cells in check, it's as if all the cells are shouting at once," Connors said, "and that cacophony causes a seizure."

The experiments were conducted by stimulating excitatory and inhibitory cells in the brains of mice with electrodes. But identifying these precise types of cells is akin to finding a needle in a haystack. So Cruikshank and Connors used cells from a mouse carrying a gene that makes its inhibitory cells glow green from a jellyfish protein -- creating a natural flag for the scientists.

Timothy Lewis, an assistant professor of mathematics at the University of California–Davis, made the models used to calculate how the speed of the cortical cells' responses affected their circuit behavior.

Source: Brown University